STANDARD SPECIFICATIONS
FOR
ARTERIAL HIGHWAY CONSTRUCTION

2020

St. Charles County Highway Department
St. Charles, Missouri
The County Engineer has established these specifications pursuant to the authority provided by Article IV, Section 4.702 of the Charter of St. Charles County, Missouri.

This version of the St. Charles County Standard Specifications for Arterial Highway Construction (rev. 7/2020) shall be used on projects awarded after September 1, 2020 and replaces the 2006 version previously published.
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Division 100

GENERAL CONDITIONS
OF THE CONTRACT
### SECTION 101
#### DEFINITION OF TERMS

Wherever the following abbreviations, terms or descriptive words are used in the plans, specifications or other contract documents, the intent and meaning shall be interpreted as follows:

**101.1 Abbreviations.**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAN</td>
<td>American Association of Nurserymen</td>
</tr>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>AISC</td>
<td>American Institute of Steel Construction</td>
</tr>
<tr>
<td>AGC</td>
<td>Associated General Contractors of America</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AREA</td>
<td>American Railroad Engineering Association</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>ASTM International</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
</tr>
<tr>
<td>AWPA</td>
<td>American Wood-Preservers’ Association</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CS</td>
<td>Commercial Standards, U. S. Department of Commerce</td>
</tr>
<tr>
<td>CSR</td>
<td>Code of State Regulations</td>
</tr>
<tr>
<td>COE</td>
<td>Corps of Engineers</td>
</tr>
<tr>
<td>CUF</td>
<td>Commercially Useful Function</td>
</tr>
<tr>
<td>DBE</td>
<td>Disadvantaged Business Enterprise</td>
</tr>
<tr>
<td>EEI</td>
<td>Electrical Engineer’s Institute</td>
</tr>
<tr>
<td>EEO</td>
<td>Equal Employment Opportunity</td>
</tr>
<tr>
<td>EMPC</td>
<td>Eastern Missouri Pavement Consortium</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>EPG</td>
<td>Engineer Policy Guide</td>
</tr>
<tr>
<td>ESAL</td>
<td>Equivalent 18-kip Single Axle Load</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Ground Granulated Blast Furnace Slag</td>
</tr>
<tr>
<td>GRI</td>
<td>Geosynthetic Research Institute</td>
</tr>
<tr>
<td>ICEA</td>
<td>Insulated Cable Engineers Association</td>
</tr>
<tr>
<td>IMSA</td>
<td>International Municipal Signal Association</td>
</tr>
<tr>
<td>ITE</td>
<td>Institute of Transportation Engineers</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>MASH</td>
<td>AASHTO Manual for Assessing Safety Hardware</td>
</tr>
<tr>
<td>MDC</td>
<td>Missouri Department of Conservation</td>
</tr>
<tr>
<td>MDNR</td>
<td>Missouri Department of Natural Resources</td>
</tr>
<tr>
<td>MGS</td>
<td>Midwest Guardrail System</td>
</tr>
<tr>
<td>MHTC</td>
<td>Missouri Highways and Transportation Commission</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Missouri Department of Transportation</td>
</tr>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheet</td>
</tr>
<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
</tbody>
</table>
101.1.1 Unit Symbols.

- **h**  hour
- **ppm**  parts per million
- **rpm**  revolutions per minute
- **pm**  vibrations per minute
- **cf**  cubic feet
- **cy**  cubic yards
- **F**  degrees Fahrenheit
- **ft**  foot/feet
- **in**  inch/inches
- **lb**  pound/pounds
- **lf**  linear foot/feet
- **psf**  pounds per square foot
- **psi**  pounds per square inch
- **sf**  square foot/square feet
- **sy**  square yard/square yards

101.2 Definitions of Terms.

**Advertisement.** The public announcement, as required by law, inviting bids for work to be performed or material to be furnished.
**Appreciable Error.** An increase in excess of 125 percent or decrease below 75 percent of the original contract quantity of an item where final measurements are not made to determine quantity for payment.

**Auxiliary Lane.** The portion of the roadway adjoining the traveled way and designated for speed change, or for other purposes supplementary to through traffic movement.

**Award.** The action of the County Council accepting the bid of the lowest responsible bidder for the work, subject to the execution and approval of a satisfactory contract therefor and bond to secure the performance thereof, and to such other conditions as may be specified or as required by law.

**Bid.** The written offer submitted by the bidder in the required manner on the bid to perform the work provided in the bidding documents at contract bid prices.

**Bid Guaranty.** The security furnished with a bid to ensure that the bidder will enter into the contract if the bid is accepted.

**Bid Records.** All writings, working papers, computer printouts, charts and all other data compilation that contain or reflect information, data or calculations used by the bidder to determine each contract unit price in the bid submitted, including but not limited to material relating to the determination and application of:

- labor rates
- equipment rates
- home and field overhead rates and related time schedules
- efficiency or productivity factors
- arithmetic extensions
- subcontractors, truckers and material supplier quotations
- profit
- contingencies

Any manuals standard to the industry that are used by the bidder in determining the bid shall be included in the bid records by reference and shall show the name and date of the publication and the publisher.

**Bidder.** Any individual, partnership, corporation, joint venturer or other entity submitting a bid to perform the contemplated work.

**Bidding Documents.** The documents furnished by the County comprising the Request for Bid, plans, *Missouri Standard Plans for Highway Construction, St. Charles County Standard Plans for Highway Construction*, addenda, Supplemental Specifications and General Provisions, *St. Charles County Standard Specifications for Arterial Highway Construction*, the Standard Drawings included in the *Metropolitan St. Louis Sewer District Standard Construction Specifications for Sewers and Drainage Facilities* and all other documents included in or referred to in those documents.

**Bridge.** A structure having a clear span greater than 20 feet measured on a horizontal plane along the centerline of roadway; also a multiple span structure where the total length of spans is in excess of 20 feet. For both single and multiple span bridges, the clear span shall be construed to mean the total distance from stream face to stream face of end bents or outer walls of the structure.

**Business Day.** A day that St. Charles County Government is open for business, excluding holidays, Saturdays and Sundays.

**Calendar Day.** Any day of the calendar year, including holidays, Saturdays and Sundays.
**Change Order.** A written order from the Engineer to the Contractor, as authorized by the contract, directing changes in the work as made necessary or desirable by unforeseen conditions or events discovered or occurring during the progress of the work.

**Change in the Work.** An item of work not provided for in the contract as awarded, but found essential to the satisfactory completion of the contract. Contract adjustments for changes in work related to differing site conditions shall be determined in accordance with the contract provisions relating to differing site conditions.

**Claim.** A written request or demand for adjustment to the compensation due or time of performance of the contract made within the time, in the form, and pursuant to the provisions for such contract adjustments specified elsewhere in the contract documents of which these specifications are a part.

**Commission.** The Missouri Highways and Transportation Commission.

**Contract.** The written agreement between the County and the Contractor covering the performance of the work for the proposed construction. The contract will include all contract documents.

**Contract Bond.** The form of security approved by the County, furnished by the Contractor and surety or sureties, guaranteeing complete performance of the contract and the payment of all legal debts pertaining to the construction of the project, or arising from the contract and the duties thereunder, and conditioned as may be required by the laws of the State of Missouri and St. Charles County.

**Contract Documents.** Notice to Contractors, all Bidding Documents, Contract Bond, Contract Agreement, Acknowledgment, Contractor Questionnaire which is filed with MoDOT, Notice to Proceed, and all Change Orders.

**Contract Time or Completion Date.** The number of working days or calendar days shown in the bidding document as the time allowed for the completion of the work contemplated in the contract. If a calendar date for completion is shown in the bidding document, the contemplated work shall be completed by that date.

**Contractor.** The individual, partnership, corporation or joint venture undertaking performance of the work under the terms of the contract, and acting directly or through the Contractor or Contractor's agents, employees or subcontractors.

**Controversy.** A dispute or disagreement between a Contractor and the County related to interpretation of contract documents or the Engineer’s decision under contracts entered into by the Contractor with the County made in writing and in compliance with the requirements for resolutions of controversies under the contract, but which is not a claim under the contract, all as provided elsewhere in the contract documents of which these specifications are a part.

**Cost.** Cost will mean the actual cost incurred, as distinguished from forecasted cost and determined in accordance with prevailing principles applicable to public contracts including *Contract Cost Principles and Procedures*, 48 CFR, Part 31 and *Government Auditing Standards*, as published by the Comptroller General of the United States.

**County.** St. Charles County, Missouri including the St. Charles County Highway Department.

**County Council.** County Council of St. Charles County.

**County Counselor.** County Counselor of St. Charles County.

**County Executive.** County Executive of St. Charles County.

**County Engineer.** Director of St. Charles County Highway Department, County Engineer of St. Charles County.
**Crashworthy End Terminal.** This term will apply to both crashworthy end terminals and crash cushions.

**Culvert.** A structure not classified as a bridge that provides an opening under any portion of a roadway.

**Days.** Days as used in the contract documents will mean calendar days, unless specified otherwise.

**Delay.** Any event, action, force or factor that causes the established contract time to be exceeded for performance of the contract.

(a) **Excusable Delay.** A delay to the contract or milestone completion date that was beyond the Contractor’s control and not caused by the Contractor’s fault or negligence and for which a contract or milestone time extension may be granted.

(b) **Noncompensable Delay.** An excusable delay for which the Contractor may be entitled to an extension of time, but no additional monetary compensation.

(c) **Nonexcusable Delay.** A delay to the contract or milestone completion date that was reasonably foreseeable and within control of the Contractor, for which no monetary compensation or time extension will be granted.

**Differing Site Conditions.** Subsurface or latent physical conditions at the site differing materially from those indicated in the contract, or unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the work.

**Disadvantaged Business Enterprise, or DBE.** A contracting firm certified to participate in U.S. Department of Transportation financial assistance programs as a DBE by MoDOT or by the Missouri Unified Certification Program (UCP) pursuant to Title 49 CFR, Part 26, and pursuant to Title 7 CSR Division 10, Chapter 8, governing MoDOT’s DBE Program.

**Divided Highway.** A highway with separated traveled ways for traffic in opposite directions. Traveled ways separated by painted medians will not be considered divided.

**Drainage Ditch.** An open depression constructed for the purpose of carrying off surface water.

**Engineer.** The county Engineer or any other authorized representative of the County. Where the term county Engineer is used, the term shall mean the county Engineer in person.

**Equitable Adjustment.** An adjustment to the time or price specified in the contract based upon Contractor's actual and reasonable costs to perform the work for the reasons and determined by the methods specified elsewhere in the contract documents.

**Extent of the Federal Share.** The percentage of federal participation in the costs of the project agreed to between USDOT, FHWA, MHTC, and St. Charles County before the project is awarded. It does not mean, with regard to contract adjustments, an amount of additional federal participation to be provided regarding the project.

**Highway.** A public way for purposes of vehicular travel, including the entire area within the right of way.

**Holidays.** St. Charles County public legal holidays are:

- January 1 - New Year's Day
- Third Monday in January - Martin Luther King Day
When any of the above holidays fall on a Sunday, the holiday will be observed on the following Monday; when any
of the above holidays fall on a Saturday, the holiday will be observed on the immediately preceding Friday.

**Laboratory.** Any testing laboratory that may be designated by the Engineer for inspecting and determining the
suitability of material.

**Lead Workers.** Hourly employees in direct charge of the specific operations on a project. Formerly referred to as
the foremen.

**Local Traffic.** Traffic that has either its origin or its destination at some point within the limits of the project. Local
traffic will also include that traffic on all side roads that lead into the project where such traffic does not have a
satisfactory outlet over a public road or street.

**Major and Minor Items of Work.** Any item having an original value in excess of 10 percent of the original contract
amount will be considered as a major item or items. All other original contract items will be considered as minor.
Where major contract items are not identified, the original contract item of greatest total cost, computed from the
original contract price and estimated quantity, and such other original contract items next in sequence of lower
total cost, computed in like manner, necessary to show a total cost at original prices and quantities of no less than
60 percent of the original contract cost will be considered as a major item or items.

**Median.** The portion of a divided highway separating the traveled ways for traffic in opposite directions.

**Notice of Bid Opening.** The notification provided prospective bidders, containing a description of the proposed
work, instructions, information and the reservation of the right of the County to reject any and all bids.

**Notice to Contractors.** The document contained in the bidding document describing the work to be performed and
including information and requirements for the submission of bids.

**Notice to Proceed.** The written notice from the Engineer notifying the Contractor of the date on or before which
prosecution of the work is to begin.

**Outer Roadway or Service Road.** A roadway auxiliary to and located on the side of the throughway for service to
abutting property and adjacent areas.

**Pay Item.** An item of work specifically described and for which a price, either unit or lump sum, is provided. It
includes the performance of all work and the furnishing of all labor, equipment and material contemplated or
described on the plans or in the text of the specification item included in the contract.

**Plans.** Detailed construction drawings or reproductions thereof, which show the location, character and details of
the work. When referenced in the contract documents, plans will include both the project specific drawings and the
standard drawings.
Project. The specific section of the highway, including all appurtenances and construction to be performed thereon under the contract.

Request for Bid. The document furnished by the County that includes a complete set of bidding forms and appendices, and certain contract terms, which are made a part of the bidding document by reference.

Right of Way. Land acquired by the County for the construction and maintenance of a highway.

Roadbed. The graded portion of a highway between the outside shoulder lines, including the base course, surface course, shoulders and median.

Roadway. The portion of the highway within the limits of construction, including bridges and other structures.

Sec. Refers to sections in the standard and supplemental specifications unless specified otherwise in the contract documents.

Shoulder. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Shall. When used in the contract documents, states a mandatory duty on the part of the Contractor.

Significant Change in the Work. When the character of the work, as altered, (1) differs materially in kind or nature from that involved or included in the original proposed construction or (2) when a major item of work as defined elsewhere in the contract is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity.

Specifications. The compilation of provisions and requirements for the performance of prescribed work.


(b) Supplemental Specifications. Approved additions and revisions to the standard specifications.

(c) Special Provisions. Revisions to the standard and supplemental specifications applicable to an individual project.

State. The State of Missouri, acting by and through the Commission.

Subcontractor. Any individual, partnership, corporation, joint venture or other entity to whom the Contractor, with the written consent of the Engineer, sublets any part of the work under the contract.

Substructure. That part of a bridge structure below the bearings of simple and continuous spans; all buttresses and piers below the skewbacks of arches; all parts of rigid frames, or integral bents below tops of footings or tops of caissons; and also, all parts of the abutments, backwalls and wingwalls, except handrails and handrail posts.

Superstructure. All parts of a bridge structure not defined as substructure.

Surety. A corporate body duly authorized to do business in the State of Missouri, and which has executed a bid bond with the bidder or a contract bond with the Contractor.

Temporary Structures. Structures required for the use of traffic while construction is in progress and not designated to remain a part of the permanent roadway.
Throughway. A general term denoting a highway primarily for through traffic, usually on a continuous route.

Through Traffic. Traffic which has neither its origin nor its destination within the limits of the project.

Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Unbalanced Bid, Materially. A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the County.

Unbalanced Bid, Mathematically. A bid containing lump sum or unit bid items that do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder’s anticipated profit, overhead costs and other indirect costs.

Will. When used in the contract documents, states a mandatory duty on the part of the Engineer or department or on the part of both the Engineer or department and the Contractor, which is indicated by the context of use.

USA. Any of the 50 states, the District of Columbia, Puerto Rico and any other territories and possessions of the United States of America.

Work. The furnishing of all labor, material, equipment and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all of the duties and obligations imposed by the contract.

Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans or similar data which the Contractor will be required to submit to the Engineer for approval.
102.1 Notice of Bid Opening. After the date is fixed for the receipt of bids, the notice of bid opening will be posted on St. Charles County’s website and published as required by law. The notice of bid opening will contain a description of the proposed work, instructions and information to the potential bidder regarding bid forms, plans, specifications, and the reservation of the right of the County to reject any and all bids.

102.2 Contractor Questionnaire. Each prospective bidder, including a joint venture, shall file a Contractor questionnaire on the form furnished by the Commission, which is available on MoDOT’s website. The Contractor questionnaire shall be furnished to the Commission as a separate document apart from any other document submitted. A bid will not be considered responsive unless a fully responsive Contractor questionnaire is on file with the Commission at least seven days prior to the time set for the opening of the bids. A new Contractor questionnaire shall be filed annually, except the Commission reserves the right to request a Contractor questionnaire from any Contractor as of any date if the Commission has shown reason to believe that the Contractor’s experience data may have changed from that shown on the questionnaire on file. This document shall include a record of the bidder’s experience data. The County will use this information as an aid to determine in each instance the lowest responsible bidder and nothing contained herein shall be construed as depriving the County of the County’s discretion in the matter of determining the lowest responsible bidder.

102.2.1 At any time prior to award, as a condition of award and for a period of three years after the date of final acceptance, the County may request true copies of the bidder’s financial data, including the bidder’s balance sheet, profit and loss statement and similar financial data, as of the close of the bidder’s most recent fiscal year prior to submission of the bid, and for each fiscal year between the contract award and final acceptance of the contract work. Unless specified otherwise by the County, financial data shall be prepared by an accountant and audited financial data shall be provided if it is available to the bidder for the fiscal period requested. A bidder who has not closed the first fiscal year prior to the date of the request shall supply the last periodic balance sheet, profit and loss statement and similar data.

102.2.2 The Contractor questionnaire contains an affidavit of labor standards compliance. Each prospective bidder shall execute the affidavit, stating that such bidder will fully comply with all written requests by the Missouri Department of Labor and Industrial Relations, Division of Labor Standards, to provide information for the purpose of establishing a prevailing wage.

102.2.3 The prospective bidder, if a corporation, shall submit with the Contractor questionnaire, a copy of the bidder’s current annual registration report or initial registration report if a new corporation, on file with the Corporation Division of the Missouri Secretary of State's Office. Each corporation that is a party to a joint venture shall submit the same required report with the corporation’s joint venture Contractor questionnaire.

102.2.4 A prospective bidder doing business in the State of Missouri under a fictitious name shall furnish to or have on file with the Commission a certified copy of the prospective bidder’s registration of the fictitious name issued by the Missouri Secretary of State, as an enclosure with the Contractor questionnaire. St. Charles County may also request a copy of the registration. No contract will be executed by the County until such a certificate is furnished by the bidder.

102.2.5 All prospective bidders who are corporations organized in states other than Missouri or countries other than the USA shall furnish, at the prospective bidder’s cost, a certified copy of a current certificate of authority to do business in Missouri, with said certificate to remain on file with the Commission. Such a certified copy may be secured from the corporation supervisor in the Office of the Secretary of State, Jefferson City, Missouri. The prospective bidder agrees to cause the prospective bidder’s authority to do business as a foreign corporation to be continued and extended throughout the life of any contract awarded and until all claims thereon and thereunder
shall have been finally settled. All prospective bidders shall have a valid certificate of authority to transact business in Missouri at the time of bid opening as a condition of responsiveness.

102.3 Bidding Documents. Bidding documents and addendums will be available on the County’s website. The documents will state the location, description and requirements of the contemplated construction and will show the estimate of the various quantities and types of work to be performed or material to be furnished, and will have a schedule of items for which unit bid prices are invited. The bidding documents will state the time in which the work shall be completed, the amount of the bid guaranty and the date, time and place of the opening of bids.

102.3.1 All papers bound with, attached to, or referenced in the bidding documents will be considered a part thereof and shall not be detached or altered when the bid is submitted.

102.3.2 The St. Charles County Standard Specifications for Arterial Highway Construction, St. Charles County Standard Plans for Highway Construction, Missouri Standard Plans for Highway Construction, the Standard Drawings included in the Metropolitan St. Louis Sewer District Standard Construction Specifications for Sewers and Drainage Facilities, including all revisions of these documents, and other items referenced in the bidding documents, whether attached or not, will be considered a part of the bid.

102.3.3 A prospective bidder will be expected to obtain the current edition of the St. Charles County Standard Specifications for Arterial Highway Construction, St. Charles County Standard Plans for Highway Construction, Metropolitan St. Louis Sewer District Standard Construction Specifications for Sewers and Drainage Facilities, and the Missouri Standard Plans for Highway Construction, including all revisions of these documents.

102.3.4 It will be conclusively presumed that all of the bidding documents are in the bidder's possession and that these documents have been reviewed and used by the bidder in the preparation of any bid submitted. A copy of the latest version of these documents is available at St. Charles County Highway Department.

102.4 Interpretation of Quantities in Bid Schedule. The quantities appearing in the bid schedule are estimated only and are prepared for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted in accordance with the contract, except where final measurements are not made, as hereinafter provided. The quantities of work to be done and material to be furnished may each be increased, decreased or omitted as hereinafter provided.

102.5 Examination of Plans, Specifications, Special Provisions and Site of Work. The Engineer will provide plans and specifications to the Contractor providing direction on the work required. Conditions indicated on the plans and in the bidding documents represent information available from surveys and studies. The bidder is expected to carefully examine the proposed work site and bidding documents before submitting a bid. Submission of a bid will be considered proof that the bidder has made an examination and is satisfied with the conditions to be encountered in performing the work.

102.5.1 Other documentary information, consisting of boring logs and other factual subsurface information that does not constitute part of the contract or contract documents, will be available from the Engineer upon the bidder's written request. This information, used for project design and quantity estimation purposes, was not obtained to determine actual subsurface conditions, actual quantities of subsurface material or appropriate construction methods, nor shall this information be considered a representation of actual conditions to be encountered during construction. Furnishing this information does not relieve a bidder from the responsibility of making an investigation of conditions to be encountered, including but not limited to site visits, and basing the bid on information obtained from these investigations and the professional interpretation and judgment of the bidder. The bidder shall assume the risk of error if the information is used for any purposes for which the information was not intended. The County makes no representation as to the accuracy of the logs or other subsurface information, since the accuracy of this information is limited by the equipment used, the personal judgment of the persons making the investigation, and by the limited number of samples taken. Records indicate conditions encountered
only at the times and the specific locations shown. Ground water observations are not routinely recorded in all boring logs. The absence of such data does not mean ground water will not be encountered. An indication of ground water constitutes no representation or warranty as to where ground water will be found, nor its volume or artesian character, during the project work. Any assumptions a bidder may make from this data is at the bidder’s risk; none are intended by the County.

102.5.2 Certain other documents in the County’s possession relating to subsurface investigations are not included in the records made available to bidders under Sec 102.5.1. These documents include correspondence and reports containing interpretations, opinions and recommendations that may or may not be factual, accurate or consistent with design decisions. Any such information that does not constitute part of the contract or contract documents is available, at a nominal cost, from the Engineer upon specific, written request by the prospective bidder. The bidder is cautioned that any and all such interpretations, conclusions and recommendations are not represented or warranted to be accurate or reliable and the County cannot be bound by them, whether or not the County may appear to have "relied" on them. These subjective findings, opinions or assumptions have not been confirmed or shown to be reliable and the bidder assumes the sole risk of liability or loss if the bidder does rely on these documentary interpretations and conclusions to its detriment, delay or loss.

102.5.3 The bidder assumes all risks that may be encountered in basing the order of work, equipment or personnel determinations, time of performance, cost of performance, working days needed, item bid prices or any other element of the work, on documents that the bidder obtains from the County, which are not expressly warranted.

102.5.4 Unless stated specifically and expressly in the bidding documents, no project involving excavation, which may include either borrow or the disposal of excess material, is represented or warranted to be a "balanced" job or project, regardless of whether the bidding documents use terms such as "balance points" or other terms that could be interpreted to suggest balance. Whether or not such projects involving excavation contain bid items for borrow or disposal of excess material, the bidder should assume that either is possible and investigate those possibilities accordingly in determining a bid.

102.5.5 Status of Utility Relocations Bidder Responsibility. Utilities are often in the process of relocation at the time a project is bid. Regardless of what utilities are shown in the bidding documents and utility locations listed, the bidder shall contact each area utility to determine the presence and location of utility lines. The bidder shall determine and shall assume the risk as to whether utilities that are to be relocated by the utility companies have in fact been relocated and if not, when the utility company anticipates the relocation shall be completed. The bidder shall independently determine the reliability of the information received from the utility companies and shall make the determination as to the sequence and timing of utility relocations in determining a bid.

102.5.6 The bidder and Contractor has an affirmative duty to inquire and obtain from the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC), from the USACE and any other cognizant government agency, historic weather and water stage information which the bidder may consider important as guides for bidding and scheduling the work. Some of that information may be contained among the bidding documents solely as a convenience and is not warranted nor represented to any degree to be complete and accurate historic data. No warranty or representation whatsoever is made or intended by the County of future weather conditions during the project. Water stages and depths of water at any place or at any time within the area of the project are acknowledged to be beyond control of the County and dependent upon future weather conditions and actions by other governmental bodies, such as the government of the USA or third parties. The County makes no representation that other governmental bodies or third parties will not take action during the period of the contract or any extended time of contract performance, which will affect water stages or depths. Bidders are put on notice that the bidder’s operations may be affected by water flows, siltation and other causes over which it is acknowledged the County has no control.

102.6 Sales and Use Taxes. This project is exempt from all Missouri sales and use tax per Missouri State regulations. Inasmuch as all Missouri sales tax will be exempt, CONTRACTORS shall not include any sales tax in their proposal.
Compliance with these tax savings procedures is compulsory and for the benefit of the COUNTY. A copy of the procedure to be followed to obtain this exemption will be furnished to the successful BIDDER. BIDDERS shall include in their proposals any other sales or use taxes which they are required by law to pay.

102.7 Preparation of Bidding Documents. All bids shall be properly signed, sealed and submitted in accordance with Sec 102.10. Each bidder shall specify in the bid, in figures, a unit price for each of the separate items listed in the bidding documents, except a unit price entry will not be necessary for those items having a quantity of one and only the amount for that item need be entered. Zero will be considered a valid bid. The bidder shall not enter zero in any "Unit Price" field unless zero is the intended bid for that item. A unit price left blank, with or without an extension, other than items having a quantity of one, will be considered as zero by the County. In case of alternate items, unit prices shall be entered for only one alternate, unless otherwise specified in the bidding documents. Bids shall not contain interlineations, alterations or erasures except as noted in Sec 102.7.1. The bidder shall show the products of the respective unit prices and quantities in the amount column provided for that purpose. These extensions shall be totaled and in case of errors or discrepancies in extensions, the unit prices shall govern. All entries in the bid shall be in ink. If, in the sole discretion of the Engineer, an obvious and apparent clerical error exists in the unit price listed for an item due to a misplaced decimal, but the extension appears to be correct and as intended in all respects, the Engineer may correct the unit price bid in accordance with the extension listed. All errors in extensions or totals will be corrected by the Engineer and such corrected extensions and totals will be used in comparing bids.

102.7.1 A bidder may alter or correct a unit price, lump sum bid, or extension entered on the bid form by crossing out the figure with ink and entering a new unit price, lump sum bid or extension above or below in ink, with the bidder’s initials.

102.7.2 Not Used

102.7.3 The bid of an individual, including those doing business under a fictitious name, shall include the signature and address of the individual. The signature shall be exactly the same as that appearing on the Contractor questionnaire.

102.7.4 The bid by a partnership or joint venture, including individuals doing business under fictitious names or corporations, shall be executed by at least one of the partners followed by the title "Partner" or one of the joint venturers followed by the title "Joint Venturer" and the business address of the partnership or joint venturer shown. The true legal name and address of each partner and joint venturer shall also be shown and shall appear exactly the same as that shown on the Contractor questionnaire.

102.7.5 The bid by a corporation, whether acting alone or as a joint venturer, shall show the address and name of the corporation exactly as shown on the Contractor questionnaire, and shall include the signature and title of a person authorized by its board of directors to bind the corporation.

102.7.6 Each bidder shall submit with each bid a sworn statement, executed by or on behalf of the bidder to whom a contract may be awarded, certifying that the bidder has not, either directly or indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with the bid or any contract that may result from its acceptance.

102.7.7 A bid will not be accepted or considered if the bid is the product of collusion among bidders, if the bidder is disqualified or determined not responsible or if the bid is irregular in accordance with Sec 102.8.

102.8 Irregular Bids. Bids that are not completed in accordance with the bidding documents that show any omissions, false statements or certifications, alterations of form, additions not called for, conditional or alternate bids unless called for, irregularities of any kind, or that are not responsive to the request for bids may be rejected. Bids combining or otherwise tying sections or projects not listed in the bidding documents, as being in combination
will be rejected. Any comment in the bid limiting or qualifying the reserved right of the County to make awards that will be to the best interest of the County, will constitute an irregular bid.

102.8.1 A bid will be considered irregular and may be rejected as non-responsive if any of the unit bid prices are mathematically or materially unbalanced to the detriment of the County.

102.8.2 A bid submitted on the "Request For Bid" document and that is otherwise complete and fully executed, will not be deemed an irregular bid and will not be subject to rejection by the County.

102.9 Bid Guaranty. No bid will be considered unless accompanied by a certified check or cashier's check on any bank or trust company insured by the Federal Deposit Insurance Corporation, payable to St. Charles County, for no less than five percent of the amount of the bid, or by a bond secured by an approved surety or sureties in accordance with Sec 103.4.2 and Sec 103.4.3, for no less than five percent of the amount of the bid. Bid bond forms shall be complete and correct at the time of submittal or the bid may be considered non-responsive. The bid bond power of attorney shall be an original document, not a facsimile. Bids accompanied by bid guaranties that are not in accordance with this section or accompanied by bid bonds that are not issued by an approved surety will be rejected.

102.10 Delivery of Bids. Bids shall be submitted in sealed envelope clearly marked in accordance with the bidding instructions. If sent by mail, the sealed bid shall be addressed to the County at the address specified in the bidding documents. All bids shall be filed prior to the time and at the place specified in the notice to Contractors. Bids received after the time for opening of bids will be returned to the bidder unopened.

102.11 Withdrawal or Revision of Bids. A bidder may withdraw or revise a bid after the bid has been deposited with the County provided the revision or the request for such withdrawal is received in writing by the County, at the address specified in the bidding documents, before the time set for opening bids.

102.12 Not Used

102.13 Public Opening of Bids. Bids will be opened and the bid totals read publicly at the time and place indicated in the notice to Contractors.

102.14 Disqualification of Bidders. Any one or more of the following reasons may be considered as being sufficient for the disqualification of a bidder and the rejection of the bid or bids:

(a) More than one bid is received for the same work from an individual, firm or corporation under the same or different name, or from different firms or corporations having common ownership, control or “Principals” that are affiliated, as described in Sec 108.13. However, a bidder may submit a bid as principal and as a subcontractor to some other principal or may submit a bid as a subcontractor to as many other principals as the bidder desires and by so doing will not be liable to disqualification in the intent of this specification.

(b) There is reason for believing that collusion exists among the bidders. Participants in such collusion will receive no recognition as bidders for any future work of the County until any such participant has been reinstated.

(c) The bidder or any officer, shareholder, owner or director of the bidder, has been terminated, debarred or suspended as an eligible Contractor or bidder by any agency of the USA, the State of Missouri, St. Charles County or any other state or any city, county, municipal corporation or other political subdivision.

(d) The Commission or the County has determined or finds that the bidder is not responsible.

(e) The bidder is a person or firm not a resident of Missouri and has failed or refused to comply with the
Missouri laws relating to nonresident or transient employers or is prohibited by Section 285.230 RSMo from contracting for or performing labor on a Missouri public works project.

102.15 Right to Reject Bids. The County reserves the right to reject any bid and also the right to reject all bids. All bids may be rejected for, without limitation, the following reasons:

(a) If in the opinion of the majority of the members of the County Council, the lowest bid or bids are excessive.

(b) The advertised bidding or contract documents are inadequate, ambiguous or otherwise deficient in any respect.

(c) The construction of all or any part of the project is no longer required.

(d) The bids received indicate that the quality requirements in the bidding or contract documents were overstated.

(e) The bidding and contract documents did not include all of the intended evaluation factors.

(f) The bids were not independently arrived at in open competition.

(g) There are indications that any of the bids were collusive or were submitted in bad faith.

(h) The bids received did not provide sufficient competition to ensure adequate price.

102.16 Opportunity to Partner. The successful bidder may enter into a cooperative partnership agreement with the County for the contract. The objective of this agreement will be the effective completion of the work, on time and to the standard of quality that will be a source of pride to both the County and the Contractor. The “Partnering” agreement will not affect the terms of the contract. The agreement will only establish an environment of cooperation between the parties. All terms of any cooperative partnership agreement are subject to approval by the County Engineer.

102.17 Disadvantaged Business Enterprise Program Bidding Requirements. Refer to the General Provisions for DBE Program Requirements.

102.18 Certifications. The bidder makes the following certifications by signing and submitting the bid.

102.18.1 Certification Regarding Affirmative Action and Equal Opportunity. If the bidder does not meet all requirements set forth in sub-paragraphs (a), (b) and (c) of this section, then the bidder shall submit a statement indicating which elements the bidder has complied with and those elements that are not in fact true and correct. The statement shall be on company letterhead, signed by the bidder and inserted inside the submitted bid. The bidder shall provide the following elements:

(a) The bidder has developed and has on file at each of the bidder’s establishments affirmative action programs pursuant to 41 CFR Part 60-2.

(b) The bidder has participated in a previous contract or subcontract subject to the equal opportunity clause set forth in 41 CFR 60-1.4 and Executive Order No. 11246.

(c) The bidder has filed with the Joint Reporting Committee, the Director of the Office of Federal Contract Compliance Programs or the Director’s designate or the EEO Commission, all reports due under the applicable filing requirements contained in 41 CFR, Part 60-1.
This certification applies to and shall be executed by each bidder or proposed subcontractor if the proposed contract or subcontract on this project will equal or exceed $10,000.00. This certification will also apply to any Contractor or subcontractor that has contracts or subcontracts on federally assisted projects in any 12-month period that have or can reasonably be expected to have an aggregate total value exceeding $10,000.00, 41 CFR 60-1.5(a)(1). The prime Contractor shall assure that each of the subcontractors that meet the criteria will also execute and submit this certification to the County.

102.18.2 Certification Regarding Disbarment, Eligibility, Indictments, Convictions or Civil Judgments. The president or authorized official of the bidder, under penalty of perjury under the laws of the USA, shall certify that, except as noted in the exceptions, the company or any person associated therewith in the capacity of owner, partner, director, officer, principal investor, project director, manager, auditor or any position involving the administration of federal funds:

(a) Is not currently under suspension, debarment, voluntary exclusion or determination of ineligibility by any federal agency.

(b) Has not been suspended, debarred, voluntarily excluded or determined ineligible by any federal agency within the past three years.

(c) Does not have a proposed debarment or suspension pending.

(d) Has not been indicted, convicted or had a civil judgment rendered against any of the listed parties by a court of competent jurisdiction in any matter involving fraud or official misconduct within the past three years.

102.18.2.1 If there are any exceptions, the bidder shall submit the exceptions on company letterhead, signed by the bidder and inserted inside the bid submitted.

102.18.2.2 Exceptions will not necessarily result in denial of award, but will be considered in determining bidder responsibility.

102.18.2.3 For any exception noted, the bidder shall indicate to whom it applies, the initiating agency, and dates of action.

102.18.2.4 Providing false information may result in criminal prosecution or administrative sanctions.

102.18.3 Certification Regarding Anti-Collusion. In accordance with 23 USC 112, the bidder shall certify, under penalty of perjury, that the bidder has not, either directly or indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this contract.

102.18.4 Certification Regarding Lobbying Activities. In accordance with 31 USC 1352, the bidder shall certify that:

(a) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any federal agency, a member of Congress, an officer or employee of Congress or an employee of a member of Congress in connection with the awarding of any federal contract, the making of any federal grant, the making of any federal loan, the entering into of any cooperative agreement and the extension, continuation, renewal, amendment or modification of any federal contract, grant, loan or cooperative agreement.

(b) If any funds other than federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any federal agency, a member of Congress, an officer or employee of Congress or an employee of a member of Congress in connection with this federal contract, grant, loan or cooperative agreement, the bidder shall complete and submit Standard Form-LLL,
"Disclosure Form to Report Lobbying," in accordance with the instructions.

102.18.4.1 This certification shall be a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification shall be a prerequisite for making or entering into this transaction imposed by 31 USC 1352. Any person who fails to file the required certification will be subject to a civil penalty of no less than $10,000 and no more than $100,000 for each such failure.

102.18.4.2 The bidder also agrees by submitting a bid that the bidder shall require that the language of this certification be included in all subcontracts that exceed $100,000, and that all such sub-recipients shall certify and disclose any lobbying activities accordingly.

102.18.5 Certification Regarding Missouri Domestic Products Procurement Act. This certification will only apply to state-funded projects as noted on the cover of the Request for Bid. The bidder's attention is directed to Sections 34.350 through 34.359 RSMo 2000, which requires all manufactured goods or commodities used or supplied in the performance of the contract or any subcontract to be manufactured, assembled or produced in the USA. Sections 34.350 through 34.359 RSMo will not apply if the total bid is less than $1000.00.

102.18.5.1 Section 34.355 RSMo requires the vendor or bidder to certify compliance with Section 34.353 RSMo and, if applicable, Section 34.359 RSMo at the time of bidding and prior to payment. Failure to comply with Section 34.353 RSMo during performance of the contract and to provide certification of compliance prior to payment will result in nonpayment for those goods or commodities.

102.18.5.2 The bidder shall certify that all the specified goods or products for which this bid was solicited are manufactured, assembled or produced in the USA. If there are any exceptions, the bidder shall submit a list of the exceptions on company letterhead, signed by the bidder and attached to the inside of the bid submitted. The list shall include the pay item number and the location where the item is manufactured. The bidder shall identify any of the exceptions in the list that are specified goods or products that are treated as manufactured, assembled or produced in the USA under an existing treaty, law, agreement or regulation of the USA regarding export/import restrictions and international trade.

102.18.5.3 The bidder shall notify the contact listed in the Request for Bid of any specified goods or products that cannot be manufactured, assembled or produced in the USA in sufficient quantities or in time to meet the contract specifications.

102.18.5.4 The bidder shall certify that the bid complies with all provisions of Section 34.350 et seq RSMo.

102.19 Preference for Missouri Products. By virtue of statutory authority, a preference will be given, on projects other than federal aid projects, to material, products, supplies, provisions and all other articles produced, manufactured, made or grown within the State of Missouri, where same are of a suitable character and can be obtained at reasonable market prices in the state and are of a quality suited to the purpose intended and can be secured without additional cost over foreign products or products of other states.
SECTION 103
AWARD AND EXECUTION OF CONTRACT

103.1 Consideration of Bids. After bids are opened and the bid totals read, the bids will be compared on the basis of the summation of the products of the approximate quantities shown in the bid schedule multiplied by the unit bid prices. The results of such comparisons will be available to the public through the Finance Department.

103.2 Award of Contract.

103.2.1 The contract will be awarded by the County to the lowest responsive, responsible bidder as soon as practical after the opening of the bids. The responsibility of the Contractor will be determined by the County based on, but not limited to, previous work, financial standing and record for the payment of the Contractor’s obligations. No contract will be executed by the County unless the Contractor has on file with the Commission a valid Contractor questionnaire in accordance with Sec 102.2. The successful bidder will be notified by letter mailed to the address shown on the bid that the bid has been accepted and the contract has been awarded.

103.2.1.1 St. Charles County will not award any bid to an individual or business having any outstanding amounts due from a prior Contract or business relationship with the County or who owes any amount(s) for delinquent taxes, fees or licenses.

103.2.2 The County may make a contingent award to the second lowest responsive, responsible bidder. If the low bidder fails to execute the contract in accordance with this section, the contract will be offered to the second lowest responsive, responsible bidder in accordance with the contingent award made by the County within 25 days after the original award date. The second low bidder shall then be bound by the same requirements as specified for the lowest responsible bidder. The Notice to Proceed may be extended by the number of days between the original County award and the day the contract has been mailed to the second lowest responsive, responsible bidder. If the contract time for completion of the work is set solely by completion date, then the completion date may be extended by the number of days between the original County award and the day the contract was mailed to the second lowest responsible bidder. The new contract will be adjusted to reflect these changes, if appropriate.

103.2.2.1 If the second low bidder is not able to perform the work at the unit prices bid by the second low bidder due solely to the fact that the low bidder is unable to perform as a subcontractor in accordance with Sec 103.6, and the second low bidder based its bid upon an offer by the low bidder to perform subcontract work for the second low bidder, the second low bidder will not be required to forfeit its bid bond, providing the second low bidder submits to the County proper documentation that its bid was based on the low bidder’s quote. Proper documentation shall include, but is not limited to, a letter to the County describing the work that was to be performed by the low bidder as a subcontractor, all quotes the Contractor received and all documentation for the work in question.

103.2.2.2 When the second low bidder is required to execute the contract and the low bidder was a DBE firm that was identified on the second low bidder’s Identification of Participating DBE’s, the second low bidder shall attempt to replace the low bidder with another DBE firm. If the second low bidder is unsuccessful in attaining another DBE firm for that work, the second low bidder shall certify that a good faith effort was made in accordance with 49 CFR 26.53. The DBE goal will be adjusted accordingly.

103.2.3 When the tabulated lowest bids are equal in all respects, including price, the successful bidder will be determined by a formal drawing of lot limited to the tied bidders. Tied bidders will be notified of the location and time of the drawing and have the opportunity to attend, but attendance will not be required.

103.2.4 Alternate Bids. In making the award, if alternate bids have been requested, the alternate that will be in the best interest of the County will be used.
103.2.5 Federal Concurrence. If the USA or any agency thereof is paying all or a portion of the cost of construction of the project, the award made by the County will be tentative until proper state and federal concurrence therein has been received.

103.3 Return of Bid Guaranty. The bid guaranty, whether check or bid bond, of the low bidder will be retained until the contract has been executed by the successful bidder, all insurance requirements have been met and a satisfactory contract bond furnished. The check of the low bidder will then be returned. The bid guaranty of the second low bidder will be returned when the County has determined that award will not be made to that firm. If errors or irregularities appear in the bid of either of the two lowest bidders that creates doubt as to the status of such a bid, the bid guaranties of other bidders may be retained. When the two lowest bidders have been definitely established, the checks of the other bidders will be returned. Any bid bond furnished as a bid guaranty will be returned only upon request of the bidder furnishing the bid bond. If an award is not made, all checks will be returned to the bidders.

103.4 Contract Bond Required.

103.4.1 The successful bidder shall, at the time of the execution of the contract, furnish a contract bond in a sum equal to the contract price. The bond shall be to St. Charles County, in a form and with surety or sureties acceptable to the County, to ensure the proper and prompt completion of the work in accordance with the provisions of the contract, the Contractor’s compliance with all of the terms and conditions of the contract, all obligations on the Contractor's part to be performed and payment of all obligations to the County by the Contractor, including any indebtedness, liquidated or unliquidated, for any reason relating to or arising from the contract, and to ensure payment for all labor performed and material consumed or used in the work. The bond, if executed by a surety that is a corporation organized in a state other than Missouri, shall be signed by an agent or broker licensed by the Missouri Department of Insurance. All bids shall be submitted on the basis of furnishing a contract bond executed by an approved surety or sureties, as herein set out. The surety's liability under the contract bond and contract shall not be limited to the penal sum as set forth in the contract bond. The surety shall be liable and responsible to the County for the Contractor's entire performance and of all obligations arising under or from the contract, which shall include, but is not limited to any change orders issued under the contract that increase the cost of the contract.

103.4.2 Certificate of Authority. Any surety company that proposes to execute a bond as required by the contract shall have on file with or furnish to the County a certified copy of the surety’s certificate of authority to transact business in the State of Missouri.

103.4.3 Surety Acceptability. A surety will be acceptable to the County if the surety is listed in the current United States Department of the Treasury, Fiscal Service, Department Circular 570, *Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies*. Individual contract bonds may not be in excess of the underwriting limitation listed in the circular.

103.5 Execution of Contract. The individual, partnership, corporation or joint venturer awarded the contract shall return the prescribed copies of the contract and bond, properly executed, to the office of the County within 10 days after the unexecuted contract has been mailed to the bidder. No bid shall be considered binding upon the County until the contract has been awarded by the County, and until the successful bidder has executed and returned the contract and a satisfactory bond. No contract will be effective until the contract has been executed by all parties.

103.6 Failure to Execute Contract. Failure to execute the contract or to file an acceptable contract bond within 10 days after the unexecuted contract has been mailed to the bidder will be just cause for the cancellation of the award and the forfeiture of the bid guaranty. A bidder failing to file an acceptable bid or contract bond from an approved surety or failing to execute the contract within the time provided resulting in a cancellation of the award to that bidder, disqualifies that bidder, and any other firm having common ownership or control with that bidder, from performing any work on the County project or projects that are the subject of that bid, as a prime Contractor, a subcontractor or a supplier.
SECTION 104
SCOPE OF WORK

104.1 Intent of Contract. The Contractor shall complete the work described and furnish all resources required to complete the work under the contract.

104.2 Differing Site Conditions. If differing site conditions are encountered during the progress of the work, the discovering party shall promptly notify the other party in accordance with Sec 104.4. No further disturbance of the site or performance of the affected work shall be done after the alleged differing site conditions are noted, unless otherwise directed in writing by the Engineer.

104.2.1 Upon written notification, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the Contractor whether or not an adjustment of the contract is warranted.

104.2.2 No contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice as specified in Sec 104.4.

104.2.3 No contract adjustment will be allowed under this section for any effects caused on unchanged work.

104.2.4 Payment will be determined in accordance with Sec 109.4 and adjustments in contract time will be determined in accordance with Sec 108.7.

104.3 Changes in the Work. When considered necessary to satisfactorily complete the project, the Engineer reserves the right to provide written notice to the Contractor, at any time during the contract, to change quantities or make other alterations for which there are no provisions included in the contract. Such changes in quantities and alterations in the work will not invalidate the contract, require consent of the surety, nor release the contract surety, and the Contractor agrees to perform the work as altered. Alterations of plans or of the nature of the work will not involve work beyond the termini of the proposed construction, except as may be necessary to satisfactorily complete the project.

104.3.1 If the alterations or changes in quantities do not cause a significant change in the work to be performed under the contract, payment for the altered work will be determined in accordance with Sec 109.3 for all work for which a contract unit price exists, and Sec 109.4 for all other work. The basis for the adjustment for work for which no unit price exists shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable. If the directed changes require additional time to complete the contract, adjustments in the contract time will be determined in accordance with Sec 108.7.

104.3.2 If the alterations or changes in quantities cause significant change in the work under the contract as defined in Sec 101, an adjustment will be made to the contract. This adjustment will occur whether such alterations or changes are in themselves a significant change in the work or by affecting other work, causing such other work to become significantly different. Payment will be determined in accordance with Sec 109.3 or Sec 109.4. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable. If the directed changes require additional time to complete the contract, adjustments in the contract time will be determined in accordance with Sec 108.7 or Sec 108.14, as appropriate.

104.4 Notification of Differing Site Conditions and Changes in the Work. The Contractor shall promptly notify the Engineer of alleged changes to the contract due to differing site conditions, altered work beyond the scope of the
contract, or actions taken by the County that changed the contract terms and conditions. Within five business days of the date the alleged change or action was noted, the Contractor shall provide the following information to the Engineer in writing:

(a) The date of occurrence and the nature of circumstances of the occurrence.

(b) The name, title and activity of Highway Department personnel having knowledge of the matter.

(c) The identity of any documents and the substance of any oral communications involved.

(d) The basis for a claim of accelerated schedule performance.

(e) The basis for a claim that the work is not required by the contract.

(f) The particular elements of contract performance for which additional compensation may be sought under this section including:

(1) Pay items that have been or will be affected.

(2) Labor or material, or both, that will be added, deleted or discarded and what equipment will be idled, extended or required on the project.

(3) Delay and disruption in the manner and sequence of performance that has been or will be caused.

(4) Estimated adjustments to contract prices, delivery schedules, staging and contract time.

(5) Estimate of the time within which the County must respond to the notice to minimize cost, delay or disruption of performance.

104.4.1 For good cause the Engineer may extend the time for the Contractor to provide any part of the above information.

104.4.2 The failure of the Contractor to provide notice under Sec 104.4 will constitute a waiver of any and all claims that may arise as a result of the allegations.

104.5 Response to Notification of Differing Site Conditions and Changes in the Work. Following submission of the Sec 104.4 notification to the Engineer, the Contractor shall continue diligent prosecution of the work not affected by the notification, unless directed otherwise in writing by the Engineer. Within ten business days after receipt of notification, the Engineer will respond in writing to the Contractor to:

(a) Confirm or deny that a change occurred and specify future action to be performed by the Contractor and the Engineer, or

(b) Advise the Contractor that specific additional information is needed and the date the information is to be received by the Engineer for further review. For good cause, the Engineer may extend the time for the Contractor to provide any of the additional information. The Engineer will respond within ten days of receipt of additional information from the Contractor. Any adjustments made to the contract will not include increased cost or time extensions for delay if the Contractor fails to provide the information required in the notice or the requested additional information by the date specified.

104.6 Contractor Proposals for Value Engineering. Value Engineering change proposals (VECP’s) shall provide a product of equal or improved quality that will reduce the project cost, improve safety or decrease the time required
to complete the project. The Contractor is encouraged to submit to the Engineer, in writing, VECP’s for modifying the plans, specifications or other requirements of the contract. Proposed modifications shall not impair, in any manner, essential functions or characteristics of the project, including but not limited to, service life, economy of operation, ease of maintenance, desired appearance, design or safety standards, and shall not significantly delay the completion of the project. Proposals shall be submitted to the Engineer in advance of the work to be performed with sufficient time allowed for review. The County will not be liable to the Contractor for failure to accept or act upon the proposal nor for any delays to the work attributable to any such proposal.

104.6.1 Submitting Proposals. Value Engineering proposals shall be submitted on the proper form, available on MoDOT’s web site, and shall contain the following information:

(a) A description of both the existing contract requirements for performing the work and the proposed changes.

(b) A detailed estimate of the cost of performing the work under the existing contract and under the proposed change.

(c) A statement of the time within which the Engineer must make a decision thereon, including the probable effect the proposal will have on the contract completion time.

(d) An itemized list of the contract items of work affected by the proposed changes, including any quantity variation attributable thereto.

(e) A description of any previous use or submission of the same proposal by the Contractor, including dates, job numbers, results, and/or outcome of proposal if previously submitted.

104.6.2 Conditions. The Engineer will only consider VECP’s that meet the following conditions.

104.6.2.1 Contractors may submit value Engineering proposals that propose changes in the basic design of a bridge or a pavement, except for pavement and shoulder type. Value Engineering proposals will be considered only when the proposal will not significantly delay the completion of the project.

104.6.2.2 The Contractor shall continue to perform the work in accordance with the requirements of the contract until a change order incorporating the value Engineering proposal has been approved, unless otherwise directed by the Engineer. If a change order has not been approved by the date upon which the Contractor’s value Engineering proposal specifies that a decision thereon should be made, the proposal shall be deemed rejected, unless the time allowed for a decision has been extended by mutual agreement of both parties.

104.6.2.3 The County expressly reserves the right to adopt a value Engineering proposal as standard practice for use on other contracts administered by the County. If an accepted value Engineering proposal is adopted as design policy, only Contractors submitting such a proposal will be eligible for compensation pursuant to this section until the proposal is incorporated into design policy, and in that case, only as to those contracts awarded to the Contractor prior to submission of the accepted value Engineering proposal. Value Engineering proposals identical or similar to previously submitted proposals will be eligible for consideration and compensation under the provisions of Sec 104.6 if the identical or similar previously submitted proposals were not adopted as design policy by the County or included in the present contract. Subject to the provisions contained herein, the state or any other public agency will have the right to use all or any part of any submitted value Engineering proposal without obligation or compensation of any kind to the Contractor, except as noted in Sec 104.6.2.4.

104.6.2.4 The Contractor may request the return of information submitted with a value Engineering proposal if the proposal is rejected, provided this request is in writing and submitted with the proposal. If the proposal is accepted,
this request will be void, and the County may use or disclose in whole or in part any information necessary to utilize the proposal.

104.6.2.5 Prior to approval, it may be necessary for the Engineer to modify a proposal, with the concurrence of the Contractor, to make the proposal acceptable. If any modification increases or decreases the net savings resulting from the proposal, the Contractor's 50 percent share will be determined on the basis of the proposal as modified.

104.6.2.6 Four copies of the complete proposal shall be submitted to the Engineer for review. The Contractor may submit a conceptual proposal for approval stating the basic proposal and approximate cost savings in order to provide the Contractor with the opportunity to submit an idea without large initial development costs if the proposal is rejected. Approval or disapproval of proposals will be granted within ten days of receipt of the proposal.

104.6.2.7 A proposal will be disqualified if additional information is not provided at the request of the Engineer. This will include design computations, field investigations, results, surveys, etc.

104.6.2.8 Reimbursement for modifications to the proposal to adjust field or other conditions will be limited to the total amount of the contract bid prices. Rejection, limitation or reimbursement shall not be a basis for any claim against the County.

104.6.2.9 The Contractor will have no claim to additional costs or delays, including development costs, loss of anticipated profits, or increased material or labor costs, if the proposal is rejected.

104.6.2.10 The Engineer will decide whether or not to consider a proposal. The basis for proposal rejections will include excessive review requirements, evaluation or investigation, or if the proposal is inconsistent with project design policies or criteria.

104.6.3 Payment. Payment will meet the following conditions:

104.6.3.1 The Engineer will be the sole judge of the acceptability of a value Engineering proposal and of the estimated net difference in construction costs from the adoption of all or any part of such a proposal. The Engineer may adjust contract prices if, in the judgment of the Engineer, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

104.6.3.2 If the Contractor's cost reduction is accepted in whole or in part, such acceptance will be by a change order, which will specifically state that the change order is executed in accordance with Sec 104.6. Such change orders will incorporate the changes in the plans and specifications necessary to permit the value Engineering proposal or any part of the proposal that has been accepted, to be put into effect, and will include any conditions upon which the County's approval thereof is based, if the approval of the County is conditional. The change order will also set forth the price for performing those items of work affected by the change order and the estimated net savings in the cost of performing the work attributable to the value Engineering proposal in the change order, and will further provide that the Contractor will be paid 50 percent of the actual net savings of the construction costs at the completion of the work affected by the change order.

104.6.3.3 The amount and time specified in the change order will be considered full compensation to the Contractor for the value Engineering proposal and for the performance of that work. All costs incurred by the Contractor to develop, design, and implement a value Engineering proposal shall be at the Contractor’s expense and no compensation will be provided to develop the proposal. All costs incurred by the County to review and implement the VECP will be at the County’s expense.

104.6.3.4 Only the Contractor may submit proposals and be reimbursed for savings, however the Contractor may submit proposals for any approved subcontractor.
104.7 Maintenance of Traffic Operations During Construction.

104.7.1 The Contractor shall maintain the flow of all traffic over the project, at the Contractor's expense, unless otherwise specified in the contract. Provisions for local traffic, including bicycle and pedestrian traffic, shall be made by the Contractor, at the Contractor's expense, at all times during construction, unless otherwise specified in the contract.

104.7.2 Contractor will make provisions to alleviate any temporary flooding caused by staging of work. The Contractor shall provide temporary ditches, temporary connections to completed storm sewer systems or pumping as necessary to ensure that, as a minimum, one ten (10) foot wide traffic lane exist at all times in the direction of traffic. Under two-way traffic conditions two ten (10) foot lanes are required. Only one 10 foot lane is required for authorized one-way sections. Payment for the maintenance of traffic shall be considered incidental to the work and no direct payment will be made for the installation or removal of any measure necessary to fulfill the intent of this section.

104.7.2.1 Water covering more than five (5) feet of the travel lane or greater than or equal to three (3) inches in depth on the roadway surface will not be allowed.

104.7.2.2 The Contractor should be prepared to provide this maintenance 24 hours a day, 7 days a week, as necessary from the Contract Notice to Proceed until Final Acceptance.

104.7.3 If the Contractor is required to maintain the flow of traffic over the project, including constructed detours or bypasses, such maintenance shall be construed to mean the satisfactory handling of all traffic to maintain safe and substantially uninterrupted flow. The Contractor shall maintain the roadbed substantially free of ruts, holes and detrimental surface deformations. The Contractor shall control the height of vegetation for traffic safety, and shall provide and maintain in a safe condition approaches, crossings and intersections with abutting property to the highway, railroads, trails, roads and streets. The Contractor shall maintain temporary signage and striping in a clear and non-conflicting manner to the traveling public. Such maintenance shall be performed as necessary from the day the Contractor starts construction operations under the contract. Snow removal will not be required of the Contractor.

104.7.4 When it is to the advantage of the County, projects involving pavement may be opened to traffic as soon as the surface has been sufficiently cured, even though the shoulders and other items of work may not be completed. Such projects or portions of projects will be inspected and a partial acceptance made as to the work completed, and the Contractor will be required to complete any remaining construction items under traffic.

104.7.5 When the Engineer opens for use by traffic any unfinished portions of the project as provided under Sec 104.7.4, the Contractor will be compensated in accordance with Sec 109.4 for any documented actual additional costs approved by the Engineer. Any documented inefficiencies, delays or other time related effects approved by the Engineer will be an excusable delay only as provided by Sec 108.14.

104.8 Surfacing for Temporary Use. Surfacing for the temporary use of traffic shall, when directed by the Engineer, be applied to areas necessary to provide satisfactory ingress and egress to private property, across the project or along the roadway. Such surfacing will be authorized if traffic cannot be handled satisfactorily by the Contractor maintaining a reasonably smooth and drainable earth surface in accordance with Sec 104.7. The quantity, quality and type of surfacing will be designated by the Engineer. Acceptance of the material will be based on visual examination.

104.8.1 Measurement of material furnished for temporary surfacing will be made in accordance with Sec 401, excluding any deductions for moisture.
104.8.2 The quantity of surfacing for temporary use authorized and accepted will be paid for at the contract unit price. Regardless of overruns or underruns, no adjustment will be made in the price for this material.

104.8.3 Preparing a subgrade, spreading or laying surfacing for temporary use, maintaining the surfacing, future removal or scarifying, if necessary, shall be at the Contractor’s expense.

104.9 Rights In and Use of Material Found on the Work. The Contractor, with written approval from the Engineer, may use in the construction of the project any stone, gravel or sand found in the excavation that conforms to the requirements of the specifications for material. The County will not pay for damages or for anticipated profits on account of the expected use of any material shown on the plans as existing and later found to be nonexistent or unfit for use. Payment will be made to cover the removal of such material at the contract unit price for excavation of the classification under which the excavation properly belongs. If such material is used instead of material that was to have been furnished at the expense of the Contractor under the terms of the contract, the Contractor shall furnish sufficient suitable material, at no additional expense to the County, to complete the roadway. Unless authorized in writing by the Engineer, the Contractor shall not excavate or remove from within the right of way any material that is not within the excavation limits as indicated by the slope and grade lines.

104.10 Mailboxes, Signs and Markers.

104.10.1 Mailboxes. Mailboxes within the limits of the project that will interfere with operations shall be removed by the Contractor before work is begun. Mailboxes shall be set temporarily where the mailbox will be accessible to both the carrier and the patron and shall be properly reset by the Contractor at designated locations before final acceptance of the work by the County. Mailboxes damaged by the Contractor shall be replaced by the Contractor at the Contractor’s expense. All mailbox supports set by the Contractor shall be in accordance with AASHTO guidelines. Mailboxes may be reset by the Contractor using only approved supports furnished either by the postal patron or by the Contractor. No direct payment will be made for the removal, relocation or replacement of mailboxes or supports.

104.10.1.1 Temporary mailboxes shall not be mounted on barrels and final installation of mailboxes shall be per US Postal Service standards.

104.10.1.2 Mailboxes shall be permanently reset in accordance with US Postal Service standards as soon as possible.

104.10.2 Signs and Markers. Signs and markers within the limits of the project that will interfere with operations shall be removed by the Contractor before work is begun. All such signs and markers required for safe control and guidance of traffic shall be temporarily reset, readily visible to traffic, and shall be maintained in a satisfactory condition. If the nature of the work makes temporary relocation impractical, the signs shall be placed on movable supports and maintained in accordance with Sec 616. Stop, yield, and Street ID signs at intersecting roadways shall be maintained where signs are readily visible to traffic at all times. Other individual signs may be moved aside only when signs interfere with actual operations. All required signs and markers shall be properly located to control traffic at all times. Final removal of signs and markers will be permitted only when permanent signs and markers have been installed. All signs and markers will remain the property of the County and shall, after final removal, be delivered without damage to locations within the project limits as directed by the Engineer. No direct payment will be made for removal, relocation, temporary supports, maintenance or final removal and delivery of signs and markers.

104.10.3 Right of Way Markers and Plaques. All right of way marker posts or markers damaged by the Contractor’s operations shall be replaced at the Contractor’s expense, and installed in accordance with Sec 602 and the standard drawings. Replacements for damaged right of way marker plaques will be furnished by the County.

104.11 Final Clean Up.
104.11.1 Before final acceptance, the Contractor shall restore the highway, all borrow areas, and all ground on or adjacent to the highway right-of-way occupied by the Contractor, in connection with the work, in an acceptable manner. All property, both public and private, which may have been damaged on account of the prosecution of work, shall be cleaned of all rubbish, excess materials, temporary structures, and equipment. All areas beyond the limits of construction that have been damaged by the Contractor's operations shall be restored by the Contractor at the Contractor's expense as directed by the Engineer. All parts of the work shall be left in an acceptable condition.

104.11.2 The Contractor shall cut all brush, grain, grass, and weeds from the entire right-of-way, except for improved or selected areas shown on the plans or designated by the Engineer, and shall clean and remove from the right-of-way all abandoned fences, surplus and discarded material, any perishable matter, rubbish, and temporary structures. The vegetation on the right-of-way outside of the construction limits shall not be removed by blading. All guardrail materials within the right-of-way shall remain the property of the County and shall be stored on the right-of-way as directed by the Engineer. The Contractor shall restore in an acceptable manner all property, both public and private, which may have been damaged on account of the prosecution of the work, and shall leave the right-of-way neat and presentable. All areas outside the rounding of fill slopes and back slopes, on which the existing turf is damaged by the Contractor's operations, shall be restored by the Contractor, at its expense, by seeding and mulching such areas at the rates designated in the contract, or as directed by the Engineer.

104.11.3 In contracts involving grading other than incidental work in connection with resurfacing, the Contractor shall open and clean all existing channels and culverts leaving them free from all excess mud or silt, drift, brush or debris of any kind.

104.11.4 Final cleaning up in accordance with the provisions of Sec 104.11.2 will not be required when the principal part of the contract consists of traffic signals, lighting, signing, fencing, plantings, surfacing, or resurfacing work. When the principal part of the contract consists of these items, the Contractor shall remove all excess excavation and all rejected or unused materials and debris from the right-of-way or as directed by the Engineer, and shall restore to a satisfactory condition all shoulders and slopes defaced by the Contractor's operations.

104.12 Not Used.

104.13 Warranty of Electrical and Mechanical Equipment.

104.13.1 On all contracts requiring the Contractor to furnish and install electronic, electrical or mechanical equipment, the Contractor shall obtain, assign and furnish to the County written manufacturer’s warranties for all such equipment consistent with those provided as customary trade practice. Additionally, a Contractor's warranty providing for satisfactory in-service operation shall be provided for a minimum period of twelve months from the date of project acceptance.

104.13.2 If the equipment fails to perform satisfactorily for the specified length of time, the manufacturer or the Contractor shall replace or repair the equipment as necessary to restore required performance. County labor costs resulting from equipment replacement will not be charged to the manufacturer or the Contractor.
105.1. Not Used.

105.1.1 Authority of the County Engineer. The County Engineer will decide all questions that may arise as to the quality, quantity and acceptability of material furnished and the work performed, and as to the rate of progress of the work; all questions that may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor; all questions of classification; the proper compensation for the performance or breach of the contract; and all claims or controversies of any character whatsoever in connection with or growing out of the construction, whether claimed under the contract, under force account or otherwise. The County Engineer’s estimates and decisions shall be final, binding, and conclusive upon all parties to the contract.

105.1.2 Suspension of Work. The Engineer may suspend the work wholly or in part in accordance with these provisions. The suspension may be given verbally, but will be followed in writing immediately.

105.1.2.1 The Engineer may suspend the work wholly or in part for the Contractor's failure to:

(a) Correct conditions unsafe for the project personnel or general public.

(b) Carry out provisions of the contract.

(c) Carry out orders of the Engineer.

105.1.2.2 Suspensions in accordance with Sec 105.1.2.1 will be nonexcusable and noncompensable.

105.1.2.3 Work may also be wholly or partially suspended for:

(a) Periods necessary due to unsuitable weather.

(b) Conditions considered unsuitable for the prosecution of the work.

(c) Any condition or reason determined to be in the public interest.

105.1.2.4 Suspensions in accordance with Sec 105.1.2.3 may be excusable but will be noncompensable as determined by the Engineer in accordance with Sec 108.

105.2 Plans and Working Drawings. The plans will be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor and shall consist of such detailed plans as may be required to adequately control the work and which are not included in the plans furnished by the County. Required working drawings must be accepted by the Engineer, and such acceptance shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

105.3 Conformity with Contract Documents. All work performed and all material furnished shall be in accordance with the lines, grades, cross sections, dimensions and material requirements, including tolerances, shown in the contract documents.

105.3.1 If the Engineer finds the material or the finished product in which the material was used is not in accordance with the contract documents, but that reasonably acceptable work has been produced, a determination will be made if the work will be accepted and remain in place. In this event, the Engineer will document the basis of
acceptance by contract modifications that may provide for an appropriate adjustment in the contract price for such work or material as deemed necessary to conform to the determination based on Engineering judgment.

105.3.2 If the Engineer finds the finished product to be unacceptable as a result of the Contractor's method of operation or the use of unacceptable material, the work shall be removed and replaced or otherwise corrected by the Contractor at the Contractor's expense.

105.4 Coordination of Contract Documents. The contract documents are essential parts of the contract, and a requirement occurring in one shall be as binding as though occurring in all. Contract documents are intended to be complementary and to describe and provide for a complete work. In case of discrepancy among contract documents, the governing ranking will be:

(a) Permits
(b) Job Special Conditions
(c) Job Special Provisions
(d) Project Specific Drawings
(e) General Provisions
(f) Standard Specifications
(g) MoDOT’s Local Public Agency (LPA) Policy Manual (On Federally Funded Projects)
(h) MSD Standard Drawings
(i) MoDOT Standard Drawings
(j) St. Charles County Standard Drawings
(k) Bid Items or Quantities

In case of discrepancies, calculated dimensions will govern over scaled dimensions.

105.4.1 All Contractors, including subcontractors, shall not take advantage of any apparent error or omission in the contract documents. If an error or omission is discovered, the Engineer shall be notified promptly so corrections and interpretations necessary to fulfill the intent of the contract can be made. A failure to give notice shall render the effects of any error or omission noncompensable and any delay nonexcusable.

105.5 Cooperation by Contractor. The Contractor shall maintain one set of contract documents at the work site at all times.

105.5.1 The Contractor shall give the work the constant attention necessary to facilitate the progress thereof and shall cooperate with the Engineer and other Contractors in every possible way.

105.5.2 The Contractor shall have at the work site at all times, as the Contractor's agent, a competent individual capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, whom shall receive instructions from the Engineer. That individual shall have full authority to execute orders or directions of the Engineer without delay and to promptly supply material, equipment, tools, labor and incidentals as may be required.
105.6 Cooperation Between Contractors. The County reserves the right at any time to contract for and perform other or additional work on or near the project limits covered by the contract.

105.6.1 If separate contracts are awarded within the limits of any one project, each Contractor shall conduct work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Full cooperation of the Contractors involved, in careful and complete coordination of their respective activities in the area, will be required.

105.6.2 Each Contractor and surety involved shall assume all liability, financial or otherwise, in connection with the contract and shall indemnify and save harmless the State, the County, and the County’s agents, employees and assigns from any and all damages or claims that may arise because of inconvenience, delay or loss experienced, caused or contributed to by the Contractor because of the presence and operations of other Contractors working within the limits of the same project.

105.6.3 The Contractor shall schedule and conduct work and shall place and dispose of material being used so as not to interfere with or cause unnecessary inconvenience or delay to the operations of other Contractors within the limits of the same project. The Contractor shall join work with other Contractors as required by the contracts or in a manner acceptable to the Engineer and shall perform the work in proper sequence with the work of the other Contractors. When necessary for proper prosecution of work, each Contractor shall permit the other Contractor's access through overlapping construction areas and shall permit the use of any access or haul roads.

105.7 Cooperation With Utilities.
All utility facilities and appurtenances within the project limits shall be installed or relocated by the utility owner, unless specified otherwise. Utility installation and relocation shall be made in accordance with 7 CSR 10-3, Utility and Private Line Location and Relocation.

105.7.1 The Contractor shall cooperate with utility owners and the Engineer in the installation and relocation of utility facilities to minimize effects on the Contractor’s work, interruption to utility service and duplication of work by the utility owners. Facilities or appurtenances that are to remain in place during construction shall be accounted for and protected by the Contractor’s work procedures.

105.7.2 The Contractor shall notify Missouri One Call (800-344-7483) with its intent to excavate, as described in Chapter 319 RSMo. Locations of all utility facilities and appurtenances within the project limits will be provided by utility owners and may not be exact, particularly with regard to underground.

105.7.3 The Contractor shall proceed in a safe and prudent manner to prevent damage to all public and private utilities. Repairs to damaged utilities caused by negligent or wrongful acts or omissions on the part of the Contractor shall be corrected at the Contractor’s expense. Damaged facilities shall be restored to a condition similar or equal to that existing before the damage occurred.

105.7.4 In the event of any damage, dislocation or disturbance of any underground facility in connection with any excavation, the Contractor shall immediately notify Missouri One Call and cooperate with the utility owners until their facilities have been restored. Work shall not begin around any fire hydrants until provisions for continued service have been made and approved by the local fire authority.

105.7.5 The Contractor shall be solely responsible and liable for incidental and consequential damage to any utility facilities or interruption of the service caused by it or its subcontractor’s operation. The Contractor shall hold and save harmless the County from damages to any utility facility's interruption of service by it or its subcontractor’s operation.
105.7.6 The Contractor agrees that any effects of the presence of the utilities, their relocation, Contractor’s coordination of work with the utilities and any delay in utility relocation shall not be compensable as a suspension of work, extra work, a change in the work, as a differing site condition or otherwise including but, without limitation, delay, impact, incidental or consequential damages. The Contractor’s sole remedy for the effects of the presence of utilities, delay in their relocation or any other effects shall be an excusable delay as provided in Sec 105.7.6.1. The Contractor waives, for itself, its subcontractors and suppliers the compensability of the presence of utilities, delay in their relocation and any cost to the Contractor, its subcontractors and suppliers in any claim or action arising out of or in relation to the work under the contract.

105.7.6.1 When the failure of the owners of utility facilities to cooperate and coordinate their work with that of the Contractor results in actual delay to the Contractor in the overall completion of the Contractor’s work, such delay will be considered in the count of working days or date specified for completion as Contractor’s sole compensation from the County, provided the Contractor notified the Engineer in writing of the delay at the time the delay occurred. The determination of whether there was an actual delay will be decided by the County Engineer and such decision will be binding upon the County and the Contractor.

105.7.7 Should there be located within the right of way any public or private utility facilities that are to remain in place and that will interfere with the Contractor’s proposed methods of operation, the Contractor, in cooperation with the Engineer, shall make all necessary arrangements with the owner for any temporary or permanent removal or relocation of such facilities desired for the Contractor’s convenience. Any cost involved shall be at the Contractor’s expense.

105.7.8 If utility facilities or appurtenances are found that are not noted in the contract documents and could not be discovered in accordance with Sec 102.5, the Engineer will determine whether relocation of the utility is necessary to accommodate construction. If relocation is necessary, the Engineer will make necessary arrangements with the utility owner and the Contractor. Compensability and excusability will be determined under Sec 104 and Sec 108.

105.8 Construction Stakes, Lines and Grades. Surveying and setting of construction stakes will be performed by the Contractor. Except when a bid item for this work is included in the contract staking will be considered incidental to other work. The Contractor shall provide the necessary surveying and staking for the successful prosecution of work in accordance with Sec 627. The Contractor shall also be responsible to provide centerline staking immediately after Notice to Proceed to assist utility Contractors. Failure to provide centerline staking in a timely manner may jeopardize the Contractor’s claim for utility delays. Further assistance to the utility companies is at the Contractor’s discretion.

105.9 Authority and Duties of Engineer. As the immediate representative of the County, the Engineer has direct charge of the Engineering details of each construction project and is delegated commensurate authority for the administration of the project. The Engineer may reject defective material and suspend and reject any work that is being improperly performed. The Engineer will have no authority to modify the contract except in accordance with the contract documents or when expressly authorized by the County.

105.10 Inspection of Work. All material and each part or detail of the work will be subject to inspection by the Engineer. The Engineer shall be allowed unlimited access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

105.10.1 If requested by the Engineer, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standards required by the contract documents. If the work thus exposed or examined proves acceptable, the uncovering, the removing, recovering or making good the parts removed will be paid for in accordance with Sec 109. If the work so exposed or examined proves unacceptable, the uncovering, removing, recovering or making good the parts removed shall be at the Contractor’s expense.
105.10.1.1 The COUNTY may waive inspection of materials and products, at its option, and may require certifications from the manufacturers or suppliers of compliance to the specifications. Supplier’s material certificate shall be provided for the following items:

(a) Class B and B-1 Concrete
(b) Portland Cement Concrete Pavement
(c) Bituminous Base
(d) Bituminous Pavement

105.10.2 Any work done or material used without inspection by an authorized County representative may be ordered removed and replaced at the Contractor’s expense.

105.10.3 If any unit of government or political subdivision pays all or a portion of the cost of the work covered by the contract, the unit’s respective representatives shall have the right to inspect the work. MoDOT and FHWA have the right to inspect any project in which Federal money is involved.

105.10.4 When any work is being done on, over or under railroad right of way or adjustments are being made to any public or privately-owned utility facility, the respective representatives shall have the right to inspect the work.

105.10.5 Inspections authorized in Sec 105.10.3 and Sec 105.10.4 will not make any of these agencies a party to the contract or affect the rights of the parties to the contract.

105.10.6 Adequate provisions for lighting, meeting the prior approval from the Engineer, shall be provided by the Contractor to permit satisfactory construction and inspection of all work done and material produced.

105.10.7 Final Inspection. Upon presumptive completion of the entire project, the Engineer will make an inspection. If all construction contemplated by the contract has been completed to the Engineer’s satisfaction, that inspection will constitute the final inspection. If corrections are required, then another inspection will be scheduled after completion of the deficiency corrections which will constitute the final inspection, once the Engineer has been notified that all corrections have been made. The Engineer will accept the project for maintenance upon completion of the final inspection. The Engineer will notify the Contractor in writing of acceptance for maintenance as of the date of the final inspection, with the exception of items covered by item specific performance bonds. Final acceptance will take place within a maximum of 30 days of receipt of final documentation from the Contractor.

105.10.7.1 Following the final inspection, the Contractor, subcontractors and suppliers will be relieved of any new or additional liability to third parties for personal injury, death or property damages which may be alleged to result from the design or construction of the work, unless additional work on the right of way will be required by the Engineer.

105.10.7.2 Nothing in Sec 105.10.7 shall be deemed to excuse the Contractor of liability or responsibility for any personal injury, death or property damages which may have occurred prior to the final inspection of the work.

105.11 Unauthorized and Defective Work.

105.11.1 All changes in the work or departures from the plans, except those due to reclassification of excavation material, will be considered unauthorized and at the Contractor’s expense unless, before proceeding with the work, the Contractor has a copy of a letter signed by the Engineer, or a change order signed by all parties whose signatures are provided for, except the federal Engineer. These forms will contain complete detailed instructions regarding the
proposed changes. Any departure from the instructions contained in such a written order will be considered unauthorized.

105.11.2 The Engineer may order unauthorized work removed and replaced at the Contractor's expense.

105.11.3 All construction and materials that have been rejected or declared unsatisfactory shall be remedied or removed and replaced in an acceptable manner by the Contractor at the Contractor's expense. Upon failure of the Contractor to remedy or remove and properly dispose of rejected material or work, or to replace them immediately after receiving written notice from the Engineer, the Engineer may employ labor to rectify the work, and the cost of rectification will be deducted from any payment due or which may become due the Contractor.

105.12 Load Restrictions.

105.12.1 The Contractor's movement of equipment and vehicles over bridges and pavements within the limits of the project will be subject to the load limit regulations for highways as prescribed by state statutes in effect when the movement occurs, and the Contractor shall acquire special permits from the County prior to the movement of any such equipment or vehicles with a gross weight (mass) in excess of the load limits permitted by statute. All costs of obtaining special permits shall be at the Contractor's expense, unless the special permit will be required by a restriction first imposed after the Contractor has submitted the bid on the project. Outside of project limits, width, length, height and weight (mass) limitations as prescribed by state statutes shall be adhered to by the Contractor during the movement of equipment and vehicles over any part of the state highway system, to include project exceptions, and the Contractor shall not move or operate any such equipment or vehicles that exceed any statutory limitation without special permits from the appropriate Governing body. All costs of obtaining special permits shall be at the Contractor's expense. Material receipts issued by the Engineer will not indicate compliance with any weight (mass) restriction regulations. All permits required for movement over highways other than those that are state owned or maintained shall be obtained by the Contractor from the respective authority at the Contractor's expense.

105.12.1.1 Special permits will not be required for the movement of construction equipment over any part of a bridge or pavement that is constructed or rehabilitated in the contract.

105.12.1.2 All movement will be subject to the same conditions and regulations established by the Commission for movements under special permits with the following additional requirements:

(a) Bridge decks shall be protected by planking of uniform thickness for the full tread width of track.

(b) All concrete in the bridge shall have achieved design strength.

(c) No more than one unit at a time may be moved over the structure.

(d) Equipment shall be centered on centerline of structure during movement.

(e) Adequate provisions shall be made to prevent marring of the pavement surface or the loss of surface texture.

(f) Portland cement concrete pavement shall have achieved the strength required for opening to all traffic.

(g) Adequate provisions shall be made to assure uniform load distribution at the edges of the pavement.

(h) All movements shall be made under the supervision of the Engineer.
105.12.1.3 Movement of equipment over bridges or pavement not constructed under the contract, but located within the limits of the contract, will be subject to all requirements of this section, and a special permit will be required.

105.12.2 Track or crawler-type equipment having a gross weight of 40,000 pounds or less, evenly distributed over the treads, may be moved over bridges not posted for lesser loads or over rigid-type pavements without special permits. Such equipment having a gross weight in excess of 40,000 pounds shall have a special permit before moving. Crawler-type equipment having a gross weight in excess of 75,000 pounds will not be permitted on bridges or rigid type pavements unless authorized by the Engineer.

105.12.3 Track or crawler-type equipment that is subject to unequal distribution of weight, such as cranes and paving mixers and which have a gross weight in excess of 18,000 pounds but less than 40,000 pounds, may be operated upon bridges not posted for lesser loads and rigid type pavements, provided special precautions satisfactory to the Engineer are taken to distribute the weight evenly over the treads. Such equipment in excess of 40,000 pounds will require a special permit from the County.

105.12.4 The Contractor shall not move or operate any type of equipment of such weight or so loaded that the equipment will cause damage to highway facilities either being constructed or in existence. Equipment and vehicles with steel lugs will not be permitted to operate directly on bridges or pavements at any time.

105.12.5 When it is required that material from roadway or borrow excavation be hauled across existing pavement, the Contractor may move the material across the pavement with equipment that results in overweight loading, provided the following requirements are met at the Contractor's expense:

(a) The Contractor and the Engineer shall select the location or locations where the crossing over the existing pavement is to be made. The width of the crossing shall be clearly marked on the pavement by painted lines and the Contractor’s equipment will be required to operate within the limits of the marked crossing.

(b) The Contractor shall obtain written permission, including the description of the location of the crossing, from the Engineer prior to movements of overweight loads across the existing pavement.

(c) The existing pavement shall be kept open at all times for highway traffic except for short periods of time when individual pieces of equipment are crossing the pavement. The pavement shall be kept reasonably free from earth or other material during hauling operations and shall be cleaned off and kept clean during periods when no hauling across the pavement is in progress.

(d) The pavement and shoulders within the crossing area shall be maintained by the Contractor in a condition satisfactory to the Engineer.

(e) The Contractor shall provide signs and flaggers to direct traffic when hauling across the pavement.

(f) If any hauling across the pavement is done at night, the Contractor shall provide adequate lighting to illuminate the crossing.

(g) If the existing pavement at the crossing is to be used in place after the contract is completed, the Contractor shall, upon completion of the hauling operations, remove the existing shoulders, pavement and base between the limits of the crossing and replace the pavement with the same type, width and thickness of shoulders, pavement and base existing prior to the beginning of hauling operations.

(h) The Contractor shall construct and maintain all necessary bypasses or temporary connections required for the proper handling of traffic during removal and replacement of the pavement in the crossing area.
105.12.6 The Contractor shall not store or stockpile any materials on a bridge without approval from the Engineer.

105.12.7 Nothing contained herein or in any special permit will relieve the Contractor of liability for any damage caused to highway facilities from the movement or operation of equipment and vehicles over the highway system.

105.13 Maintenance of the Work. The Contractor shall maintain the work during construction until the work is accepted. This maintenance shall be prosecuted such that the roadway or structures are kept in satisfactory condition at all times.

105.13.1 In the case of a contract for placing a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

105.13.2 No direct payment will be made for maintenance of the work before the work is accepted.

105.14 Failure to Maintain Roadway or Structure. If the Contractor’s performance at any time fails to comply with the provisions of Sec 105.13, the Engineer will notify the Contractor of such non-compliance. If notice is provided verbally, notice will be promptly confirmed in writing. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor.

105.15 Acceptance.

105.15.1 Partial Acceptance. If at any time during the prosecution of the work the Contractor completes any significant or disparate section of work, the Contractor may request that the Engineer inspect that section. If the Engineer agrees to perform the inspection and finds upon inspection that the section has been completed in accordance with the contract, the Engineer will accept that section as being completed and the Contractor will be relieved of further responsibility for that section. Partial acceptance will also include identified work inspected and accepted in accordance with Sec 104.7.

105.15.1.1 If the contract contains seasonal items, such as sodding, painting or such items as might delay the final completion of the project, a partial acceptance of the completed portion may be made prior to completion of the entire project. If the Engineer finds upon inspection that the completed work is in acceptable condition, the Contractor will be notified in writing and after such notice has been given, the Contractor will be relieved of the duty of maintaining and protecting that work to the extent provided in the notice.

105.15.1.2 Nothing in the contract shall be construed to relieve the Contractor of full responsibility for making good any non-latent defect in work or material found on any section of work prior to final acceptance of the entire project, to alter in any manner the method of payment prescribed in the contract or to constitute a waiver of any claim the County might have against the Contractor on the entire project.

105.15.2 Final Acceptance. Upon receipt by the Engineer of all project documentation required by the contract and verification by the Engineer that all material incorporated into the work has been properly inspected, the Engineer will make the final acceptance upon completion of the final inspection and acceptance for maintenance in accordance with Sec 105.10.7.

105.15.2.1 Project documentation shall consist of the following: Contractor’s Affidavit Regarding Settlement of Claims (Form C-242), Final Change Order, DBE Participation List and Final Verification, FHWA-47 (Statement of Materials and Labor Used By Contractors on Highway Construction Involving Federal Funds), Affidavit – Compliance with the Prevailing Wage Law (Prime Contractor and all Subcontractors), Contractors Final Lien Waiver (Prime Contractor and all Subcontractors), Contractor’s Final Payment Estimate, and As-built markups (in accordance with Sec 627, if required by the contract).
105.15.2.2 Final acceptance will not excuse the Contractor's liability or responsibility to the County for any latent defects in the work or material incorporated into the work, or for claims relating to any work or material incorporated into the work.

105.16 Controversies and Claims for Adjustment.

105.16.1 The Contractor shall follow the requirements of Sec 104.4 for written notification of differing site conditions or significant changes in the character of work and Sec 108.15 for suspensions of work directed by the Engineer. If, after receiving a written reply from the Engineer the Contractor considers additional compensation is due, the Contractor shall file a written notice of claim for additional compensation within 60 days after completing the work in question. The procedure for filing a claim shall be as described in Sec 105.16.6 through Sec 105.16.8.2.

105.16.2 If the Contractor considers additional compensation may be due for work or material not clearly covered in the contract or not ordered in writing by the Engineer as change in the work, the Contractor shall notify the Engineer in writing of the intention to make a claim before beginning the work in question. If notification is not given and the Engineer is not afforded proper facilities by the Contractor to provide necessary inspection and for keeping strict account of actual costs, the Contractor agrees to waive any claims for additional compensation. Notice by the Contractor and the fact that the Engineer has kept account of the costs shall not be construed as substantiating the validity of the claim. The Contractor shall file a written notice of claim for additional compensation within 60 days after completing the work in question. The procedure for filing the claim shall be as described in Sec 105.16.6 through Sec 105.16.8.2.

105.16.3 Claims for additional time or compensation under Sec 104 shall be filed within 60 days after completing the work in question. Claims for additional time or compensation in accordance with Sec 108 shall be filed within 60 days after receipt of the Engineer's determination. The procedures for filing and the disposition of the claim or controversy shall be in accordance with Sec 105.16.3 through Sec 105.16.9.

105.16.4 If the Contractor has any claim against the County arising out of the provisions of the contract or the performance or non-performance thereunder, and is not within the scope of Sec 105.16.1 through Sec 105.16.3, the claim shall be filed within the earlier of:

(a) 90 days after the date of final inspection under Sec 105.10.7.

(b) 60 days after the date of declaration of default or termination of the contract under Sec 108.

(c) As provided in Sec 108 upon a termination of the contract for convenience of the County.

105.16.5 If the County has a claim against the Contractor that in any way arises out of the provisions of the contract or the performance or non-performance thereunder, the claim will be filed within 90 days after the date of final inspection under Sec 105.10.7, except for claims of a differing site condition or defects in work or material under Sec 105.15.2.2.

105.16.6 If the claim is against the County, the written claim shall be personally delivered or sent by certified mail to the Office of the County Engineer in St. Charles, Missouri. If the claim is against the Contractor, the written claim will be personally delivered or sent by certified mail to the Contractor at the address shown under the signature on the contract. If the claim is against an assignee, the written claim will be personally delivered or sent by certified mail to the assignee at the address shown on the accepted notice of assignment.

105.16.6.1 This provision shall not extend the claim filing time limits of the Contractor or the County in the case of a differing site condition or a suspension of the work under Sec 108.
105.16.6.2 This provision will not limit the County’s claim filing time for defects in work or material not discovered within 90 days after the date of final inspection under Sec 105.10.7 or other claim rights not discovered within 60 days of filing of any claim by the Contractor, or as to any work covered by a separate or continuing performance bond specified to survive project final acceptance.

105.16.7 Claim submittals on the Contractor’s part shall be in sufficient detail, as specified in this section, to enable the Engineer to determine the basis for additional time or compensation. The following minimum information shall accompany each claim submitted:

(a) A detailed factual statement of the claim, providing all necessary dates, locations and items of work affected by the claim.

(b) The date actions resulting in the claim occurred or conditions resulting in the claim became evident.

(c) A copy of the notice of claim filed by the Contractor for the specific claim.

(d) The name, title and activity of each Highway Department employee knowledgeable about facts that gave rise to such claim.

(e) The name, title and activity of each Contractor or subcontractor employee knowledgeable about facts that gave rise to such claim.

(f) The specific provisions of the contract supporting the claim, and a statement why the provisions support the claim.

(g) The identification of any pertinent documents, and the substance and date of any material oral communication relating to the claim.

(h) A statement whether the additional compensation or extension of time is based on the provisions of the contract, including breach of contract, or other basis in law outside the contract, with detailed support of the basis a claim may be made outside the terms of the contract.

(i) If an extension of time is also sought, the specific days for which the extension is sought and the basis for such a claim as determined by an analysis of the construction schedule.

(j) The amount of additional compensation sought with an itemized accounting of that amount.

105.16.8 Required Certification of Claims. The claim submittal shall include the Contractor's written certification, under oath, attesting to the following:

(a) The claim is made in good faith.

(b) Supporting data is accurate and complete to the Contractor's best knowledge and belief.

(c) The amount requested includes all costs related to the specific claim and that no additional related claims will be submitted.

(d) The amount of the claim accurately reflects the Contractor's actual cost incurred. To comply with this requirement, the Contractor shall file a notarized statement with the claim, in which the statement includes at least the following:
AFFIDAVIT FOR CLAIM

State of ( )

County of ( )

(Name of the Person Making this Affidavit), the (State Your Title or Position in the Firm) [hereinafter ""the Affiant""], of (State the Name of the Firm Submitting the Claim), [hereinafter ""the Claimant""], being first duly sworn upon his or her oath, states as follows:

1. This Affidavit is made upon the personal knowledge of the Affiant, and is authorized by the Claimant to be made in behalf of the Claimant.

2. The Claim being submitted by the Claimant to the St. Charles County Highway Department at this time on (Road), (County), (Job No.), is made in good faith. The Affiant has the requisite knowledge of the Claim, and the facts and supporting data, to be able to make this Affidavit and accurately attest to the facts herein.

3. The amount requested includes all costs related to the claim or controversy and that no additional claim will be submitted.

4. All documents, records, charts, schedules, computer programs and printouts, and other data of any nature or description, which are submitted in support of this Claim pursuant to Sec 105.16.7 of the St. Charles County Standard Specifications for Arterial Highway Construction are accurate and complete in all respects, to the best knowledge and belief of the Affiant and the Claimant.

5. Under all applicable penalties of state or federal law for perjury, submitting a false affidavit or statement, fraud, stealing or other falsification, the Affiant hereby certifies that this Claim for extra compensation and time, if any, submitted herewith by the Claimant for work performed on this contract, is a true and accurate statement of the Claimant's actual costs incurred and time sought in performing the contract work, and is fully documented and supported under and pursuant to the contract described above between the Claimant and St. Charles County.

6. This Affidavit is given in compliance with Sec 105.16 of the St. Charles County Standard Specifications for Arterial Highway Construction, which forms a part of that contract.

________________________________________
(Type or Print Name of the Claimant)

By: (Affiant's Legal Signature)

Subscribed and sworn to before me, a notary public, on this day of ________, (year).

________________________________________
Notary Public

My commission expires:

105.16.8.1 The person signing the claim and affidavit under oath shall be the owner if the Contractor is a sole proprietorship, shall be a general partner if the Contractor is a partnership, shall be an authorized agent if the Contractor is a limited liability company or joint venture, or shall be an authorized officer or member of the board if the Contractor is a corporation.
105.16.8.2 No claim shall be deemed filed under the contract by a Contractor until:

(a) Every item of information provided for in Sec 105.16.7 has been provided or the Contractor makes an affirmative, unequivocal statement as part of its claim that no record, document or information provided for by a specific provision of that section exists, and

(b) The sworn certification precisely as set forth in Sec 105.16.8 has been made and delivered to the St. Charles County Engineer.

105.16.9 Duty to Supply Records and Information Regarding a Claim or Controversy. The County is subject to a legal duty to pay no additional sum to a Contractor after a contract has been entered into and performed in whole or part, or any claim under any agreement or contract made without express authority of law. The County is under the further legal duty to pay only those claims that are supported, which have a basis in the terms of the contract and applicable state law as fairly construed and which are in accordance with prevailing principles of public contract law. The County is obligated by law to set forth both the contractual basis and the cost data, supported by audit, of actual costs incurred by the Contractor to substantiate any amount paid.

105.16.9.1 Record Retention. From and after the date the Contractor determines a cause has occurred for a possible contract adjustment, and notwithstanding any policy the Contractor may have regarding record retention, the Contractor shall retain all files, records and data, in whatever form, that relate to the Contractor’s bid and performance of the contract relevant to the possible contract adjustment.

105.16.9.2 Duty to Supply Information. During the review of the claim, the Contractor and the Contractor’s subcontractors and suppliers shall cooperate with St. Charles County and shall provide, if requested, access to the documents that contain the below information, to the extent requested by the County and the County’s attorneys or consultants. Request for some, but not all, of the following information will not preclude the County’s right to request the same or additional information at another time:

(a) Job site superintendent and foreman diaries, daily time sheets and daily reports of all types.

(b) Any union agreements applicable to the work, including any amendments.

(c) Insurance, welfare and benefits records.

(d) Earnings records of salaried and hourly personnel charged as costs of the work.

(e) Payroll tax and withholding returns.

(f) Material invoices, purchase orders, and all material and supply acquisition contracts.

(g) Material cost distribution worksheets.

(h) Records for all equipment whose use was included either in the bid or which was charged to the project. This should include internal equipment rates used for both purposes, as well as equipment leased from third parties and from affiliates and related parties. All lease or rental agreements shall be provided.

(i) Vendor rental agreements and contracts with subcontractors and suppliers.

(j) Payment records and invoices for subcontracted work.

(k) Canceled checks (payroll and vendors).
(l) Job cost reports, both periodic and final, and both the summary and supporting reports, for all costs charged to the contract and for any changes to the work, including any reports that compare estimated with actual costs.

(m) General ledger, general journal (if used) and all subsidiary ledgers and journals, including all supporting documentation pertinent to entries made in these ledgers and journals, whether paper or computer-maintained.

(n) Financial statements with all footnotes and attachments for all years in which the Contractor performed work on the project.

(o) Depreciation records on all company equipment, and all documents used to develop the actual cost of owning and operating equipment used in the work.

(p) All documents that reflect the Contractor's actual profit and overhead during the time the work was being performed, and for each of the two years prior to the beginning of the project.

(q) All bid records related to the preparation of the Contractor's bid, including the final calculations on which the bid was determined.

(r) Worksheets, working papers and all other records used in or the product of preparation of the claim. This includes those showing the cost components claimed and how the amounts claimed were computed. Without limitation, this is intended to include personnel and equipment production analysis, schedule analysis, all data inputs used or developed for computer analysis or generation of the claim.

(s) Projected and actual personnel and equipment loading plans.

(t) Any internal budget for the project.

105.16.9.3 Confidentiality of Records. The Contractor and, if applicable, the Contractor’s subcontractors and suppliers, shall deliver to the County and the County’s attorneys or consultants, all information and documents requested, not withstanding any claim of confidentiality or proprietary interest in the records. The County and the County’s attorneys and consultants will affirmatively act to protect the records and information from disclosure beyond those persons having a need to know the information for the purpose of making a decision regarding the claim, or for law enforcement purposes. The Contractor shall identify and segregate any documents or information that the Contractor considers particularly sensitive.

105.16.10 On any claim for additional compensation for work on the project, whether claimed under the contract, for a differing site condition, as a change in the work, for breach of the contract, for a positive representation by which the contract was induced or otherwise, the following items shall never be allowable or claimed directly or indirectly:

(a) Attorney fees, consultant or claims preparation costs, or costs related to litigation.

(b) Any item that would not be eligible for federal-aid participation under the provisions of 23 CFR 635.124, regardless of whether the project is one approved by the FHWA.

(c) Any item that would be an expressly unallowable cost under the provisions of 48 CFR Part 31, Subparts 31.1 and 31.2, or as it may be amended, superseded or replaced during the life of the contract.

105.16.11 Any claim, controversy or item of any claim or controversy not included in the writings required to be filed in Sec. 105.16, or any claim included but not clearly defined and specifically set out, itemized and supported,
or any notice or claim not filed within the time and in the manner provided in Sec 105.16, shall be forever waived, and shall neither constitute the basis of nor be included in any legal action, counterclaim, defense, set-off, arbitration or other alternative dispute resolution procedure mutually agreed upon between the parties.

105.16.11.1 The omission of any claim or of the detail required to be in a claim in accordance with Sec 105.16 will not be subject to cure by making the claim or supplying the details in any later court or alternative dispute resolution proceeding.

105.16.11.2 The County has established a written procedure for handling Contractor claims and controversies that provides the process for resolution of all claims and the Engineer's final decision. The completion of that process and the Engineer's final decision will be a condition precedent to any legal action, counterclaim, defense or set-off concerning the matters claimed. Any claim or controversy, or any portion thereof that has not been presented for handling in accordance with the County’s Contractor claims and controversies procedure will not be subject to resolution in an alternate dispute resolution process.

105.16.12 The County’s review of a claim pursuant to Sec 105.16 will be in addition to the right or duty of the County to conduct audits or other reviews of a claim or Contractor's books of account or operations otherwise provided by federal or state laws or the rules of civil procedure.

105.17 Venue. Any action concerning any matter, thing or dispute arising out of or relating to the terms, performance, non-performance or otherwise of the agreement, shall be filed in the Circuit Court of St. Charles County, Missouri. The parties agree that the contract is entered into at St. Charles, Missouri, and substantial elements of the contract’s performance will take place or be delivered at St. Charles, Missouri, by reason of which the Contractor consents to venue of any action by or against the Contractor in St. Charles County, Missouri. The Contractor shall cause this provision to be incorporated in all of the Contractor’s agreements with, and to be binding upon, all subcontractors in the performance of this agreement.

105.18 Equipment/Vehicle Parking on Public and Private Property.

105.18.1 The Contractor’s equipment and vehicles may be parked on the St. Charles County maintained road or adjacent right-of-way at the close of each day and at the termination of operations for each job site unless other arrangements have been made by the Contractor. If the Contractor elects to park equipment and vehicles on private property, it shall produce and submit a letter of authorization from the affected property owner at least one working day prior to the time it intends to use the property for that purpose. Private roads and public streets not maintained by St. Charles County may not be utilized for parking as part of the contract.

105.18.2 Prior to the parking of equipment or storing of material on public and/or private property, the Contractor shall also receive approval from the Engineer. The location of the parked equipment or stored materials shall not restrict sight distance at any street or driveway intersection, cause lane restrictions, or block fire hydrants or mailboxes. Any parked equipment or stored material shall be properly protected as directed by the Engineer.
SECTION 106
CONTROL OF MATERIAL

106.1 Source of Supply and Quality Requirements.

106.1.1 All material needed in the work shall be furnished by the Contractor, unless otherwise stated in the contract. The Contractor shall assume full responsibility for ordering material of the required quality and quantity. The Contractor shall be responsible for the delivered costs of all material ordered.

106.1.2 The material used in the work shall meet all quality requirements of the contract, and shall be obtained from supply sources that meet the approval of the Engineer. If a uniform product is not being furnished from a supply source or if for any reason, the product from any source at any time proves to be unsatisfactory, the Contractor may be required to furnish approved material from other sources. The Engineer may reject the entire output of any source where it is impractical to secure a continuous flow of uniformly satisfactory material.

106.1.3 Any work incorporating material having no prior approval from the Engineer shall be performed at the Contractor's risk and may be considered unacceptable and unauthorized and, if so considered, will not be paid for. If a change in source will affect the control or appearance of the work, the use of any one kind or class of material for a specific project from more than one source will be prohibited, except as approved by the Engineer. If approved, the Engineer will set forth the conditions under which the change may be made.

106.1.4 Material will be subject to inspection or test at any time during production or manufacture or at any subsequent time prior to or after incorporation into the work. The points of inspection will be determined by the Engineer. Material for sampling will be selected by the Engineer. Material provided by the source solely as a sample of that material for testing verification will not be permitted. Initial inspection, testing and approval or rejection will be made as early as practical. The Engineer may waive any of the requirements regarding determination of quality and accept material on certification or visual inspection if, in the judgment of the Engineer, the quantity involved is too small or the material use is not sufficiently important to warrant tests.

106.1.5 To expedite the inspection and testing of material, the Contractor shall submit a list of proposed sources of material to the Engineer at the pre-construction conference or two weeks prior to beginning work, whichever is earlier. The list shall be in a format acceptable to the Engineer. At the option of the Engineer, material may be approved at the source of supply before delivery is started.

106.2 Local Material Sources.

106.2.1 Designated Sources. The County may acquire the right and make available to the Contractor the right to take material from sources designated on the plans or described in the contract including the right to use designated property if so specified, for plant site, stockpiles and haul roads. In general, the quality of material contained in such sources will be considered acceptable, but the Contractor shall determine the method of operation, equipment and work required to produce a material meeting the specifications from the source. Designation of a source for material will not be a representation of the quantity of acceptable material obtainable or the method, equipment or work required to obtain material from the source. It is not feasible to ascertain from samples the limits for an entire deposit, and variations will be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable.

106.2.2 Contractor Furnished Sources. If sources of material are not designated on the plans or described in the contract, or if the Contractor desires to use material from sources other than those designated, the Contractor shall acquire the necessary rights to take material from the sources and shall pay all costs related thereto, including any that may result from an increase in length of haul. All costs of exploring, meeting environmental requirements and developing such other sources shall be at the Contractor’s expense. Environmental compliance documentation shall follow MoDOT guidance for Contractor furnished borrow and shall be submitted to the County for review and
approval. The use of material from other than designated sources will not be permitted until representative samples taken by the Contractor in the presence of the Engineer have been approved and written authority is issued for the use thereof. If sources of material or material deposits are provided by the Contractor, the Engineer will test the samples and determine the suitability of the material.

106.2.3 Operation of Sources. Whether sources of material are acquired and made available by the County or are furnished by the Contractor, activities shall be in compliance with all federal and state laws and the areas shall be excavated or worked in such a manner to comply with the current St. Charles County Pollution Prevention Plan and minimize siltation of streams, lakes, ponds and reservoirs.

106.2.4 Final Condition of Sources. Unless otherwise permitted, pits and quarries shall be excavated such that water will not collect and stand therein. Sites from which material has been removed shall be left in such a condition to avoid or minimize siltation of streams, lakes, ponds and reservoirs, and shall be left in a neat and presentable condition upon completion of the work.

106.3 Samples, Tests and Cited Specifications. There shall be no direct charge to the County for material taken as samples, either for field tests or for laboratory tests. If a specification of a recognized national standard agency (AASHTO, ASTM, AWS, AWWA, etc.) is designated, the material shall meet either the designated specification if a date is indicated or the latest revision thereof in effect at the time of bid opening. Tests of samples of material will be conducted by the Engineer in accordance with the methods specified in the contract or in accordance with the latest methods in effect at the time of bid opening, as prescribed by the national standard agency. Such national standard specifications and methods of tests will include those designated as tentative, interim or amended and officially approved and published by the sponsoring agency. If appropriate methods have not been so prescribed, tests shall be performed in a manner determined by the Engineer.

106.3.1 Contractors and subcontractors will be required to produce letters of certification or certified test reports from material producers and suppliers in order to determine compliance with specifications for designated materials prior to the incorporation thereof into the work. No payment will be made to the Contractor by the Engineer for pay items, either in whole or in part, until certifications related to that pay item are received by the Engineer. No direct payment will be made for this work.

106.3.2 The Engineer will determine which materials are to be tested. The form and content of these reports shall be in accordance with recognized standards and practices for this work or as otherwise determined by the Engineer. No direct payment will be made for this work.

106.4 Plant Inspection. The Engineer may inspect material at the source. If plant inspection is undertaken the following conditions shall be met.

106.4.1 The Engineer shall have the cooperation and assistance of the Contractor and the producer of the material.

106.4.2 The Engineer shall be permitted unlimited access to all parts of the plant as required for adequate inspection of the plant equipment and for selection of samples. Facilities shall be furnished for the procurement of samples, performance of the tests and for the protection of testing equipment and supplies when tests are conducted at the source of production.

106.4.3 If bituminous shipments are considered by the Engineer to justify testing at the source, laboratory facilities and testing equipment meeting requirements of the prescribed methods shall be provided by the supplier. The space and equipment shall be adequate for the orderly and proper testing of material without interference to or by the refinery personnel.

106.4.4 Not Used.
106.4.5 The County will refuse to provide plant inspection at sources where adequate safety measures are not provided and maintained.

106.4.6 The County reserves the right to inspect plant equipment and to retest all material prior to or after incorporation into the work and to reject all material which, when retested, do not meet the requirements of the specifications.

106.5 Storage of Material. The Contractor shall be responsible for proper storage and handling of all materials to insure preservation of required quality. The Engineer may direct that materials be placed on wood platforms, or other hard, clean surfaces, or that they be protected from the weather. Materials in storage shall be so arranged as to facilitate inspection.

106.6 Handling Material. All material shall be handled in such a manner as to preserve the material's quality and fitness for the work. Aggregate shall be transported from the storage site to the work in tight vehicles constructed to prevent loss or segregation of material after loading and measuring.

106.7 Unacceptable Material. All material not in accordance with the specifications, when initially inspected and tested, will be considered defective, and all such material, whether in place or not, will be rejected and unless remedied, shall be removed from the site of the work. Test results from any sample will be considered representative of the material, and a final determination of specification compliance will be made on the basis of that sample. Any approved material that, in the judgment of the Engineer, is no longer specification compliant will be rejected. Defective material, including any material furnished by the County that has been damaged by the Contractor after delivery, shall be replaced or reconditioned by the Contractor at the Contractor's expense. Rejected material that has been reconditioned or corrected such that the material satisfactorily meets the specifications shall not be used without the Engineer's written approval.

106.8 Material Furnished by the County. If any material is to be furnished by the County, special provisions designating such material will be included in the contract documents. The cost of handling and placing such material after delivery to the Contractor will be considered as part of the contract price for that material or work. The Contractor shall be responsible for all material upon receipt, and deductions will be made from any monies due to the Contractor to make good any shortages and deficiencies, from any cause whatsoever, for any damage that may occur after such delivery and for any demurrage charges.

106.9 Buy America Requirement. Section 337 of the Surface Transportation and Uniform Relocation Assistance Act of 1987, and 23 CFR 635.410 impose certain Buy America provisions that limit the procurement of foreign products and materials. On all Federal-aid construction projects, all products of iron, steel, or a coating of steel which are incorporated into the work must have been manufactured in the United States. The Contracting Authority may allow minimal amounts of these materials from foreign sources, provided the cost does not exceed 0.1 percent of the contract sum or $2,500, whichever is greater. The Contractor certifies that these materials are of domestic origin. Additional information regarding the “Buy America” requirements can be found at: https://www.fhwa.dot.gov/construction/cqit/buyam.cfm.

106.10 Units.

106.10.1 Equipment. Equipment such as scales, concrete and asphalt plants, and placement equipment shall be scaled in or measured in English units. Equipment requiring calibration will be calibrated using the equipment’s “as manufactured” units.

106.10.2 Material. All material shall be furnished quantified in the specified units of measure for dimensions and other physical aspects. Any cost of re-design due to use of material with units of measure other than as specified by the contract shall be at the Contractor’s expense.
106.10.3 Project Documentation. All project tickets, paperwork for measurement, certifications or reporting of material shall be in English units.
107.1 Laws to be Observed. The Contractor shall know, observe and comply with all federal and state laws, local laws, codes, ordinances, orders, decrees and regulations existing at the time of or enacted subsequent to the execution of the contract that in any manner affect the prosecution of the work, except as specified in the contract or as directed by the Engineer. The Contractor shall also ensure that any subcontractor of the Contractor know, observe and comply with all federal and state laws, local laws, codes, ordinances, orders, decrees and regulations as outlined above. The Contractor and surety shall indemnify and save harmless the State, the County, the County’s agents, employees and assigns from any claim or liability arising from or based on the violation of any such law, code, ordinance, regulation, order or decree, except any local regulations, decrees, orders, codes or ordinances that the contract or the Engineer has specifically directed that the Contractor need not obey.

107.1.1 Federal Aid Provisions. When the United States Government pays all or any portion of the cost of a project, the Federal laws, and the rules and regulations made pursuant to such laws, shall be observed by the Federal agency as provided in Sec. 105.10. The Missouri Highway and Transportation Commission acts as a coordinating agent between the County and the Federal agency and, therefore, the work and project records shall also be subject to inspection by agents of the Missouri Highway and Transportation Commission.

107.1.2 Contract and Legal Inconsistency. The Engineer shall be notified immediately in writing if any discrepancy or inconsistency is discovered between the contract and any law, ordinance, regulation, order or decree.

107.1.3 Local Building and Zoning Codes or Ordinances. The projects of the County are not typically subject to local building or zoning codes. Therefore, the Contractor usually need not obtain a local building or zoning permit or variance for work done exclusively as the County's Contractor on the County's project and the County's right of way. Other local codes or ordinances may not apply to the County, and thus to the Contractor as well. If any questions arise concerning whether the Contractor shall comply with a local code, ordinance, decree or order of any type, the Contractor shall advise the Engineer of the problem immediately, for resolution by the Engineer. This provision will not exempt the Contractor from the requirement of thoroughly researching and determining, before submitting a bid on the contract and from complying with, all federal, state or local laws, regulations, codes, ordinances, decrees or orders that may apply to the contract work. The County will not be responsible for the Contractor's failure to be informed before bidding as to the federal, state and local laws, regulations, codes, ordinances, decrees or orders that may govern the contract work, or for the Contractor's failure to determine before bidding which of these does not govern the contract work.

107.1.4 Authentication of Certain Documents. If plans, plats, detailed drawings or specifications for falsework, cofferdams or any other work are required to be submitted to the Engineer, the documents shall be signed, sealed and stamped in accordance with the laws relating to the practice of architecture and professional Engineering in the State of Missouri (Chapter 327, RSMo).

107.2 Permits, Licenses and Taxes. Except as otherwise provided in the contract, the Contractor shall procure all permits and licenses, shall pay all charges, fees and taxes, and shall give all notices necessary and incidental to the due and lawful prosecution of the work. No direct payment will be made for the cost of complying with this requirement.

107.3 Patented or Copyrighted Devices, Material and Processes. If the Contractor is required or desires to use any design, device, material or process covered by letters, patent, copyright, service or trademark, the Contractor shall arrange and provide for such use by suitable agreement with the patentee or owner, and a copy of the agreement may be required by the County. The Contractor and surety shall indemnify and save harmless the State, the County, the County’s agents, employees and assigns from any suits, claims or damages arising from the infringement upon or use of any patented, copyrighted or registered design, device, material, process or mark.
107.4 Safety and Sanitary Provisions. The Contractor shall at all times take the necessary precautions to protect the life, health, safety and welfare of all persons employed on the project, including subcontractors, governmental representatives, and inspection personnel. The Contractor shall also take necessary precautions to protect the safety and welfare of the public while traveling or residing within the project limits from any hazard associated with the project work. The Contractor shall be familiar with the latest accepted traffic control and accident prevention methods and shall provide the necessary signage, safety devices and safeguards accordingly. The County reserves the right to refuse to provide inspection services at plants or work sites where adequate safety measures are not provided and maintained. As it is the Contractor’s responsibility to maintain all work areas in a safe condition, it will be the responsibility of the Contractor to continuously inspect the work site and traffic control for unsafe conditions arising from its work and shall to take all necessary actions to correct unsafe conditions, whether noted or unnoted by the County.

107.4.1 Safety officer. The Contractor shall provide to the County the name of the Company’s Safety Officer prior to the start of any work. The company Safety Officer will be notified anytime the County determines that, despite previous instruction to correct, the Contractor’s field personnel are not properly establishing or maintaining traffic control devices or using construction practices that adhere to the specifications regarding traffic handling and/or otherwise present a threat to the public safety and welfare. In the case where a Safety Officer does not exist, the name of an officer in the company with the authority to implement immediate corrections to the safety deficiencies shall be provided.

107.4.2 The Contractor shall provide and maintain in a neat and sanitary condition, such accommodations for the use of employees as may be necessary to comply with the requirements and regulations of any agency having jurisdiction over public health and sanitation. The Contractor shall permit no public or private nuisance.

107.4.3 All sanitary facilities and safety devices shall be furnished free to employees and no direct payment will be made for such facilities or devices.

107.5 Public Conveniences and Safety. The Contractor shall conduct the work in a manner that will ensure, as far as practical, the least obstruction to traffic and shall provide for the convenience and safety of the general public and residents along and adjacent to the highway in an adequate and satisfactory manner.

107.5.1 Obstructions Prohibited. Fire hydrants on and adjacent to the highway shall be kept accessible to firefighting apparatus at all times, and no obstruction shall be placed within 15 feet of any such hydrant. Footways, gutters, sewers, outlets, inlets and portions of highways adjoining the work under construction shall not be obstructed. Pavements over which hauling is performed shall be kept clean of spilled or tracked-on material at all times when in use by traffic.

107.5.2 Objects Potentially Affecting Navigable Airspace. The Contractor shall comply with all federal regulations pertaining to constructing, erecting or installing any object, temporary or permanent, which could potentially affect navigable airspace.

107.5.3 Material and Equipment. During construction hours, equipment, material and vehicles utilized in construction of the project will only be permitted on shoulders, medians or pavements where the locations are closed to traffic, properly signed and occupied by ongoing construction operations, unless otherwise approved by the Engineer. Except in cases of emergency, construction equipment, material and vehicles will not be permitted on pavements or shoulders being utilized by traffic. If the contract specifies time periods the Contractor will not be permitted to perform work, construction equipment or vehicles shall not enter or leave the construction area via the pavements handling traffic nor be operated on the pavements handling traffic within the construction area during the restricted time periods. During non-construction hours, construction equipment, material and vehicles will not be permitted within 12 feet of the edge of the pavement or shoulders carrying traffic unless the equipment, material and vehicles are located in a properly protected area, an off-site storage area or as otherwise directed by the Engineer.
107.5.4 Temporary Ways. The Contractor shall provide and maintain at its expense such temporary roads, pedestrian walkways and other items as may be necessary to provide access to residential properties and commercial establishments abutting the highway under construction, as well as temporary approaches to and crossings of intersecting roads and railroads, unless otherwise provided in the contract. To accommodate traffic on the roadway under construction, the Contractor shall at its expense provide and maintain in a passable condition all necessary bypasses around culverts.

107.5.4.1 Parcel Access. The Contractor shall provide access to driveways at all times unless approval has been otherwise given by the property owner. Proof of such approval must be provided to the Engineer. The Contractor should expect to stage driveway work to provide access to property owners. The Contractor must notify each homeowner 48 hours in advance of any work which will affect access to their property. The Contractor shall provide access suitable for the needs of the parcel owners’ vehicles (e.g. low riding vehicles, trailers, RVS, farm equipment, etc.).

107.6 Bridges over Navigable Waters. All work on navigable waters shall be conducted such that free navigation of the waterways will not be interfered with and that existing navigable depths will not be impaired except as allowed by permit issued by the USCG or the USACE.

107.7 Use of Explosives. The use of explosives is not encouraged. The Contractor must obtain approval in writing from the County Engineer prior to use of explosives. The Contractor should not assume that the use of explosives will be approved in making any bid.

107.7.1 All blasting operations shall be conducted under the direct supervision of a licensed blaster as required by the Missouri Blasting Safety Act. When explosives are used in the prosecution of the work, the Contractor shall use the utmost care to prevent bodily injury and property damage. The Contractor shall be responsible for damage resulting from the use of explosives. The Engineer will have the authority to suspend any unsafe blasting operation. The Contractor shall be familiar and comply with the rules and regulations of any city, county, state or federal agency or any other agency that may have jurisdiction in the handling, loading, transporting, storage and use of explosives. All places used for explosives storage shall be marked clearly "DANGEROUS EXPLOSIVES".

107.7.2 Before beginning work, the Contractor shall furnish the Engineer letters of approval for the proposed operation from the appropriate regulating agencies. Prior to submitting a request to use explosives the contractor must obtain a permit from the St. Charles County Community Development Department. All cost of obtaining the permit shall be borne by the Contractor. The Contractor shall notify in writing the appropriate fire protection jurisdiction of the intent to store, transport or use explosives and shall provide proof of notice to the Engineer. The Contractor shall provide the Engineer with copies of all permits, blasting logs and seismic monitoring data.

107.7.3 The Contractor shall notify in advance each property owner, tenant and public utility company having structures or facilities which may be impacted by the use of explosives.

107.7.4 Removal of any item or material of any nature by blasting shall be done in such a manner and at such time as to avoid damage affecting the integrity of the design and to avoid damage to any new or existing structure, whether on County right of way or private property, included in or adjacent to the work. Unless the contract documents or the Engineer restricts such operation, the Contractor shall be responsible for determining a method of operation to ensure the desired results and the integrity of the completed work.

107.7.5 The Contractor and surety shall indemnify and save harmless the County, it’s agents, employees and assigns from any claim related to the possession, transportation, storage or use of explosives.

107.8 Preservation of Monuments and Artifacts.
107.8.1 Monuments. The Contractor shall not disturb or damage any land monument or property landmark unless authorized by the Engineer.

107.8.2 Human and Archaeological Remains. The Contractor shall report to the Engineer the discovery of human remains, artifacts, fossils and other items of historical, archaeological or geological significance discovered within the right of way during construction. Such items will remain in the County's custody and shall not be removed from the site unless directed by the Engineer. The preservation and handling of such items shall be in accordance with Sec 203.2.9.

107.9 Forest and Park Protection. Environmental and sanitary laws and regulations regarding the performance of work within or adjacent to state or national forests or parks shall be obeyed. The Contractor shall keep the project site in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with the regulations and instructions issued by the forest or park supervisor. The Contractor shall require employees and subcontractors, independently, and at the request of forest officials, to prevent and suppress forest fires, and to notify a forest official of the location and extent of any fire.

107.10 Environmental Protection. The Contractor shall comply with all federal, state and local laws and regulations controlling pollution of the environment. Pollution of streams, lakes, ponds and reservoirs with fuels, oils, bitumens, chemicals or other harmful material and pollution of the atmosphere from particulate and gaseous matter shall be avoided.

107.10.1 Fording of streams and fill for temporary work not specified on design plans will not be permitted unless the plan for such operation is authorized by the Corps of Engineers, meets the approval of the Engineer, complies with the current St. Charles County Pollution Plan and results in minimum siltation to the stream. Temporary stream crossings shall not be constructed unless specifically designated as a condition of the Corps of Engineers Section 404 permit or a permit is obtained, and the temporary stream crossing is in accordance with Sec 806.100.

107.10.2 When work areas or pits are located in or adjacent to streams, the areas shall be separated from the main stream by a dike or barrier to keep sediment from entering the stream. Care shall be taken during the construction and removal of such barriers to minimize siltation of the stream.

107.10.3 Disposal of Portland cement concrete residue and wash water, water from aggregate washing or other operations resulting in sediment shall be treated by filtration, settling basins or other means sufficient to reduce the sediment concentration to applicable limits established by MDNR.

107.10.4 Sec 806 and the erosion control sheets of the construction plans provide the minimum requirements for the Storm Water Pollution Prevention Plan (SWPPP) that the Contractor must provide. The Contractor by entering into the Contract assumes the responsibility as an agent of St. Charles County to adhere to all provisions of the County’s General Operating Permit issued by Missouri Department of Natural Resources (MDNR) for land disturbances. The County reserves the right to deduct monies owed the Contractor for any fine levied on the County as a result of the Contractor not adhering to Best Management Practices in relation to Storm Water Control.

107.11 Responsibility for Claims for Damage or Injury. The Contractor and insurance company shall indemnify and save harmless the State, the County, the County’s agents, employees and assigns from all claims or suits made or brought for bodily injury, death or property damage, arising from performance of the work to the extent of:

(a) The negligent acts or omissions of the Contractor, subcontractors, suppliers or their respective officers, agents or employees.

(b) The creation or maintenance of a dangerous condition of or on the County's property or right of way, which condition occurred due to the acts or omissions of the Contractor, subcontractors, suppliers or their
respective officers, agents or employees or for which the Contractor had knowledge of or could have had knowledge of the condition in time to warn of or repair said condition.

(c) The failure of the Contractor, subcontractors, suppliers or their respective officers, agents or employees, to perform the work in accordance with the plans and specifications.

107.11.1 The Contractor will not be required to defend, indemnify or hold harmless any other person, including the State, the County, or the County’s agents, employees or assigns for any acts, omissions or negligence of other persons.

107.11.2 Neither the County nor the Contractor, by execution of a contract, shall intend to or create a new or enlarge an existing cause of action in any third party. This provision shall not be interpreted to create any new liability that does not exist under the statutory limited waiver of sovereign immunity, or to waive or extinguish any defense that either party to this contract or their respective agents and employees may have to an action or suit by a third party.

107.12 Contractor’s Responsibility for Work. From the earlier of the date of commencement of the work or the effective date of the notice to proceed, and until any work is accepted by the Engineer, the work shall be in the custody and under the charge and care of the Contractor. Issuance of a payment invoice on any part of the work done will not be considered as final acceptance of any work completed up to that time.

107.12.1 Damages to any portion of the work before the work is completed and accepted, caused by the action of the elements or from any other reason, shall be repaired or replaced at the Contractor's expense. The Contractor, at the Contractor’s option, may insure against any such damages. The County may, in its discretion, make such a payment, determined in accordance with Sec 109.4, for damage to the work due to unforeseeable causes beyond the control of, and without fault or negligence on the part of the Contractor, unless the Contractor has been reimbursed for such damages by the Contractor’s insurer. Prior to reimbursement, the Contractor shall furnish documentary evidence of all efforts to recover such repair costs.

107.12.2 The Contractor shall immediately give written notice to the Engineer of any pedestrian or vehicular accident. The Contractor may be directed by the Engineer to repair permanent County facilities that have been damaged by events that are beyond the control of the Contractor. Reimbursement will be provided by the County, determined in accordance with Sec 109.4, for the actual direct cost of labor, equipment and material, exclusive of overhead, indirect or consequential costs of profit. The County may elect to make such repairs in lieu of the Contractor.

107.13 Insurance Requirements. The Contractor shall procure and maintain at the Contractor’s expense until acceptance of the project by the Engineer, insurance for all damages and losses imposed by law and assumed under the contract, of the kinds and in the amounts specified in Sec 107.13.1 through Sec 107.13.4. Before the Contractor begins the work, the Contractor shall require the insurance company or companies to furnish to the Engineer evidence of such insurance showing compliance with these specifications. All insurance required in Sec 107.13 shall be occurrence policies in a form acceptable to the Engineer, and shall remain in force until all work required to be performed under the terms of the contract is satisfactorily completed as evidenced by formal acceptance by the Engineer. Each policy or policy’s declaration pages shall provide that the policy shall not be materially changed or canceled until the Engineer has been given at least 30 days advance notice in writing. If any policy is canceled before the contract work is complete, a satisfactory replacement policy shall be in force, with notice and evidence of insurance submitted to the Engineer, prior to the effective date of cancellation of the former policy. All evidence of insurance and notices shall be submitted to: St. Charles County Highway Department, 301 N. Third Street, St. Charles, MO 63301. Upon request, the Contractor shall promptly furnish the Engineer with a complete copy of the policy. Failure to furnish evidence of proper insurance, or complete insurance policies when requested, will result in the temporary suspension of work as provided in Sec 108, and may result in other claims or actions for breach of contract or otherwise, as may be recognized at law or in equity.
107.13.1 Workers' Compensation Insurance. The Contractor shall furnish evidence to the Engineer that, with respect to the operations the Contractor performs, the Contractor carries workers' compensation insurance, or is qualified by the Missouri Division of Workers’ Compensation as self-insured, and carries insurance for employer’s liability sufficient to comply with all obligations under state laws relating to workers' compensation and employer’s liability. The Contractor shall require each subcontractor on the project to furnish the same evidence to the Engineer. This evidence shall be furnished to and approved by the Engineer prior to the time the Contractor or subcontractor commences work on the site of the project.

107.13.2 Contractor's Liability Insurance with Additional Insured Parties.

107.13.2.1 Commercial Liability Insurance. The Contractor shall carry commercial general liability insurance and commercial automobile liability insurance from a company authorized to issue insurance in Missouri. Each such policy shall name the County Engineer, and the St. Charles County and its employees, as additional named insureds, in amounts sufficient to cover the sovereign immunity limits for Missouri public entities as calculated by the Missouri Department of Insurance, Financial Institutions and Professional Registration, and published annually in the Missouri Register pursuant to Section 537.610, RSMo. These amounts may also be posted on this website: https://insurance.mo.gov/industry/sovimmunity.php. Each policy shall be endorsed to cover liability arising from blasting if applicable, other inherently dangerous activities, and underground property damage. Each policy shall be endorsed to include broad form general liability, contractual liability and completed operations coverage.

107.13.2.2 Annual Updates. The Contractor shall cause the insurer to update the Contractor's liability insurance coverage minimums annually to correspond to the statutory limits as adjusted on an annual basis effective January 1st, and published in the Missouri Register as provided for in section 537.610 RSMo. If a statutory limit of liability for a type of liability specified in this section is repealed or does not exist, the County shall set reasonable limits for that insurance coverage which shall be subject to adjustment periodically, in a written notice from the County to the Contractor.

107.13.2.3 Subcontractor's Coverage. If any part of the contract is subcontracted, each subcontractor, or the Contractor on behalf of that subcontractor, shall obtain the same commercial general liability insurance and commercial automobile liability insurance coverage. The commercial general liability insurance shall name the same entities specified in Sec 107.13.2.3 as additional insureds, and shall have the same separation of insureds conditions.

107.13.3 Navigable Waters Insurance Protection.

107.13.3.1 Description. Any Contractor performing contract work on or adjacent to the Missouri and Mississippi rivers, and any other waters classified as "navigable waters of the United States" by the USACE, shall obtain insurance coverage in accordance with these specifications. The Contractor may also obtain this insurance coverage for any subcontractor who will perform contract work under that contract. Employees of Contractors or subcontractors that perform marine construction work on or near a waterway that is a navigable water of the United States may be subject to maritime law liability for injuries to employees working from vessels in waterways or working from nearby facilities in relation to construction on or over such waterways. Contractors and subcontractors for such work on these navigable waters of the United States shall purchase coverages as required in Sec 107.13.3.2.1 and Sec 107.13.3.2.2.

107.13.3.2 Insurance Requirements. Jones Act Insurance, Longshore and Harbor Workers' Compensation Act Insurance, and Maritime Law Liability Insurance will apply as provided in Sec 107.13.3.2.1 and Sec 107.13.3.2.2.

107.13.3.2.1 Jones Act Insurance. Insurance shall be purchased by any Contractor or subcontractor performing work on or near the Missouri or Mississippi Rivers, or any other navigable waters of the United States, for exposures under the Jones Act, 46 USC, with a minimum limit of $2,000,000 per occurrence and in the aggregate, or as may
be specified by law, whichever amount is higher. The Contractor or subcontractor may obtain insurance covering employees under the Jones Act for any other project for which the Contractor’s insurer deems there is exposure. Insurance under this section covers any employee deemed by the courts as masters or members of crews of vessels who are entitled to seek recovery as “seamen” for injury or death under the Jones Act, or general maritime law. Such coverage may be provided through appropriate endorsements to the Contractor’s or subcontractor’s workers’ compensation policy.

107.13.3.2.2 US Longshore and Harbor Workers’ Compensation Act Insurance. Insurance shall be purchased by any Contractor or subcontractor performing work on or near the Missouri or Mississippi Rivers, or any other navigable waters of the United States, for exposures under the US Longshore and Harbor Workers’ Compensation Act, USC, Title 33, with a minimum limit of $2,000,000 per occurrence, and in the aggregate, or as may be specified by law, whichever amount is higher. The Contractor or subcontractor may obtain insurance covering employees under the US Longshore and Harbor Worker’s Act as defined in this section for any other project for which the Contractor’s insurer deems there is exposure. Insurance under this section covers any employees who do not qualify as masters or members of a crew of a vessel, but perform work in loading or unloading vessels or work from docks, barges or other platforms, and who may be deemed by the courts as entitled to seek compensation for injury or death under the US Longshore and Harbor Workers’ Compensation Act. Such coverage may be provided through appropriate endorsements to the Contractor’s or subcontractor’s workers’ compensation policy.

107.13.4 Railroad Protective Liability Insurance. In addition to other forms of required insurance, the Contractor shall carry railroad protective liability insurance when any of the Contractor’s work is to be performed within any railroad right of way. The policy shall be written using one of the following combinations of Insurance Services Office (“ISO”) Form Numbers: CG 00 35 01 96 and CG 28 31 10 93, or CG 00 35 07 98 and CG 28 31 07 98. The name or names of the railroad companies to be insured will be specified in each contract. The minimum limits of the insurance will be established in the contract documents and provided to the Contractors prior to the opening of bids. The Contractor shall submit the original policy in its entirety and one duplicate to the County for review and transmittal to the railroad. No work will be permitted within any railroad’s right of way until the railroad involved has reviewed and approved the insurance policy. Any day upon which the Contractor cannot perform work due to such a policy not being approved by the railroad will not be counted as a working day under Sec 108.7. SubContractors for any part of the work that is sublet will not be required to obtain railroad protective liability insurance or provide evidence thereof, if the Contractor’s insurance for that purpose covers subcontractors.

107.13.5 Insurance with Other Than Missouri Companies. Any insurance policy required as specified above, if written by an insurance company organized in a state other than Missouri, shall be signed by an agent or broker licensed by the State of Missouri. In the case of policies written by companies organized in a state other than Missouri, the evidence of insurance submitted as authorized in the contract shall be signed by an agent or broker licensed by the State of Missouri. Nothing in this provision limits or waives the requirement that each insurance policy shall be issued by a company authorized to issue such insurance in Missouri.

107.13.6 Combinations. Employer’s liability insurance, commercial general liability insurance and commercial auto liability insurance and insurance under the Jones Act or Longshore and Harbor Workers Compensation Act or Maritime Law Liability requirements, as required by this section, may be arranged under a single policy for the full limits required or by a combination of underlying policies and an excess liability policy, or “umbrella” coverage, which follows the form of the underlying policy.

107.14 Third Party Liability. Neither the State of Missouri, including the County, nor the Contractor, by execution of the contract including these specifications, intend to create a right of action in a third party beneficiary, except as specifically set out in these specifications and the contract. It is not intended by any required contractual liability in the contract or in these specifications that any third party beneficiary has a cause of action arising out of the condition of the project when completed in accordance with the plans and accepted by the County.
107.15 Personal Liability of Public Officials. There shall be no personal liability upon the County Engineer, or any member, employee or agent of the County in carrying out any of the provisions of the contract or in exercising any power or authority granted to the individual, it being understood that in such matters the individual acts as an agent and representative of the County, with official and public duty doctrine immunity. If any provision of the contract appears to impose a duty on such an individual, the duty will remain exclusively that of the County and will not be a personal duty or obligation of the individual.

107.16 Contractors That Are Not Resident In Missouri. Any Contractor that is not a permanent resident of or domiciled in Missouri shall provide to the County proof of compliance with the Missouri "nonresident employers" financial assurance laws at Sections 285.230 to 285.234, RSMo, before the Contractor performs any work on a project.

107.16.1 A nonresident Contractor that is a "transient employer" as that term is defined in Section 285.230.1, RSMo, and 12 CSR 10-2.017(1)(A), shall file with the County a photocopy of the Contractor’s current transient employer's certificate of registration issued by the Missouri Department of Revenue before performing any work on a project. A nonresident Contractor that is not classified by the Missouri Department of Revenue as a "transient employer" because the nonresident Contractor has properly registered with the Missouri Department of Revenue and the Missouri Division of Employment Security, and has filed and paid Missouri state income taxes for more than 24 consecutive months, shall file with the County a photocopy of the Contractor’s certificate of registration, issued by the Missouri Department of Revenue, that it is not a "transient employer" before performing any work on a project.

107.16.2 The Contractor shall require a nonresident subcontractor to file with the County a photocopy of the subcontractor’s current transient employer’s or alternate certificate of registration, as issued by the Missouri Department of Revenue, before that subcontractor performs any work on a project.

107.16.3 Any nonresident Contractor or subcontractor that fails to file the financial assurance forms with the Missouri Department of Revenue as required by Missouri law will be prohibited from contracting for or performing labor on any project for a period of one year.

107.17 Basis of Payment. No direct payment will be made for compliance with Sec 107, except as provided by Sec 618.
108.1 Subletting of Contract.

108.1.1 The Contractor shall not sublet, sell, transfer, assign or otherwise dispose of the contract or contracts or any portion thereof, or of any right, title, or interest therein, without written consent of the Engineer. Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and accompanied by evidence that the organization that will perform the work is particularly experienced and equipped for such work. On contracts with Federal participation, all subcontractors and DBE subcontractors must be approved by MoDOT. In case such consent is given, the Contractor will be permitted to sublet a portion thereof, but the Contractor’s organization shall perform work amounting to no less than 40 percent of the total contract cost. Certification or classification of a Contractor by type of work performed or consent to a subcontract shall not constitute the County’s endorsement of the qualifications of the subcontractor or that the particular subcontractor’s work will constitute compliance with any other provisions of the contract.

108.1.2 The value of the work sublet will be determined by multiplying the number of units of any contract item sublet by the contract unit price in accordance with the original contract or by a price agreed to by the Engineer where no contract unit price is included in the contract for the work sublet. Approval of a subcontract will not constitute approval of the agreed contract unit prices in the subcontract. The subcontractor shall perform the work described in the subcontract agreement. No subcontracts, or transfer of contract, will in any case release the Contractor’s liability under the contract and bonds. Consent to a subcontract will not create a direct contractual relationship between the subcontractor and the County.

108.1.3 The Contractor shall furnish to the County a complete copy of the signed subcontract, and all revisions upon request.

108.1.4 Second tier subcontracting will not be permitted. It will be the responsibility of the Contractor to ensure that its subcontractors do not, in turn, subcontract any portion of the work.

108.1.5 A Contractor, at the discretion of the Engineer, may make a substitution for a subcontract that was disclosed with the bid in accordance with Sec 102.7 or may add a subcontract that would have required disclosure in accordance with Sec 102.7. The Contractor shall submit the name of the new subcontractor, the category of work, the dollar value of each subcontract and the reason for the substitution or addition in writing to the Engineer for consideration.

108.2 Notice to Proceed. The notice to proceed will stipulate the date the Contractor is expected to begin work. The County will issue the notice to proceed by stipulating the date on the notice of award sent to all successful bidders, or on a separate form for this purpose. Prior to the stipulated date, the Contractor shall execute and file the prescribed number of copies of the contract and bond and shall furnish to the County satisfactory evidence of having complied with insurance requirements.

108.3 Prosecution of Work. The Contractor will be expected to start work on the date stipulated by the notice to proceed. If all contract requirements have been met in accordance with Sec 108.2 the Contractor may start work before the date stipulated by the notice to proceed, provided the Engineer is notified in writing at least three days prior to the date on which the Contractor expects to begin.

108.3.1 The Contractor shall continuously and diligently prosecute the work in such order and manner as will ensure the completion of the work within the specified time, and the Contractor shall be fully responsible for the prosecution and coordination of all work being performed under the contract.
108.3.2 The work in progress shall receive the personal attention either of the Contractor or of a competent and reliable representative of the Contractor who shall have full and final authority to act for the Contractor. If authority is delegated to a representative of the Contractor, the Contractor shall notify the Engineer in writing, stating the name of the person authorized to act as the Contractor's representative, and stating the name or names of persons authorized to sign the various documents such as weekly reports, change orders, force account statements, labor payrolls and any other documents that may be required during the progress of the work. If progress at any time is not adequate to meet the Contractor's schedule and the contract completion time, the Contractor shall take all steps necessary to complete the work in the time and manner specified in the contract.

108.3.3 Prior to beginning any work on contracts involving a joint venture, the joint venturers shall appoint and maintain a single representative having full and final authority to act for the joint venture. The Engineer shall be notified in writing of the name of this representative and of any replacements.

108.4 Progress Schedules. The Contractor shall submit a progress schedule to the Engineer for review prior to or at the pre-construction conference. The progress schedule shall be used to establish construction operations and to monitor the progress of the work, although the Engineer's determination of the then major operation or controlling item of work will always prevail. The progress schedule shall be in the form specified in Sec 108.4.1, unless the contract contains different requirements. The progress schedule shall be based on the number of working days, calendar days or other increments as set forth in the contract that the Contractor expects to require in completing the project, recognizing the capabilities of labor, equipment, arrangements for material, mobilization, shop drawing preparation and approvals, and other relevant items. If an electronic computer software program is used to generate the schedule, the initial and any revised schedules shall be accompanied by a disk containing the schedule files in the native format of the software program used to create the schedule. The disk shall be labeled with the contract ID, route, county, date of revision, and the name of the software program used. The Contractor will not be required to provide any copies of the software program.

108.4.1 Form and Contents of Progress Schedule. The progress schedule shall contain an activities schedule chart and written narrative which shall break down into detail the time in working days, calendar days or completion date involved in performing all construction activities for the duration of the project, and shall be in a suitable scale as to indicate the percentage of work scheduled for completion at any time.

108.4.1.1 The activities schedule chart shall contain:

a) A bar chart chronologically sequenced and to time scale showing the order, identity and duration of all construction prosecution and preparation activities and the planned starting date of each activity.

b) The durations represented by a bar shall note periods of planned non-work which exceed three consecutive calendar days and work planned during periods of normal seasonal shutdown or when certain activities are prevented by other provisions of the contract.

c) The critical path of construction activities.

108.4.1.2 The written narrative shall contain:

a) A description of activities so that work can be measured by working days, calendar days or completion date schedule, and activity dependencies are identified;

b) A description of each activity identifying the item and location of the work;

c) A description of the activities schedule chart indicating planned work days per week, days allowed for weather, holidays, number of shifts per day, number of worker hours per shift and major items of equipment to be used to perform each activity.
108.4.1.3 The activities schedule chart and written narrative shall also clearly outline the intended maintenance of traffic, work phasing provided by the contract and such other information as required by the contract or as deemed appropriate by the Engineer.

108.4.2 Preparation of Initial Schedule. The Contractor shall complete development of a progress schedule and present a copy to the Engineer prior to or at the pre-construction conference.

108.4.2.1 The construction time, as indicated by the progress schedule, for the entire project or any milestone, shall not exceed the specified contract time. If any milestone date or contract completion date is exceeded in the schedule, time estimates on the progress schedule shall be revised. The controlling activity shall be clearly shown for each day of the schedule. A controlling activity will be defined as that part of a progress-controlling item or items that must be performed before the next progress-controlling item of work can be started. Following a review of the progress schedule by the Engineer, the Engineer and Contractor will meet for a joint review, correction and adjustment of the schedule, if necessary.

108.4.2.2 If necessary this process will be repeated. However, the schedule shall be finalized by the Contractor within seven days after request for correction and adjustment to the schedule.

108.4.3 Cost and Intent of Progress Schedules The review by the Engineer of any progress schedule will not constitute a determination that the schedule is reasonable, that following the schedule will result in timely completion, or that deviation will result in a delayed completion. The progress schedule, and any updates provided, is not a part of the contract. If the schedule reflects a completion date different than that specified in the contract, that does not void the completion date or working days specified in the contract. If any schedule reflects a completion time earlier than that specified in the contract, the Contractor specifically understands that no claim for additional contract time or compensation will lie against the County if the work is not completed by the earlier time shown on the schedule. It will be the Contractor’s responsibility to determine the most feasible order of work consistent with the requirements of the contract.

108.4.3.1 No direct payment will be made for furnishing progress schedules or revisions.

108.4.3.2 If the Contractor fails to comply with the requirement to supply an initial or any revised progress schedule or if the Engineer determines the original or any revised progress schedule does not provide the information required, the Engineer may withhold progress payments until a schedule complying with this section has been submitted and reviewed.

108.4.4 Revised Progress Schedules. The Contractor shall provide a revised progress schedule, which will then become the current progress schedule:

   a) When requested by the Engineer or required by the contract;

   b) When departure from the existing progress schedule makes it apparent that the project will not be completed in the time provided in the contract;

   c) When the Contractor determines that the progress schedule requires revision for any reason.

108.5 Labor, Methods and Equipment. The Contractor shall at all times employ sufficient labor, methods and equipment for prosecuting the work to full completion in the time and manner required by the contract.

108.5.1 All workers shall have sufficient skill and experience to properly perform work assigned. The Engineer may demand the dismissal of any person employed by the Contractor in, about or upon the work, who engages in misconduct, is incompetent or negligent in the due and proper performance of assigned duties, or who neglects or
refuses to comply with any proper directions given. Such a person shall not again be employed thereon without the written consent of the Engineer. Should the Contractor continue to employ or re-employ any such person, the Engineer may suspend the work until the Contractor complies with such orders.

108.5.2 All equipment used on the work shall be of sufficient size and in such mechanical condition to meet requirements of the work and to produce satisfactory work. The condition or use of equipment on any portion of the project shall not cause damage to the roadway, adjacent property or other highways, or injury to any person.

108.5.3 If the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any method or equipment that will accomplish the contract work in conformity with the requirements of the contract. The failure of the Engineer to object to Contractor's equipment or methods will never constitute agreement that the equipment or methods used are appropriate.

108.5.4 If the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless otherwise authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the contract, authority shall be requested from the Engineer. The request shall be in writing, including a full description of the proposed methods and equipment to be used and an explanation of the reasons for making the change. If approval is given, the Contractor shall be fully responsible for producing work in conformity with the contract. If the Engineer determines that the work produced does not meet contract requirements after use of the substitute method or equipment, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the methods and equipment specified in the contract. The Contractor shall remove deficient work and replace the work as specified in the contract, or take such other corrective action as directed by the Engineer. Except as provided in Sec 104, no change will be made in the basis of payment for the construction items involved or in contract time as a result of approving any method or equipment change.

108.6 Temporary Suspension of Work. The Engineer has authority to suspend any or all of the work in accordance with Sec 105 for such time as necessary. If it becomes necessary to stop work for an indefinite period, the Contractor shall store all material in a manner that will protect the material from theft or damage, shall not unnecessarily obstruct traffic, shall take every precaution to prevent damage to or deterioration of work performed, shall provide suitable drainage of the roadway by opening ditches, shoulder drains, etc. and shall erect temporary structures where necessary. The Contractor may suspend work for reasonable cause upon written approval from the Engineer. During such a period in which work is suspended, liquidated damages will not accrue unless such suspension is due to the Contractor's failure to comply with the contract. If work has been suspended, the Contractor shall notify the Engineer in writing at least 48 hours before resuming operations.

108.7 Contract Time for Completion of the Work. The time for the completion of the work is specified by calendar days, calendar date, or working days, and it is an essential part of the contract. The Contractor will not be entitled to any extension of contract time because of unsuitable weather conditions or contract plan changes unless suspension of the work for such conditions or contract plan changes were approved in writing by the Engineer. Time is an essential element of the contract, and is therefore important that the work be pursued vigorously to completion.

108.7.1 The Engineer may make allowance for time lost due to causes the Engineer determines justify an extension of contract time. If the Contractor claims an extension of contract time on the grounds that it is unable to work due to causes beyond its control, written notice of intention to claim an extension of contract time on the above grounds shall be filed with the Engineer at the time the cause or causes occur. The claim shall be filed in writing within 30 days after the claimed cause for the delay has ceased to exist and shall include a statement of the reasons for the delay, proof to establish the claim, and a statement of the number of days the Contractor was delayed.
108.7.2 Contract completion shall be defined as 100% completion of all items of the project including correction of deficiencies.

108.7.3 Completion by Calendar Days or Calendar Date. Any computation of time by calendar days or calendar date will be based on the seasonal importance of days on the basis of weighted time tables on file and available in the Office of the County Engineer. If a change in the work is directed by the Engineer, the Contractor will be allowed an extension of contract time based on the weighted time tables and the ratio of the cost of such additional work to the contract price, unless it can be established that the additional work required more time than is indicated. In such cases, the actual time required, as determined by the Engineer, may be allowed.

108.7.3.1 If the notice to proceed is not issued and effective within 50 days after the award or the later date specified in the contract due to any failure of the County, the Contractor will be given an extension of contract time equal to the number of calendar days after the 50th day or the later date specified in the contract, until the notice to proceed is effective. Such a delay in the effective date of the notice to proceed will be an excusable, noncompensable delay.

108.7.3.2 The Contractor will not be entitled to any extension of contract time because of unsuitable weather conditions or the effects of weather conditions unless authorized in writing by the Engineer as an excusable, noncompensable delay under Sec 108.14.1.

108.7.4 Completion by Working Days. If the time for the completion of the work is based on working days, this time will be specified in the contract. A working day will be defined as any day when, in the judgment of the Engineer, soil and weather conditions would permit the major operation of the project for six hours or more, unless other unavoidable conditions prevent the Contractor’s operations. If conditions require the Contractor to stop work in less than six hours, the day will not be counted as a working day.

108.7.4.1 December 15 to March 15, both dates inclusive and Saturdays, Sundays, and holidays established by law will not be counted as working days.

108.7.4.2 The count of working days will start on the date the Contractor starts construction operations, or the effective date of the notice to proceed, whichever is earlier. The Engineer will determine when a working day is to be charged. The Engineer may make allowance for working days lost due to causes justifying their elimination from the count of working days. No allowance will be made for delay or suspension of the prosecution of the work due to fault of the Contractor. Throughout the duration of the project, the Engineer will keep the Contractor apprised of the number of working days charged. Any objection by the Contractor to the number of working days so charged shall be made in writing within five days of receipt of said notice of days charged from the Engineer, setting forth the Contractor’s objections and specifying the reasons therefore, or those objections shall be forever waived and will not constitute the basis for an excusable delay.

108.7.4.2.1 Where projects specify signal or lighting equipment as the major work items, working days will not begin until 104 calendar days after the date of the Notice to Proceed or until such time as the signal or lighting equipment is available to the Contractor, or until the Contractor begins work, whichever date is the earliest, to allow time for the fabrication and delivery of signal posts and lighting poles.

108.7.4.3 In case the final value of all work performed exceeds the original contract amount, an extension in the working days will be granted the Contractor. The extension will be made by increasing the contract time by the ratio of the total final cost of all work performed under the contract to the total amount of the original contract. Incentive/disincentive, bonus or deduction adjustments will not be used in this computation. If it can be established that the extra work required more time than indicated, the actual number of working days required, as determined by the Engineer, may be allowed.

108.8 Liquidated Damages for Failure or Delay in Completing Work on Time.
108.8.1 If the Contractor or, in case of default, the surety fails to complete the work within the time specified in the contract, or within such extra time as may be allowed in the preceding sections, a deduction of an amount specified in the contract will be made for each day that the contract remains incomplete after the time allowed for completion. The amount specified in the contract is agreed upon, not as a penalty, but as liquidated damages for loss to the County and the public. This amount will be deducted from any money due the Contractor. The Contractor and surety will be liable for all liquidated damages. Permitting the Contractor to continue the work after the expiration of the specified time or any extension of time will not constitute a waiver by the County of any contractual rights.

108.8.1.1 Not used.

108.8.1.2 Regardless of the method used to specify contract time for completion of the work, liquidated damages will not be charged as follows:

(a) For Sundays and holidays established by law (observed by St. Charles County).

(b) During any period of sod maintenance, as specified in Sec 803, if such maintenance is the only work remaining and the Contractor can perform the maintenance without inconveniencing the traveling public.

(c) During the final 15 consecutive day test period for a signal system, as specified in Sec 902, provided all other work has been completed.

108.8.2 The County will not be required to file a claim or counterclaim under Sec 105.16.5 or any other provision, to assess or retain liquidated damages.

108.8.3 The Contractor and surety shall be liable for liquidated damages chargeable under the contract when the work is completed after default of the contract, unless the delay is caused by the County. A delay in the work or the final completion of the project caused by the County shall not void the provisions of the contract as to liquidated damages and will be considered an excusable, noncompensable delay.

108.9 Signal and Lighting Malfunctions. If the Engineer invokes the option under Sec 901, Sec 902, or Sec 903 to have County personnel or a third party correct a lighting, signal or sign lighting malfunction, the Contractor will be charged for the service. If County personnel make the correction, the charge will be computed as five times the cost for all replacement parts, equipment rental, salaries and fringe benefits. If a third party makes the correction, the Contractor will be charged 1.2 times the charges billed the County by the third party. However, in no case will the charge be less than $100.

108.10 Default of Contract. After notice and an opportunity to remedy, the Engineer may declare the Contractor in default, if the Contractor:

(a) Fails to begin the work under the contract within the time specified to begin work.

(b) Fails to perform the work with sufficient resources to assure the timely completion of the work.

(c) Fails to perform the work in accordance with the contract requirements, or neglects or refuses to remove and replace rejected material or unacceptable work.

(d) Discontinues the prosecution of the work.

(e) Fails to resume work that has been discontinued within a reasonable time after notice to do so.

(f) Becomes insolvent, is declared bankrupt or commits any act of bankruptcy or insolvency, allows any final
judgment to remain unsatisfied or makes an assignment for the benefit of creditors.

(g) Fails to comply with contract requirements regarding prevailing wage payments, DBE or EEO requirements.

(h) Is a party to fraud.

108.10.1 The Engineer will give notice in writing to the Contractor and surety of the condition described in Sec 108.10, and advise the Contractor and surety of the actions required for remedy. If the Contractor does not proceed to remedy the condition within ten days of receipt of this notice, the Engineer may declare the Contractor in default. The declaration of default will be made in writing to the Contractor and the surety.

108.10.2 If within ten days after receipt of the declaration of default, the surety does not proceed to assume the contract for completion under the direction of the Engineer, the County has full power and authority, without impairing the obligation of the contract or the bond:

(a) To take over the completion of the work.

(b) To appropriate or use any or all project material and equipment that is suitable and acceptable.

(c) To enter into agreements with others.

(d) To use such other methods as in its judgment may be required for the completion of the contract in an acceptable manner.

108.10.3 Liability for Costs. The Contractor and surety shall be liable for all costs and expenses incurred in completing the work, and for all liquidated damages in conformity with the contract. The Contractor and surety are obligated to comply with all change orders and directives of the Engineer to the same extent, and for the same compensation, if any, as the Contractor would have been in the absence of default. In case the sum of such liquidated damages and the expense so incurred is less than the sum that would have been payable under the contract if the work had been completed by the Contractor, the Contractor or surety will be entitled to receive the difference. If the sum of such expense and such liquidated damages exceeds the sum that would have been payable under the contract, the Contractor and surety will be liable and shall pay the amount of such excess. This provision will apply regardless of whether the surety or the County completes the contract work. The Contractor and surety will solely be liable for the costs and expenses of a completing Contractor, laborers and suppliers with which either has contracted.

108.10.4 If it is determined after termination of the Contractor’s right to proceed that the Contractor was not in default, the rights and obligations of the parties will be the same as if the termination had been issued for the convenience of the County under Sec 108.11. Sums to which a Contractor may be entitled as a result of the contract termination will be limited to amounts determined under Sec 108.11.

108.10.5 Sureties' Continued Acceptability. A surety failing to proceed within ten days after the written declaration of default by the Engineer under Sec 108.10 may be required to show cause to the County why the surety should continue to be accepted for future bonds.

108.11 Termination of Contract for Convenience of the County. The County may terminate the entire contract, or any portion thereof, if the Engineer determines that a termination is in the County’s best interest. The Engineer will deliver to the Contractor and surety a notice of termination specifying the extent of termination and the effective date. A termination of the contract for convenience may be directed at any time after the County has made a determination to award a contract. The bidding documents may provide for a termination of the contract for convenience under this section upon the occurrence or nonoccurrence of a specified event after bid opening.
108.11.1 Submittals and Procedures. After receipt of a notice of termination, the Contractor shall immediately proceed with the following obligations:

(a) Stop work as specified in the notice.

(b) Place no further subcontracts or orders for material, supplies, services or facilities, except as necessary to complete the portion of the contract that has not been terminated.

(c) Terminate all subcontracts to the extent they relate to the work terminated.

(d) Settle with subcontractors and suppliers all outstanding liabilities arising from the termination.

(e) Transfer title and deliver to the County, work in progress, completed work, supplies and other material produced or acquired for the work terminated, and completed or partially completed plans, drawings, information and other property that, if the contract had been completed, would be required to be furnished to the County.

(f) Complete performance of the work not terminated.

(g) Take any action that the Engineer directs to protect and preserve contract-related property that is in the possession of the Contractor in which the County has or may acquire an interest.

108.11.2 Settlement Provisions. When the County orders termination of all or a part of the contract effective on a certain date, completed items of work as of that date will be paid for at the contract unit price. Payment for partially completed work will be made either at agreed prices or under the provisions below. When items are eliminated in their entirety by such termination, the Contractor will be paid for actual work done and actual costs incurred before notification, including mobilization of equipment or material.

108.11.2.1 Additional Costs. Within 60 days of the effective termination date, the Contractor shall submit any request for additional damages or costs not covered in Sec 108.11 or elsewhere in the contract. Such a request may include only such cost items as: mobilization, overhead expenses proven to be attributable to the project or the part terminated and not paid for under work not terminated, subcontractor costs not otherwise paid for, actual idle equipment and idle labor cost only for any time the work is stopped in advance of the termination date, guaranteed payments for private land usage as part of the original contract, and any other actual cost for which the Contractor feels reimbursement should be made.

108.11.2.1.1 Anticipated profits, including anticipated earnings on usage of owned equipment, and impact, delay or other direct or indirect costs resulting from this termination that are not expressly authorized, will not be compensable as part of any settlement.

108.11.2.2 The Contractor and the Engineer may agree upon the whole or any part of the amount to be paid because of the termination. The amount may include a reasonable allowance for profit on work done. The agreed amount may not exceed the total contract price as reduced by the amount of payments previously made and the contract price of work not terminated. The contract will be amended and the Contractor paid the agreed amount.

108.11.2.2 Additional Cost Review. If the Contractor and the Engineer fail to agree on the whole amount to be paid the Contractor because of the termination of work, the County will pay the amounts determined as follows, but without duplication of any amounts agreed upon in Sec 108.11.2.1:

(a) For contract work performed before the effective date of termination, the total, without duplication of any items of:
(1) The actual cost of work performed.

(2) The cost of settling and paying termination settlements under terminated subcontracts that is properly chargeable to the terminated portion of the contract if not included in Sec 108.11.2.1.

(3) A sum for profit on the actual cost of work performed as determined by the Engineer to be fair and reasonable. The Engineer will allow no profit under this section if the Contractor's costs incurred on work performed exceed the contract prices paid.

(b) The reasonable costs to settle the work terminated, including:

(1) Internal accounting and clerical expenses reasonably necessary for the preparation of termination settlement proposals and support data, including expenses for termination and settlement of subcontracts.

(2) Storage, transportation and other costs incurred, reasonably necessary for the preservation, protection or disposition of the termination inventory.

(c) For normal spoilage and to the extent that the Engineer expressly accepts the risk of loss. The Engineer will exclude the fair value of property that is destroyed, lost, stolen or damaged so as to become undeliverable to the County or to the buyer.

108.11.2.2.1 In arriving at the amount due the Contractor under this clause, there will be deducted:

(a) All advanced payments for mobilization, services or facilities, or other payments to the Contractor under the terminated portion of the contract.

(b) Any claim that the County has against the Contractor under the contract.

(c) The agreed price for or the proceeds from the sale of material, supplies or other items acquired and sold by the Contractor, and not recovered by or credited to the County.

(d) Any costs saved as a result of the termination.

108.11.2.2.2 If the termination is partial, the Contractor may file a proposal with the Engineer for an equitable adjustment of the price or prices of the continued portion of the contract. The Engineer will make any equitable adjustment agreed upon. Any proposal for an equitable adjustment under this clause shall be requested within 60 days from the effective date of termination unless extended in writing by the Engineer.

108.11.2.2.3 The Contractor shall maintain and make available all project cost records to the Engineer for audit to the extent necessary to determine the validity and amount for each item requested. This will include, but is not limited to, all items described in Sec 105.16. These records and documents shall be made available to the Engineer at the Contractor's office at all reasonable times, without any direct charge. If approved by the Engineer, photographs, microphotographs or other authentic reproductions may be maintained instead of original records and documents.

108.11.3 Effect of Termination. Termination of the contract or portion thereof will not relieve the Contractor of contractual responsibilities for the work completed, nor will termination relieve the surety of the surety's obligation for and concerning that part of the contract not terminated or any just claim arising out of the work performed.

108.12 Notice to Contractor and Surety. Notice to the Contractor, in case of default or termination of the contract, shall be deemed to be served when delivered to the person in charge of any office used by the Contractor, the
Contractor's representative at or near the work or by certified mail addressed to the Contractor's last known place of business. Notice to the surety shall be deemed served when mailed to the surety's address as shown in the contract by certified mail.

108.13 Termination of Contract for Misconduct. For the purposes of the following provision, "state" will include the State of Missouri and any other state, commonwealth or territory of the United States. The County may declare the contract to be terminated at any time after the contract is awarded and prior to final acceptance of the project, for any one or more of the acts set forth below, if the act occurred after the bid opening or within two years immediately preceding the date of the bid opening, unless the act is a basis for an adverse action under 49 CFR, Part 29 in which case the time limit will not apply, on any County or other federal, state or local government or privately awarded contract:

(a) Receiving or giving any currency or item of value in order to influence the competitive bidding process or the award of a competitively bid contract; bid-rigging, collusion or any similar act or communication with any person or firm in restraint of competitive bidding on a contract; or to obtain or grant an advantage in obtaining the award of such a contract.

(b) Fraud, dishonesty or a material misrepresentation or omission of fact in any request for proposal or bid submitted to a private firm or governmental agency, or in any contract documents submitted to such a firm or agency.

(c) Making or receiving kickbacks or payments of currency or any item of value in order to obtain or retain any contract or payment thereunder, or in return for an agreement to make or for the making of any false statements or material misrepresentations or omissions of fact to any federal, state or local governmental agency or private firm relevant to contract compliance.

(d) Suspension, debarment or other disqualification of the Contractor, or determination that the Contractor is not a responsible bidder for public contracting purposes, by any federal, state or local governmental agency, regardless of whether the sanction is still in effect at the time of the bid or contract award by the County.

(e) Conviction or adjudication of guilt in any criminal proceeding in a federal or state court, regardless of whether sentence was suspended or executed, for any act an element of which is fraud, dishonesty or moral turpitude, which conduct is relevant to a determination of the responsibility of the Contractor.

(f) Commission of any act or failure to act, such that the Contractor is subject to the determination that the Contractor is not a responsible bidder under the contract or under applicable Missouri or federal law.

108.13.1 The acts, omissions and liabilities of persons or firms affiliated with the Contractor or of persons that are principals of the Contractor, are those of the Contractor, unless the circumstances clearly negate that conclusion. Persons or firms are "affiliates" of each other if, directly or indirectly, either one controls or has the power to control the other or a third person controls or has the power to control both. Examples of control include, but are not limited to: interlocking management or ownership, identity of interests among family members, shared facilities and equipment, common use of employees on projects or a new business entity organized following the determination of ineligibility or non-responsibility of a person or firm which has the same or similar management, ownership or principal employees as the ineligible person. A "principal" will be defined as an officer, director, owner, partner or other natural person within a firm with primary management, supervisory or contracting responsibilities.

108.13.2 The County will not declare the contract terminated pursuant to this section if the Contractor made a full and complete disclosure of the acts and circumstances described in Sec 108.13 to the County in the bid or in writings submitted with the bid and the County did not determine the Contractor to be non-responsible prior to making the award of the contract. The County will not be precluded from terminating the contract under this section if the
information provided by the Contractor did not constitute a full and complete disclosure of all facts and circumstances pertinent to the issue of the responsibility and integrity of the Contractor.

108.13.3 The procedures for notice of the proposed termination of the contract and the Contractor’s right to be heard regarding that proposed action will be those in accordance with a proposed disqualification or suspension under the provisions of 7 CSR 10-18. After notice and an opportunity to be heard, upon a finding of the existence of a basis to terminate a contract under this section, the County may terminate the contract immediately or at the occurrence of some specific date or event in the future, prior to project completion, upon delivery of a written notice to the Contractor by actual service or by certified mail, return receipt requested, sent to the address of record of the Contractor. Effective with the contract termination date, the Contractor shall discontinue further work on the project and shall instruct subcontractors and suppliers to do the same, other than to remove promptly the Contractor’s personnel, equipment and supplies from the project site. The Contractor will be paid for all completed work to that date at the contract price. At the option of the Engineer, the County may assume the possession and cost of any specially fabricated material or supplies for the project that have been ordered prior to notice of termination, but have not been installed on the date of termination. The Contractor and surety will be liable to the County for all costs and expenses incurred by the County in completing the project, including, but not limited to, the County's costs to redraft and rebid the project, which costs and expenses exceed the total of the Contractor's bid price plus additional expenses allowed by the Engineer during the Contractor's work on the project, less the amount paid to the Contractor by the County. The County will not be liable for damages for breach of contract or in any other action or respect for declaring a default if one exists under this section and for terminating the contract prior to completion by the Contractor.

108.13.4 The satisfactory performance of a contract, prior to the notice to the Contractor of the intent to terminate the contract for misconduct, will not be a basis to determine whether the contract may be terminated for misconduct under this section.

108.13.5 The Contractor shall file any claim the Contractor has against the County within 60 days after the effective date of termination, pursuant to the procedures of Sec 105. The County will file any claim the County has against the Contractor or surety within 60 days of the date of final acceptance of the project, whether or not it is renumbered or redesigned, and whether completed by the surety, by a successor Contractor retained by the County, or by the County itself. Any County claim will be filed pursuant to the procedures of Sec 105.

108.14 Determination of Contract Time Extension for Excusable, Noncompensable Delays. An extension of the contract time may be granted under the following conditions provided documentation has been given to the Engineer in accordance with Sec 108.14.3 through Sec 108.14.5. Strict adherence to the provisions of this section will be a condition precedent to the Contractor's entitlement to an extension of contract time because of project delays.

108.14.1 Excusable or Noncompensable Delay. Contract time allowed for the performance of the work may be extended for delays caused by acts of God, acts of the public enemy, fires, floods, earthquakes, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather or other delays not caused by the Contractor's fault or negligence.

108. 14.2 Not used.

108.14.3 Notification of Delay. Within seven days of the occurrence of a delay to the prosecution of any phase of the work, the Contractor shall notify the Engineer in writing of such a delay and indicate that a request for delay consideration will be filed. Delay time incurred prior to notifying the Engineer that operations have been delayed will be noncompensable.

108.14.4 Procedures Following a Delay. The Contractor shall keep daily records of all operations affected by the delay.
108.14.4.1 The Contractor shall maintain a daily record of each operation affected by the delay and the station location of the operations affected. Daily records of the operations and stations will also be maintained by the Engineer. Each Monday, the Contractor shall compare the previous week’s daily records with the records kept by the Engineer. The Contractor shall also prepare and submit written reports to the Engineer each Monday containing the following information:

(a) Number of days behind schedule due to the delay.

(b) A summary of all operations that have been delayed or will be delayed.

108.14.4.2 The Contractor shall provide written notice to the Engineer within seven days of the results of the comparison of the detailed reports performed each Monday and shall define any disagreements between specific records.

108.14.4.3 Failure to meet to review the Engineer’s records or to report disagreements between the records will be considered conclusive evidence that the Engineer’s records are accurate.

108.14.5 Procedures Following Completion of Work Allegedly Delayed. Within the earlier of 15 days of completion of any phase of work allegedly delayed, or of project completion, the Contractor shall submit a report to the Engineer containing the following information:

(a) A description of the operations that were delayed and the documentation and explanation of the reason for the delay, including all reports prepared by or for the Contractor.

(b) An as-built chart or other graphic depiction of how the operations were delayed based on the Contractor’s most recent progress schedule prior to the delay event.

108.15 Suspension of Work Directed by the Engineer.

108.15.1 If the performance of all or any portion of the work is suspended or delayed by the Engineer for an unreasonable period of time not originally anticipated, customary or inherent to the construction industry, and the Contractor believes that additional compensation or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Engineer in writing a request for adjustment within seven days of receipt of the notice to resume work. The request shall set forth the reasons and support for such an adjustment. The procedures of Sec 108.14.4 and Sec 108.14.5 will apply to requests for additional compensation or time claimed by the Contractor as a result of a suspension of work directed by the Engineer under this section.

108.15.2 Upon receipt, the Engineer will evaluate the Contractor’s request. If the Engineer agrees that the cost or time required for the performance of the contract has increased as a result of such a suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, suppliers or subcontractors, and not caused by weather, the Engineer will make an adjustment, excluding profit, and modify the contract in writing accordingly. The Engineer will notify the Contractor of the Engineer’s determination whether or not an adjustment of the contract is warranted.

108.15.3 No contract adjustment will be made unless the Contractor has submitted the request for adjustment within the time prescribed.
108.15.4 No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or an adjustment is provided for or excluded under any other term or condition of the contract.
SECTION 109
MEASUREMENT AND PAYMENT

109.1 Measurement of Quantities. All work completed under the contract will be measured by the Engineer according to United States standard measure or will be paid for on a contract quantity basis as set out elsewhere in these specifications. The method of measurement and basis of payment will be made to the nearest whole number unless specified otherwise. When the contract quantity of any item is found to include appreciable errors, or when an authorized revision of the plans is made, the quantity will be corrected before making final payment. The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good Engineering practice.

109.2 Scope of Payment.

109.2.1 Compensation. The Contractor shall receive and accept compensation provided for in the contract as full payment for performing all work under the contract in a complete and acceptable manner, and for all risk, loss, damage or expense arising from the work or the prosecution thereof subject to Sec 109.8.

109.2.2 Completed Improvements. The payment of any current or final invoice, or the acceptance of any portion of the work as provided in the specifications, will not affect the obligation of the Contractor to submit for final acceptance a completed improvement in accordance with the contract.

109.3 Compensation for Altered Quantities. When the accepted quantities of work vary from the quantities in the contract, the Contractor shall accept payment at the original contract unit prices for the accepted quantities of work done. No allowance will be made for any increased cost, except as provided in Sec 104 and Sec 108.

109.4 Differing Site Conditions and Changes in the Work. Contract adjustments to compensate for changes in the work or extra work caused by differing site conditions or changes in the work performed in accordance with Sec 104 will be determined by use of one of the following methods, in order of precedence:

109.4.1 Contract Unit Prices. Where contract unit prices exist, the contract unit price will always be applied without deviation, unless the effect of a differing site condition or a significant change in the character of the work requires an equitable adjustment to a contract unit price under the terms of this contract. Equitable adjustments will exclude any anticipated profits.

109.4.2 Unit Prices or Lump Sum Amount Agreed Upon in the Change Order Authorizing the Work. Where contract unit prices do not exist for the work to be done, the parties may agree to such unit prices or a lump sum price for that work. The Contractor shall not include profit and overhead charges exceeding the following percentages of such unit prices or lump sum price: in cases where the total cost of changes in the work are $10,000 or less, 20%; in cases where the total cost of changes in the work are greater than $10,000 and less than or equal to $50,000, 18%; and in cases where the total cost of changes in the work exceed $50,000, 15%.

For work completed by subcontractors the prime Contractor shall not include profit and overhead charges exceeding the following percentages of such unit prices or lump sum price: in cases where the total cost of changes in the work are $10,000 or less, 10%; in cases where the total cost of changes in the work are greater than $10,000 and less than or equal to $50,000, 7.5%; and in cases where the total cost of changes in the work exceed $50,000, 5%.

Where an equitable adjustment to a unit price is required, the parties may agree to the adjustment to be made to the contract unit price, excluding any anticipated profits. Prior to agreeing upon such unit or lump sum prices, the Engineer may require from the Contractor any information to which the Engineer is authorized under Sec 104.
109.4.3 Equitable Adjustment. In all other cases, except work ordered to be performed under force account, the Engineer will make an equitable adjustment to or determination of the affected contract prices for the work, based on the Contractor’s actual costs to perform the work. This determination will be consistent with the Contractor’s other proven costs to perform the contract work, as shown in the Contractor’s bid computations and project cost records, produced and kept in the ordinary course of business. Prior to making an equitable adjustment, the Engineer may require from the Contractor any information relevant to that determination, including the information authorized under Sec 104. The condition precedent to determination of Contractor entitlement and amount of any contract adjustment and County liability will be that the adjustment:

(a) Is supported by demonstrated actual excess costs incurred, including by an audit of the actual costs, unless expressly waived by FHWA on federal aid projects;
(b) Has a basis in the terms of the contract;
(c) Has a basis in terms of applicable Missouri law and;
(d) Is in accordance with prevailing principles of public contract law.

109.4.4 Application of Force Account. Force account, as computed under Sec 109.5, will apply to determine the amount of compensation for a contract adjustment under Sec 109.4 only when expressly directed to be used in writing by the Engineer and in no other instance whatsoever for any determination of contract adjustments for any work performed on the project, whether claimed under the contract, for breach of the contract, arising from a claimed representation by which the contract was induced or any other basis.

109.5 Force Account Computation.

109.5.1 Labor. For all lead workers and laborers, the Contractor will receive the rate of wage paid for each hour that said lead workers and laborers are engaged in the force account work.

109.5.1.1 The Contractor will receive the actual costs paid to, or on behalf of, employees for subsistence and travel allowances, health and welfare benefits, pension fund benefits or other benefits, if such amounts are required by the collective bargaining agreement or employment contract applicable to the classes of labor employed on the work.

109.5.1.2 An amount equal to 20 percent (5 percent profit and 15 percent overhead) of the sum of the above items will also be paid the Contractor.

109.5.2 Bond, Insurance, and Taxes. For property damage, liability and worker’s compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the Contractor will receive the actual cost paid, to which 20 percent (5 percent profit and 15 percent overhead) will be added.

109.5.3 Material. For material accepted by the Engineer and used, the Contractor will receive the actual cost of such material delivered on the work, including transportation charges paid (exclusive of equipment rentals as hereinafter set forth), to which cost 20 percent (5 percent profit and 15 percent overhead) will be added. For all material used in connection with, but not entering permanently into the work, reasonable depreciation will be allowed.

109.5.4 Equipment. For only that Contractor-owned equipment necessary to accomplish the force account work, including all fuel and lubricants, tires and repairs, the Contractor will be allowed an hourly rate equal to the monthly rental rate divided by 176 hours as set out in the Rental Rate Blue Book http://equipmentwatch.com/blue-book-cost-recovery/ at the time the force account is ordered. The allowed rates will be the rate adjustment factor multiplied by the bare hourly rates multiplied by the regional adjustment factor, plus the estimated operating cost.
per hour. The allowed time will be the actual operating time on the work. For the time required to move the equipment to and from the site of the work and any authorized standby time, the rate will be 50 percent of the hourly rate after the actual operating costs have been deducted. All allowed time shall fall within the authorized working hours for such extra work. No payment will be allowed for time elapsed while equipment is broken down or being replaced. The hourly rental rates will apply only to equipment that is already on the job. If the actual unit of equipment to be used is not listed in the schedule, the rate listed for similar equipment with the approximate same initial cost shall be used. Equipment to be used and all prices shall be agreed upon in writing before such equipment is used. An amount equal to 20 percent (5 percent profit and 15 percent overhead) of the sum of these items will also be paid the Contractor. Whenever it is necessary for the Contractor to rent equipment, the rental and transportation costs of the equipment plus five percent for overhead will be paid. In no case shall the rental rates exceed those of established distributors or equipment rental agencies. All prices shall be agreed upon in writing before such equipment is used.

109.5.5 Miscellaneous. No additional allowance will be made for general superintendence, the use of small tools or other costs for which no specific allowance is herein provided. Jobsite and home office overhead expenses shall be considered fully compensated by the payments provided in Sec 109.5.

109.5.6 Subcontracted Work.

109.5.6.1 For administration and all overhead costs in connection with approved subcontract work, the Contractor will receive an amount equal to five percent of the actual cost of the subcontracted work.

109.5.6.2 The Engineer has the authority to require alterations in the equipment and labor force assigned to force account work, to limit authorization of overtime work to that normally used on a project for work of similar nature or to require overtime work when an emergency exists, and to require the cessation of force account work when adverse conditions seriously limit productivity.

109.5.7 Statements. No payment will be made for work performed on a force account basis until the Contractor has furnished the Engineer with duplicate itemized statements of the cost of such force account work detailed as follows:

(a) Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.

(b) Designation, dates, daily hours, total hours, rental rate and extension for each unit of machinery and equipment.

(c) Quantities of material, prices and extensions.

(d) Transportation of material.

(e) Cost of property damage, liability and worker's compensation insurance premiums, unemployment insurance contributions and social security.

109.5.7.1 Statements shall be accompanied and supported by receipted invoices for all rental equipment, material used and transportation charges.

109.5.7.2 If material used on the force account work is not specifically purchased for such work but is taken from the Contractor’s stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such material was taken from Contractor's stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.5.8 Compensation. Each day the Contractor’s representative and the Engineer shall compare records of the cost of work done as ordered on a force account basis. Two copies of these records will be made by the Engineer.
on forms provided by the County, and the copies shall be signed at the end of each day by both the Engineer and the Contractor, one copy to be retained by the Engineer, and one copy to be retained by the Contractor. The total payment made, as provided in Sec 109.5, shall constitute full compensation for such work.

109.6 Method of Payment. Payment to the Contractor for furnishing all material and performing all work under the contract will be by check and either mailed to the Contractor at the address stipulated in the contract or the Contractor may pick up the check at the Office of the County Engineer.

109.7 Partial Payments.

109.7.1 Payment Invoices. The Contractor will make monthly payment invoices in writing for the material in place and the work performed during the monthly interval and the value thereof at the contract unit bid prices. For partially complete items, the proper percentage with relation to completion will be allowed. The Contractor’s invoices will be reviewed by the construction Engineer. Once the invoice is agreed upon by construction Engineer and Contractor it will be processed for payment.

109.7.2 Material Allowance. The Contractor may, in any payment invoices, include the value of any non-perishable material that will be finally incorporated in the completed work. The material shall be in conformity with the plans and specifications in the contract, and shall not have been used at the time of such invoices. The value of such material on a single invoice from one supplier shall be no less than $10,000.00. The material shall be delivered to the project or other location that is approved by the Engineer. Any storage area not within the right of way shall be leased at the Contractor’s expense with provisions for right of entry by the Engineer during the period of storage. Invoices for material payment shall be submitted to the Engineer at least four days prior to the invoice date. Receipted invoices for all material payments previously allowed on the invoices shall be submitted to the Engineer within 28 days of the date of the invoices on which material allowance was made or such material allowance will be deducted from future payments. The amounts paid for such material shall reduce the amount of other partial or final payments due the Contractor for the work performed as the materials are fabricated or incorporated in the completed work.

109.7.2.1 No partial payment will be made for living or perishable plant material until planted.

109.7.2.2 All material furnished for the work as noted in these specifications will be subject to shop inspection by the Engineer.

109.8 Final Acceptance and Payment. When the project has been accepted as provided in Sec 105, the Engineer will prepare the final tabulation of the quantities of work performed. All prior partial invoices and payments will be subject to correction in the final tabulation and payment. The Contractor will be paid the entire sum found to be due after deducting all previous payments and all amounts to be retained or deducted under the provisions of the contract. The Contractor shall submit the following for file with the County:

(a) An affidavit, on the form prescribed by the County, to the effect that all payments have been made and all claims have been released for all material, labor and other items covered by the contract bond.

(b) The written consent of the surety to such payment.

(c) Any other documents that may be required by the contract.

109.8.1 Final Payment and Claims. If said affidavit regarding subcontractor and third-party debts and claims cannot be given because of a dispute as to the amount or legality of a claim, the Engineer, with the consent of the surety, may consent to and make payment of all of the final amounts due the Contractor if:

(a) The Engineer is of the opinion that the claim has not been paid solely because the Contractor is, in good
faith, questioning the legality of said claim or its amount.

(b) The Engineer is further satisfied that there is good and sufficient bond to fully protect said claimant.

(c) The Contractor's affidavit clearly sets out the facts as to the name and address of the unpaid claimant or claimants, the amount of the disputed claim, and a brief statement of the cause of the dispute.

109.8.2 Corrections. Final acceptance will not prevent the County from correcting any measurement, invoices or certificate made before or after completion of the contract. The County will not be prevented from recovering, from the Contractor or surety, or both, overpayments made or costs sustained by the County for failure of the Contractor to fulfill the obligations under the contract. A waiver on the part of the County of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

109.8.3 Defects. The Contractor and surety shall be liable to the County for latent defects, fraud or such gross mistakes as may amount to fraud, or as regards the County's rights under any warranty or guaranty without prejudice to the terms of the contract.

109.9 Retained Percentage.

109.9.1 Withholding of Retained Percentage. Retainage of the Contractor’s payment will not automatically be applied; however, the County may withhold payment for any of the following deficiencies, or for others as determined by the Engineer:

(1) liquidated damages

(2) unsatisfactory job progress

(3) defective construction work or material not remedied

(4) disputed work

(5) failure to comply with any material provision of the contract

(6) third party claims filed or information indicating such claim is likely to be filed

(7) failure to make timely payments for labor, equipment or materials

(8) damage to a Contractor, subcontractor or material supplier

(9) information indicating it is likely that a subcontractor or material supplier cannot be fully compensated under its contract with the contractor for the unpaid balance of the contract sum

(10) citation by the enforcing authority for acts of the Contractor or subcontractor which do not comply with any material provision of the contract and which result in a violation of any federal, state or local law, regulation or ordinance applicable to that project causing additional costs or damages to the owner.

109.9.1.2 If retainage is initiated during contract performance, then the greater of the amount allowed under 34.057 RSMo or five percent will be deducted from the total amount of remaining work items of each estimate. The retained percentage will be released as provided in these specifications. The net amount due on the estimate will be certified to the County for payment. This method of retained percentage will not apply to Sec 808.6.
109.9.2 Release of Retained Percentage. That portion of the Contractor’s payment that is retained for project deficiencies, including but not limited to those identified in Sec 109.9.1, shall be released upon correction of the deficiency prompting the retained payment to the satisfaction of the Engineer.

109.10 Assignments. Neither the contract, nor any duties or obligations or rights of the Contractor or the Contractor’s surety arising under, from or relating to the contract, or to be performed as required by the contract, and whether present or prospective, including, without limitation, money due at any time or any claim of any character arising from or relating to performance or nonperformance of the contract, whether for breach or otherwise, shall be assigned or transferred to any other person so as to bind or affect the County absent the express written consent of the surety and the County and upon a written request and compliance with such requirements as the Engineer or County may provide.

109.11 Not Used.

109.12 Change Orders. Except as otherwise provided for in the change order, an adjustment of the contract price or time of contract performance in a change order constitutes compensation in full to the Contractor and the Contractor’s subcontractors and suppliers for all costs and time effects directly or indirectly attributable to the matter described in the change order, for all delays related thereto, for all impact, cumulative impacts and for performance of the change within the time stated. The surety’s liability under the contract bond and contract shall not be limited to the penal sum as set forth in the contract bond. The surety shall be liable and responsible to the County for the Contractor’s entire performance and of all obligations arising under or from the contract, which shall include, but not be limited to, any change orders issued under the contract that increase the cost of the contract.

109.12.1 The parties agree that, in any adjustment for delay costs, the County will have no liability for the following items of damages or expense.

(a) Profit in excess of that provided herein.

(b) Loss of profit.

(c) Labor inefficiencies.

(d) Equipment inefficiencies or reduced production.

(e) Consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities and insolvency.

(f) Indirect costs or expenses of any nature.

(g) Attorney’s fees, claims preparation expenses or costs of litigation.

109.13 Prompt Payment to Subcontractors and Suppliers. The requirements set forth in this section will apply to all contracts where the federal government is participating in the cost of construction.

109.13.1 When the Contractor receives any payment from the County, the Contractor shall, within the earlier of fifteen days of receipt of that payment, or the date provided by the subcontract or purchase order, pay each subcontractor or supplier a sum, less only any retention provided by the subcontractor or purchase order or sum withheld as allowed by Sec 109.13.3, equal to one of the following:

(a) The value of that subcontractor’s work, services or material included on the Contractor payment invoice applicable to that payment.
(b) The amount of any material allowance under Sec 109.7.

(c) Such greater sum as provided by the subcontract or purchase order for work included on the Contractor payment invoice.

109.13.2 Notwithstanding any conflicting provision in a subcontract or purchase order and subject only to the requirements of Sec 109.13.3, the Contractor shall make final payment of the balance of all sums under a subcontract or purchase order, including any retention, within 30 days of the satisfactory completion of the subcontractor's work or services, or a supplier's final delivery of materials to be provided.

109.13.3 The Contractor may withhold periodic payment or final payment to a subcontractor or supplier only for the following causes and only if that subcontractor or supplier is directly involved:

(a) The Engineer has rejected specific areas or items of work or materials as not conforming to the contract or such areas or items of work or materials are deemed not suitable for payment.

(b) Unsatisfactory job progress.

(c) Defective construction work or materials not remedied.

(d) Disputed work, but only the disputed amount.

(e) Failure to comply with other material provisions of the contract.

(f) Third party claims filed, or reasonable evidence that a claim will be filed, but not claims covered by a subcontractor or supplier's insurance required by Sec 107.

(g) Substantial evidence of the subcontractor or supplier's failure to make timely payments for labor, equipment or materials; damage to the Contractor or another subcontractor or material supplier, but not such damage as is covered by a subcontractor or supplier's insurance required by Sec 107.13.

(h) Substantial evidence that the subcontractor or supplier's work cannot be completed for the unpaid balance of the subcontract or purchase order sum, or a reasonable amount for retention.

109.14 Not Used.

109.15 Price Adjustment for Asphalt Cement.

109.15.1 Asphalt Cement Price Index. The Contractor may select an option, in the manner specified below, to have adjustments made to the payments due the Contractor for any plant mix bituminous base, plant mix bituminous pavement, plant mix bituminous surface leveling, asphaltic concrete pavement and ultrathin bonded asphalt wearing surface that contains performance graded (PG) asphalt binder when it has been determined that the Monthly Asphalt Index for the month prior to placement of the asphalt mixture has fluctuated from the Monthly Asphalt Index for the month the project was let. The Monthly Asphalt Index shall be established for each calendar month as the average of the midpoint selling prices of PG64-22 for St. Louis and Kansas City, Missouri areas, as published by Poten and Partners Inc. in the Asphalt Weekly Monitor®, on the first Monday preceding the date of the normal monthly MoDOT letting. For months when there is no normal monthly letting, the published price on the third Monday of that month shall be used for the Monthly Asphalt Index. Special lettings shall have no effect on determining the Monthly Asphalt Index. The asphalt base index shall be the Monthly Asphalt Index for the month of the bid opening. For calculation of the price adjustment, any asphalt placed on the first day of a month will be
included with the asphalt placed the previous month in order to keep price adjustments in sync with the payment estimate period schedule.

109.15.1.1 The price adjustment will be applied to the actual amount of virgin PG asphalt binder used by the Contractor for all asphalt items specified in Sec 109.15.1. For asphalt mixtures that are paid for by the square yard, the price adjustments will be made for applicable equivalent tons, as calculated by the Engineer, based upon the plan square yard quantity and thickness converted to tons, excluding the 1:1 wedge. The price adjustment will be applied to all Job Order Contract projects for all quantities of the wet ton and square yard asphalt mix. The percentage of virgin PG asphalt binder as shown in the job mix formula, in accordance with Sec 401 and Sec 413, will be the basis for price adjustments for any asphalt mix type placed on the project. The effective asphalt binder obtained from the use of Recycled Asphalt Pavement (RAP) and/or Recycled Asphalt Shingles (RAS) will not be eligible for adjustment. The Monthly Asphalt Index for PG64-22 will be applied to the asphalt mix for mixes using any PG asphalt binder.

109.15.1.2 Price Adjustment Calculated. To determine the price adjustment for any asphalt mix specified in this provision, the following formula will be used.

\[ A = (B \times C/100) \times (D - E) \]

Where:
- \( A \) = Dollar value adjustment for mix placed during the payment estimate period
- \( B \) = Tons of asphalt mixture placed during the payment estimate period
- \( C \) = Percent of virgin PG asphalt binder as listed in the job mix formula in use
- \( D \) = The Monthly Asphalt Index for the month prior to the month the asphalt mix was placed
- \( E \) = The asphalt base index = the Monthly Asphalt Index for the month the project was let

109.15.1.3 The Engineer will apply the price adjustments, as determined by the price adjustment calculation established herein, for each payment estimate period in which asphalt is placed, except for any asphalt placed after the allowable contract time period as defined in Sec 108. For asphalt placed after the contract completion time limit, the "D" value used for the price adjustment calculated shall be either the last "D" value prior to the date that contract time was exceeded, or the current monthly "D" value, whichever is lower.

109.15.1.4 Optional. This provision is optional. If the Contractor wishes to be bound by this provision, the Contractor shall execute the acceptance form in the Bid. Failure by the Contractor to execute the acceptance form will be interpreted to mean election to not participate in the Asphalt Cement Price Index. If the Asphalt Cement Price Index is accepted, PG asphalt binder for the project will not be eligible for a material allowance as described in Sec 109.

109.16 Fixed Cost Items. The following fixed prices shall be used when referenced in the specifications:
<table>
<thead>
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<th>Section</th>
<th>Item No.</th>
<th>Item of Work</th>
<th>Unit</th>
<th>Fixed Price</th>
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SECTION 110
STATE AND FEDERAL WAGE RATES AND OTHER REQUIREMENTS

110.1 Wage Rates. The Contractor will be required to pay either the state or federal prevailing hourly wage rate for any craft or type of worker required to perform the work, except when expressly provided by the contract documents. State wage rates, information on the required federal aid provisions, and the current federal wage rates are available on MoDOT’s web site. Applicable federal and state wage rates will be included in the bidding documents. These supplemental bidding documents have important legal consequences. It shall be conclusively presumed that the documents applicable to the contract are in the bidder’s possession and have been reviewed and used by the bidder in the preparation of any bid submitted on a project.

110.2 Federal-Aid Projects. If the federal government is participating in the cost of construction of the project, all applicable federal laws, and the regulations made pursuant to such laws, will be applicable to and become part of the contract, shall be observed by the Contractor, and the work will be subject to the inspection of the appropriate federal agency in accordance with Sec 105.10. Contracts with federal-aid will require payment of the prevailing hourly wage rate for each craft or type of work required to execute the contract as determined by the Missouri Department of Labor and Industrial Relations, and will require adherence to a schedule of minimum wages as determined by the U.S. Department of Labor. For work performed anywhere on the project, the Contractor and the Contractor’s subcontractors shall pay the higher of these two applicable wage rates.

110.3 Prevailing Wages and Records. The prevailing state wage rate, overtime and fringe benefits for the locality of the work as determined by the Missouri Department of Labor and Industrial Relations, or by a court decision on appeal, will be contained in the contract. The effective date for the current wage rate, overtime and fringe benefits, for bidding purposes, will be in the bid documents by special provision. The Contractor and all subcontractors shall pay no less than the prevailing wage rate, overtime and fringe benefits as specified or as same may be changed by a court decision on appeal, for all work performed under the contract. Per 290.250 RSMo., the Contractor shall forfeit a penalty up to $100 per day per worker for each worker that is paid less than the prevailing rate for any work done under the contract by the Contractor or any subcontractor as determined by the Missouri Department of Labor.

110.3.1 The Contractor is advised that the prevailing wage rate, overtime and fringe benefits are subject to change during the life of the contract by court decision. No such change shall be the basis for adjustment in the contract price.

110.3.2 The Contractor and each subcontractor shall keep an accurate record showing the names and occupation of all workers employed by the Contractor, including the actual wages, overtime and fringe benefits paid to each worker. The record shall be open to inspection at all reasonable hours by the representatives of the Department of Labor and Industrial Relations of Missouri or the County. The Contractor shall submit certified copies of payrolls to the Engineer each week.

110.3.3 Subsistence Deductions. The Contractor shall comply with all applicable federal and state laws for employee payroll deductions for subsistence and as specified herein:

(a) The Contractor shall provide to the Engineer a copy of the employee-signed agreement for each employee that agrees to a subsistence deduction prior to that employee beginning work on the project. If the employee does not speak English, such agreement shall be written in his/her native language.

(b) The Contractor shall document each purpose (food, lodging, travel etc.) and amount of all subsistence deductions and provide documentation in support of each deduction to the Engineer.
(c) The subsistence deductions shall serve the convenience and interest of the employee. No profit or other benefit shall otherwise be obtained, directly or indirectly, by the Contractor or subcontractor or any affiliated person in the form of commission, dividend or otherwise.
Division 200

EARTHWORK
SECTION 201
CLEARING AND GRUBBING

201.1 Description. This work shall consist of clearing, grubbing, removing, and disposing of vegetation within the limits of right-of-way and easement areas, except such vegetation as is designated to remain or to be selectively treated.

201.2 Construction Requirements.

201.2.1 The plans will establish right-of-way and construction lines and will designate all trees, shrubs, and plants that are to remain or be removed. No tree outside of the clearing limits shall be removed without express approval of the Engineer. The Contractor shall preserve without damage the vegetation designated to remain. All designated items shall be preserved. Any damage to natural terrain, vegetation or objects designated to remain shall be repaired or replaced, as determined by the Engineer, at the Contractor’s expense. All trees, stumps, brush, and hedge not designated to remain shall be cleared, grubbed, or cleared and grubbed as required and shall be disposed of in an acceptable manner.

201.2.2 Limits of Grubbing. Within the limits of the cut areas, grubbing shall be performed to a minimum depth of 18 inches below the finished earth grade of roadways, ditches, channels, borrows and structures. Grubbing of Osage orange or locust hedge shall include removal of roots. The areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs and other objectionable material. In embankment areas, undisturbed stumps and roots extending no more than 6 inches above the ground line may remain, provided the stumps and roots are a minimum of 4 feet below the finished earth grade. Except in areas to be excavated, holes created by removals shall be backfilled with suitable material and compacted to the approximate density of the adjacent area. Grubbing of borrow areas, channel changes, and inlet and outlet easements will be required only to the extent necessitated by the proposed construction.

201.2.2.1 Selective Clearing and Grubbing. All areas outside the limits designated for clearing and grubbing, but on the right of way, shall be free of unsightly vegetation, debris and other objectionable matter. In lieu of grubbing, undisturbed stumps outside the slope stake limits and in mowable areas may be cut to a maximum height of 3 inches above the ground. Low hanging, unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed by the Engineer, and in accordance with good tree surgery practices.

201.2.3 Open Burning. Open burning will be permitted only under a permit or waiver from MDNR. In lieu of open burning the Contractor shall make efforts to harvest marketable timber, utilize mulched timber for erosion control and utilized excess mulch for composting. The Contractor shall obtain all necessary permits and approvals before open burning is initiated, and shall comply with permit conditions, MDNR regulations, and all laws in accordance with Sec 107. A Contractor representative shall be present during all burning. Measures shall be taken to ensure that structures or vegetation on adjacent property, or items designated to remain on the right of way, shall not be jeopardized. Fires set for the purpose of training fire fighters and industrial employees in firefighting methods may be permitted after coordination with MDNR or local fire departments, and shall be in strict accordance with NFPA standards.

201.2.4 Disposal. The burial of stumps and debris will not be permitted in the construction limits. Products of clearing and grubbing may be removed from the construction limits and disposed of out of sight from the roadway provided an acceptable written agreement with the property owner on whose property the products are placed is submitted by the Contractor. All timber not designated to remain and that has not been removed from the right-of-way prior to the beginning of construction shall become the property of the Contractor, unless otherwise specified.

201.2.5 Scalping. The Contractor shall scalp all areas where excavation or embankment is to be made, except that mowed, burned over sod need not be removed where the embankment to be constructed is 4 feet or more in
height. Scalping shall include the removal of material such as sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground without removing more earth than is necessary. The products of scalping shall be deposited at the toe of embankments where such areas are available within the limits of the roadway balance affected. If such areas are not available, the products shall be suitably removed in accordance with Sec 201.2.4.

201.2.6 Graves Sites. Should grave sites be found during clearing or grading, the Contractor will stop all construction work in the immediate area and notify the Engineer.

201.3 Method of Measurement. Clearing and grubbing work will not be measured for payment but will be considered a plan quantity. Payment will be on a lump sum basis or per acre, based on the bid. The following exceptions will be made on a measured quantity basis:

(a) An authorized change in the line or grade, or appreciable deviations in the original ground elevations in accordance with Sec 203.8.1, significantly alters the original construction limits of the contract.

(b) Authorized alterations or corrections to the plans provide additional work outside the original construction limits of the contract and will materially affect the final payment quantity.

(c) Appreciable errors within the original limits of construction, if the Contractor provides written notification, and measurements of the proposed change to the Engineer prior to commencing clearing operations. The Engineer will accept or reject the changes by the close of the next business day.

201.3.1 If payment for additional work is required, a combined measurement of clearing and grubbing will be made on an area basis to the nearest 1/10 acre.

201.4 Basis of Payment.

201.4.1 The accepted quantities of clearing and grubbing will be paid for at the unit bid price or per lump sum, however bid.

201.4.2 Exclusions. If a bid item for clearing and grubbing is not included in the contract, any necessary clearing and grubbing, including scalping, selective clearing and the removal and disposal of all the resulting material required within the contract items specified, will be considered incidental to the contract and additional compensation will not be made.

201.4.3 No special payment will be made for removal and storage of salvageable items.

201.4.4 If clearing and grubbing is required beyond or outside the initial contract work, payment for the clearing and grubbing will be made at the unit bid price per acre. When the original clearing and grubbing has been bid as a lump sum the additional clearing and grubbing will be made per acre at the fixed contract unit price specified in Sec 109.
SECTION 202
REMOVAL OF IMPROVEMENTS

202.1 Description. This work shall consist of the removal and disposal of all existing improvements from the right of way and within the limits of any construction area outside the right of way, except improvements designated or permitted to remain in place or to be removed under other items of work. These specifications will apply to all removal work performed by the Contractor.

202.1.1 Removal of improvements shall include removing all buildings, drainage structures, bridges, all rigid, reinforced, flexible or combination pavements, surfacing, and base courses of all types, curb, curb and gutter, sidewalk approaches (residential, commercial and street) and house walks, steps, retaining walls, foundation walls, columns, footings, floors and any other types of building appurtenances, cisterns, catch basins, uncontaminated storage tanks, manholes, drainage and sewer pipes, box culverts, water and gas main pipes, signs, fences, other objects or structures including scattered or piled bricks, stones, broken masonry, rubbish, debris, outdoor advertising signs, etc., from existing improvements and building demolition work.

202.1.2 The plans may not show a complete list of all items to be removed. There may be an undetermined number of abandoned utilities, basement or foundation walls, columns, footings or other improvements encountered. The contractor shall determine for itself the extent of the work to be performed under this item and shall base its bid accordingly. When portions of existing buildings are to be removed and portions are to remain, the contractor shall exercise extreme care to protect the portions of the buildings that are to remain. The contractor shall confine its activities within the construction limits and the slope license line shown on the plans.

202.2 General Requirements.

202.2.1 Containment and Disposal of Material. All abrasives used in blasting activities shall be collected using a containment system or enclosure to prevent the release of material to the environment. All improvements not designated to remain shall be removed or disposed of by the Contractor as required. The work may involve the generation of excess material, which may be solid waste under the definitions of the MDNR Solid Waste Management Program. The Contractor shall dispose of solid waste in accordance with the Missouri Solid Waste Management Law and implementing regulations, 10 CSR 80.

202.2.1.1 Regulated solid waste, including waste tires, shall be handled, transported and disposed of in accordance with applicable regulations. Documentary proof of proper transport and disposal of this waste, including transport forms, disposal forms, scale tickets, cancelled checks and receipts, shall be provided to MDNR and to the Engineer prior to acceptance of the work.

202.2.2 Damaged Items. Any item damaged by the Contractor’s operations that is designated to remain in place, to be used elsewhere, or to be used by the public or an adjoining property owner, shall be repaired or replaced at the Contractor’s expense, in a manner satisfactory to the Engineer in accordance with Sec 107.12.

202.2.3 Dust and Emissions Control. All operations during demolition and removal shall be adequately controlled to prevent dust and visible emissions, unless otherwise approved by the Engineer. All measures taken shall be provided by the Contractor at the Contractor’s expense unless specified otherwise.

202.2.4 Salvage. All material designated in the contract to be salvaged for County use from existing structures or improvements shall be removed without damage, in sections that may be readily handled, transported and stored
as approved by the Engineer. Unless otherwise designated in the contract, coldmilled material shall remain the property of the Contractor. Unless otherwise designated in the contract, guardrail material shall remain the property of the County and stockpiled as specified in the contract or as directed by the Engineer. Any damaged sign or post shall be replaced by the Contractor at no cost to the County. All buildings, material and equipment of any description not designated for salvage by the County shall become the property of the Contractor, unless owned and claimed by a political subdivision or utility company. Salvaged material becoming the property of the Contractor shall not be stored on the right of way, nor shall any portion of the right of way or land owned by the County be used by the Contractor as a place of sale for salvaged material.

202.3 Construction Requirements.

202.3.1 Disposal of Material.

202.3.1.1 Clean fill, including uncontaminated soil, rock, sand, gravel, concrete, minimal amounts of wood, metal and inert solids, as approved by rule or policy by MDNR’s Solid Waste Management Program, will not be regulated. These materials will not be considered solid waste, and may be disposed of without prior approval from MDNR's Solid Waste Management Program.

202.3.1.2 Material that is not clean fill by definition shall be disposed of in accordance with MDNR's or local regulations, and the Contractor shall provide appropriate documentation, i.e. landfill receipts or a private owner waiver letter or statement from MDNR, that the disposal complies with applicable laws or regulations.

202.3.2 Removal Requirements. Removal of pavement, curb, curb and gutter, gutter, sidewalk and other similar improvements, and where a portion of such improvements are to be left in place, shall be removed to an existing joint or to a joint face sawed to a full depth of pavement thickness with a true line and vertical face. Sufficient removal shall be made to provide for proper grades and connections in the new work regardless of removal limits shown on the plans. When portions of existing pavements are to be removed and portions are to remain in place, the Contractor shall exercise care to protect the portions of rigid pavements that are to remain. Existing rigid pavements used for handling temporary traffic shall not be removed until the replacement pavements are open to traffic.

202.3.2.1 Removal of concrete or bituminous material shall consist of breaking up and disposing of the material in areas furnished at the Contractor’s expense, within a basement excavation where approved backfill material over 24 inches deep is to be placed over such broken material, or within embankments where new embankment over 24 inches is to be placed over the broken material. If concrete or bituminous slabs are to be left within an embankment or basement, the slabs shall be broken into pieces not exceeding 4 square feet. At locations shown on the plans where piling is to be driven, existing pavement, sidewalks, footings, foundations, walls and all other types of removal items shall be completely removed for a sufficient distance to permit piles to be driven. Existing improvements not removed in their entirety shall be removed to a minimum depth of 12 inches below the finished grade section or natural ground. All reinforcing steel extending from concrete shall be removed to the exposed face prior to placement within water or on exposed ground surfaces.

202.3.2.2 The Contractor shall remove slabs on grade more than 6 inches higher than existing street or alley grades or surrounding low grades. All other aboveground concrete and masonry improvements, fences, posts and other structures on the parcel shall be removed to adjacent surface grades. For any location on the plans designated as a bridge site, the Contractor shall remove all basement and foundation walls, footings, floors, and any other incidental masonry construction prior to backfilling. All material from such removals meeting the requirements of clean fill shall be disposed of as directed by the Engineer. All other material shall be disposed of offsite at the Contractor’s expense.

202.3.2.3 All sidewalk slabs over basements, areaways, and all beams, fixtures and supports shall be removed except slabs that are part of the public sidewalks adjacent to structures being demolished. The Contractor shall not
remove coal hole covers, trap doors, sidewalk doors, gratings and similar appurtenances that occur in the public sidewalk adjacent to buildings being demolished.

202.3.2.4 The Contractor shall leave in place any walls or structures that retain adjacent property to ensure lateral support to that property. Any wall perpendicular to and connected to the said wall or structure shall remain in place and connected to the wall for a distance at least one-half the height of the wall. The slope of the top of the perpendicular wall shall be 1:2 or flatter, sloping downward from the top of the wall or structure.

202.3.3 Sewers and Drains. All sewers, drainage pipes and floor drains which have been or are to be abandoned in place shall be completely filled with flowable fill or commercial mix concrete meeting the requirements of Sec 501.17 with sufficient water to form a plastic mortar like mixture of a consistency appropriate for pumping into place with pressure pumping equipment. The sand and cement shall be mixed in a mixer of a type approved by the Engineer, after which water shall be added and the mixing continued until a consistency of mixture has been attained which can be pumped into the sewer openings under sufficient pressure, to insure the filling of all openings free of voids and air pockets or at the request of the Contractor and with the approval of the Engineer, the existing pipe may be crushed in place or removed. All floor drains shall be sealed by bulkhead in an acceptable manner by concrete meeting the requirements of Sec 501.17 or brick masonry as directed by the Engineer.

202.3.4 Backfill. All trenches, holes and pits resulting from the removal of improvements, contaminated material, soil, tanks and piping shall be backfilled and graded to shape and finish disturbed areas. Backfilling shall be performed in accordance with applicable portions of Sec 203 and compacted in accordance with Sec 203.5 unless otherwise designated by the Engineer. Material shall be placed in the same manner and compacted to the same density required in adjoining areas and shall be done in such a manner as to ensure proper drainage.

202.3.4.1 Backfill material may consist of previously stockpiled uncontaminated soil or may be obtained from the right of way if approved by the Engineer. Only approved material free of trees, stumps, rubbish and any other deleterious material shall be used in the construction of backfills. Rock, broken concrete or other solid material shall not be placed in bridge fill areas. No slope shall be steeper than 2:1. Broken masonry resulting from demolition of buildings or other improvements on the parcel may be used for backfill provided the masonry meets the requirements of clean fill. In no case shall broken masonry extend closer than 12 inches to the finished surface. In the event there is insufficient material in the immediate vicinity, the Contractor shall provide material, at the Contractor’s expense, from a source obtained by the Contractor and approved by the Engineer in accordance with Sec 106.

202.3.4.2 All trees, shrubs or other vegetation within the limits of the Contractor’s backfilling operations shall be removed and disposed of in accordance with Sec 201.

202.3.5 Hazardous Material.

202.3.5.1 The Contractor may encounter small quantities of hazardous material as defined by MDNR. This material shall be recycled or disposed of in a manner that maintains the material’s qualifications as “small quantities” in accordance with MDNR regulations.

202.3.5.2 In the event the Contractor encounters what is reasonably suspected to be large quantities of hazardous material, the Contractor shall immediately cease work and notify the Engineer in accordance with the contract requirements. If the Engineer determines the suspect material is not hazardous or does not constitute a large quantity of hazardous material, the Contractor will be notified to continue the work. If the Engineer determines the suspect material is hazardous or constitutes a large quantity of hazardous material, the Engineer may require the Contractor to perform work necessary to abate the hazardous material.

202.3.6 Street Identification Signs. When street identification signs are removed as part of the removal of improvements, the signs shall be reinstalled by the end of the work day. The Contractor shall be responsible for
maintaining these signs throughout the duration of the project. If the street identification signs are damaged or disappear during the project the Contractor shall replace them, at no additional cost, with acceptable signs according to the Engineer.

202.4 Method of Measurement. The work provided herein will not be measured for payment, but will be considered a lump sum unit. This shall include the removal of all items, whether in view or hidden underneath the surface of the ground, regardless of whether shown on the plans or encountered during construction. No deductions will be made from the volumes measured for payment of roadway excavation where existing improvements are removed from within the limits of the sections measured for determining pay volumes of excavation.

202.5 Basis of Payment. The accepted removal of improvements will be paid for at the contract lump sum price. If no lump sum unit for the removal of improvements is included in the contract, the removal of improvements required to complete the contract, or as directed by the Engineer, will be considered incidental to the work and no direct payment for the removal will be made. If additional removals are encountered as described in Sec. 202.30, payment will be accordance with Sec 104.3.

202.5.1 No direct payment will be made, unless specified in the contract for the following work:

(a) Removal and disposal of abandoned fences and mailboxes.

(b) Filling and Sealing abandoned sewers, drainage pipes or floor drains.

(c) Removal and disposal of small quantities of hazardous material.

202.5.2 Payment for any additional work required for hazardous material abatement will be handled in accordance with Sec 104.3.

SECTION 202.10 PLUGGING AND CLOSURE OF WELLS.

202.10.1 Description. This work shall consist of plugging and closing wells as shown on the plans or as directed by the Engineer.

202.10.2 Conformance Requirements. The Contractor shall notify the Engineer at least 24 hours in advance of the Contractor’s intent to plug the well. The Contractor shall be in possession of a valid MDNR permit for well or pump closure. The abandonment procedure for wells shall be in accordance with requirements in specific MDNR regulations for monitoring wells, heat pump wells, test holes or all other wells, as applicable. A copy of the completed closed well registration shall be furnished to the Engineer.

202.10.3 Basis of Payment. The accepted quantity of plugged and closed wells will be paid for at the contract unit price per each. Payment will be considered full compensation for all labor, equipment and material for plugging and closing, and the costs and fees associated with closed well registration.

SECTION 202.20 SEPTIC TANK PLUGGING AND DISPOSAL.

202.20.1 Description. This work shall consist of plugging and disposing of septic tanks shown on the plans or as directed by the Engineer.

202.20.2 Conformance Requirements. The Contractor shall notify the Engineer at least 24 hours in advance of the Contractor’s intent to plug and dispose of the septic tank. The Contractor shall be in possession of a valid septic tank abandonment permit from the County’s Community Development Department. Septic tanks shall be abandoned by pumping the septic tank, collapsing the top of the tank, plugging incoming and outgoing laterals, and
breaking the bottom to permit drainage. The tank trench shall be backfilled with coarse gravel or rock, agricultural lime, or sand to a depth of 2 feet below the existing ground surface. The top 2 feet shall be backfilled with soil from the parcel and compacted in 6 inch lifts to the approximate density of the adjacent soil. In the event there is insufficient material in the immediate vicinity, the Contractor shall provide material meeting the approval of the Engineer, at the Contractor's expense. All material pumped from septic tanks shall be properly disposed of at a permitted sewage treatment facility or other location approved by the Engineer.

202.20.3 Basis of Payment. The accepted quantity of septic tanks, plugged and disposed of, will be paid for at the contract unit price per each. Payment will be considered full compensation for disposal of tank contents, permits, labor, equipment and material to complete the described work.

SECTION 202.30 Not Used.

SECTION 202.40 DEMOLITION AND REMOVAL OF BUILDINGS.

202.40.1 Description. This work shall consist of testing for asbestos containing material (ACM), demolishing, removing and disposing of all existing buildings from the right of way or within the limits of any construction easement outside the right of way as shown on the plans. Removal of buildings shall include all attached structures, existing rubbish, trash and contents in and adjacent to the building on each parcel.

202.40.1.1 Notification of Demolition. The Contractor shall provide proper notification to all appropriate federal, state and local agencies prior to demolition and shall obtain and keep in its possession a valid building demolition permit from the County’s Community Development Department. Notification is necessary for the demolition of a building. The notification procedures and forms are available from MDNR. The Contractor shall provide copies of all completed and approved forms to the Engineer prior to any demolition work.

202.40.2 Schedule. The Contractor shall submit a plan and schedule for demolition and removal of any designated improvements, asbestos containing material (ACM), buildings, contaminated material, and storage tanks on the parcel. Prior to the start of removals, the Contractor shall obtain approval from the Engineer for all schedules and plans. The work shall be performed in accordance with the approved plan and schedule unless otherwise approved by the Engineer. The Contractor shall complete all demolition, removal and disposal of buildings, other than ACM removal, within seven days after starting work on the building, unless otherwise approved by the Engineer. Additional calendar days may be granted by the Engineer for building demolition if significant remediation work is required.

202.40.3 Demolition and Removal General Requirements.

202.40.3.1 Backfilling. Backfilling operations for residential basements shall be completed within four days after residential buildings are removed. Backfilling operations for commercial basements shall be completed within 14 days after commercial buildings are removed in accordance with the demolition and removal work schedule required in Sec 202.40.2.

202.40.3.2 Site Maintenance. All parcels included with each notice to remove shall be maintained by the Contractor and kept in a safe and clean condition until acceptance of the work by the Engineer. All access to the interior of buildings located on a parcel for which a notice to remove has been issued shall be closed up and secured or otherwise covered such that the public cannot enter the buildings.

202.40.3.3 Utilities. Before beginning demolition, the Contractor shall arrange for the disconnection of utilities to buildings to be demolished in accordance with the regulations of the utility concerned. The Contractor shall take measures to prevent any material from entering storm and sanitary sewers. In the event that utility service lines are disrupted and utility service is needed, the Contractor shall provide adequate substitute utility service, at the Contractor's expense.
202.40.3.4 Site Security. Before starting demolition for each parcel, the Contractor shall provide adequate security around buildings to be demolished to protect the public and workers from operating equipment and falling debris, and to block access to any situation that constitutes a hazard to the public.

202.40.4 Removal of Asbestos Containing Material. Unless designated otherwise, the Contractor will test all buildings or structures to be removed for ACM. Testing of buildings will be limited to ACM. Buildings will not be tested for other substances. The County disclaims any representation that the buildings are hazard-free. If ACM is present in a building or structure, the ACM shall be removed and disposed of by the Contractor in accordance with the contract documents. All regulated asbestos containing material (RACM), as defined in Sec. 202.40.4.5, and Category I nonfriable ACM on concrete shall be removed from the buildings prior to demolition or salvage. Category II nonfriable ACM that does not have a high probability of becoming crumbled, pulverized or reduced to powder in the course of demolition, and Category I nonfriable ACM, except floor tile or sheeting on concrete, may remain in the building during demolition. All building demolition material, including the Category II nonfriable ACM and Category I nonfriable ACM, shall be disposed of in a licensed landfill. The Contractor shall not crumble, pulverize or reduce to powder Category II nonfriable ACM and shall not cut, grind, sand, abrade or render the Category I nonfriable ACM friable during demolition and transportation to the licensed landfill. If the Contractor elects to remove and dispose of Category II nonfriable ACM and Category I nonfriable ACM prior to demolition, disposal shall be performed properly and at the Contractor’s expense.

202.40.4.1 Asbestos Identification and Testing. Suspect ACM will be sampled and tested. The Contractor shall submit the results of the testing for friable and nonfriable ACM requiring removal to the County, for review 14 days prior to any building demolition work. The Contractor may only proceed with building demolition work after written notice is provided from the County.

202.40.4.2 Licensing and Permits. The Contractor performing friable asbestos abatement in accordance with the regulations shall be registered with MDNR and certified as an asbestos Contractor with the agency. Before beginning work on any parcel, the Contractor shall provide the Engineer with copies of all permits, licenses and certifications in accordance with local, state, or federal agencies.

202.40.4.3 Notification and Reporting. The Contractor shall provide all information regarding asbestos abatement to the EPA, OSHA, MDNR and local agencies in accordance with applicable regulations concerning asbestos removal work. Notification shall be provided by the Contractor to all applicable regulating agencies for all asbestos removal before removal and demolition begins. The Contractor shall obtain any necessary authorization for the work from all applicable federal, state and local agencies. The Contractor shall provide copies of all reports and authorization information to the Engineer prior to beginning work on the project.

202.40.4.4 On-Site Supervisor. The Contractor shall provide a trained supervisor to remain on site during all ACM removal work in accordance with EPA regulations. The Contractor shall provide evidence of the supervisor’s training to the Engineer before any work begins.

202.40.4.5 Regulated Asbestos Containing Material and Category I Nonfriable Asbestos Containing Material on Concrete. The Contractor shall remove, transfer and dispose of RACM and Category I nonfriable ACM (floor tile and sheeting on concrete) specified in the contract. The following material will be considered RACM:

(a) Friable asbestos material.

(b) Category I nonfriable ACM that has become friable.

(c) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting or abrading.
(d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized or reduced to powder by the forces expected to act on the material in the course of demolition.

202.40.4.6 Unidentified Asbestos. If the Contractor encounters suspect ACM not previously identified in the contract, the Contractor shall immediately notify the Engineer in accordance with the contract requirements. The Engineer will have the suspect material sampled and tested, and the Contractor shall not remove the additional suspect ACM until directed by the Engineer.

202.40.4.7 No Salvage Permitted. No salvage of items containing asbestos material will be permitted.

202.40.4.8 Airborne Asbestos Particle Testing. The Contractor shall monitor and test for airborne asbestos particles during working hours within the area of the property or fence line. The Contractor shall conduct operations to keep airborne particles beyond this area within the established regulation limits. The Contractor shall furnish the Engineer copies of correspondence, test results, recommendations and other information to document Contractor's compliance with the following requirements:

(a) When asbestos removal is completed, all work shall be inspected by the Contractor for the presence of asbestos debris. Removal and cleaning shall continue until air monitoring clearance testing indicates the level of airborne fibers meets required levels. The Engineer shall be notified when sampling is started. The Contractor shall provide documentation to the Engineer within 24 hours after the sampling has been completed that the level of airborne fibers meets required levels.

(b) For asbestos abatement projects requiring third party air monitoring as determined by the Engineer, the Contractor shall cooperate and coordinate with the Engineer and the third party air sampler designated by the Engineer to perform the third party air sampling. The Contractor shall provide to the Engineer a minimum of 48 hours notice of the time when the services of the third party air sampler will be required as a result of the Contractor's work. The Contractor shall arrange work so as not to interfere with the third party air sampler's ability to conduct the necessary air sampling. The Contractor and the third party air sampler shall work cooperatively with the Engineer in a sequence such that air sampling shall be conducted in a proper and timely manner by the third party air sampler with minimal interruption to any other party.

202.40.4.9 Disposal. All RACM and Category I nonfriable ACM shall be disposed of within seven days of removal from the building or structure. All RACM and ACM shall be disposed in accordance with applicable EPA, OSHA, MDNR and local agencies' regulations.

202.40.4.9.1 The Contractor shall identify or mark hauling vehicles used to transport asbestos waste during loading, transporting and unloading in accordance with applicable regulations for transporting asbestos waste. The waste shall be transported in enclosed roll-offs or dumpsters, vehicles that have completely enclosed cargo areas, or a four-sided cargo area that shall be completely covered with two layers of 6-mil thick plastic sheeting or equivalent covering while the waste is being transported.

202.40.4.9.2 The Contractor shall provide a Waste Shipment Record to the waste site owner or operator at the time the waste is delivered to the waste disposal site. A copy of the Waste Shipment Record shall be provided to the Engineer.

202.40.5 Removal of Buildings. Removal of buildings shall include all attached structures. Under no circumstances shall the Contractor burn, grind, pulverize or otherwise reduce any portion of the building into fine particles without prior approval from the Engineer. Any buildings or portion thereof located on the parcel may be removed intact or substantially intact subject to the Contractor's adherence to the following conditions:
(a) The Contractor shall declare, in writing, the intention to move any building or substantial portion thereof to any other location. Such declarations shall be made within 30 days of the issuance of the notice to remove for the building. The Contractor shall submit a separate declaration for each building.

(b) The name of the house mover or house moving company shall be included in the declaration. The Engineer reserves the right to disapprove a house mover or house moving company with no prior performance record or based on unsatisfactory performance on previous moving jobs. Conditional approval may be given at the discretion of the Engineer for previously disapproved house movers or house moving companies for one building at a time.

(c) No building or portion thereof shall be removed from the parcel until the Contractor has received written approval from the Engineer and other authority having jurisdiction over the area involved in the total move by issuance of the proper permits.

(d) The Contractor shall commence the removal of buildings promptly. Buildings removed shall not be placed on other portions of state right of way for storage or for any other purpose, except as specifically allowed by issuance of an over dimension permit from the County.

(e) Interim storage of buildings for resale or any other purpose will be limited to areas where zoning allows for such storage. No public lands or right of way shall be used unless a permit is granted by the responsible agency.

(f) The Contractor shall remove all components of the building to the foundation level, including those components suspended from the main level subfloor structure. The primary components of the building shall be removed intact as a whole structure. The Contractor will not be paid for ACM removal from these structures unless required from the disturbance of the foundation or on the remaining foundation components after building removal, as determined by the Engineer.

202.40.5.1 Demolition of Walls. All exterior walls shall be removed to the level of existing adjacent ground, streets, alleys or sidewalks. Interior walls shall be removed to the level of existing basement floors.

202.40.5.1.1 Where joint or party walls exist between two buildings that are not being demolished at the same time, the part of wall or walls serving both buildings shall be removed with the demolition of the last structure. No demolition work shall damage or weaken walls or portions of walls serving adjacent buildings.

202.40.5.1.2 Remaining portions of party walls shall be left in sound condition with demolition terminating in neat vertical and horizontal lines. Care shall be taken to ensure demolition without damage to roofs or other parts of adjoining buildings.

202.40.5.2 Removal of Flooring. Floor construction over basements, sub-basements or cellars, and all other floors regardless of elevation, shall be removed. All existing wood and other material attached to concrete and masonry construction shall be removed.

202.40.5.3 Disposal of Debris. The Contractor shall remove any debris resulting from demolition as work progresses and dispose of the material in a licensed landfill.

202.40.5.4 Cooling Systems. Buildings to be demolished may have various cooling systems that contain freon or other refrigerants. The Contractor shall identify the type of refrigerant present in each system and properly recover the refrigerant prior to salvage or demolition of the cooling systems.

202.40.6 Removal of Appurtenances. Removal and disposal shall include all existing building appurtenances on each parcel in the demolition and removal contracts from the right of way and within the limits of any construction.
easement outside the right of way, except those items designated to remain in place or to be removed under other items of work.

202.40.6.1 All elevated sidewalks, steps, retaining walls, basement and foundation walls, columns, footings, concrete floors, cisterns, catch basins, uncontaminated storage tanks, manholes, signs, fences, bricks, stones, broken masonry, rubbish, debris and any other items not covered elsewhere in Sec 202 will be considered building appurtenances.

202.40.6.2 The plans may not show a complete list of all items to be removed. There may be an undetermined number of basement or foundation walls, columns, footings or other improvements encountered. The Contractor shall determine the extent of the work to be performed under this item.

202.40.7 Method of Measurement.

202.40.7.1 Final measurement of removal for ACM will be made to the nearest square foot or linear foot based on the asbestos survey test report.

202.40.7.2 Measurement for testing for ACM, demolition, and removal of buildings and appurtenances will be considered a lump sum unit per parcel.

202.40.8 Basis of Payment.

202.40.8.1 Payment for removal of ACM will be made for field-measured quantities as approved by the Engineer at the contract unit price. If additional suspect material tests positive for the presence of asbestos, payment will be made per the contract unit price. No direct payment will be made for recovering refrigerant.

202.40.8.2 Payment for testing for ACM demolition and removal of buildings and appurtenances will be made at the contract lump sum unit price per parcel.

SECTION 202.50 REMOVAL OF CONTAMINATED MATERIAL AND STORAGE TANKS.

202.50.1 Description. This work shall consist of removing and disposing of designated residual material, pavement, pump islands, all storage tanks and piping; excavation and disposal of uncontaminated and contaminated soil as required; obtaining the necessary regulatory permits; backfilling the excavated areas with uncontaminated soil after clean up levels have been achieved; and any incidental work or material required to complete the job. The contractor shall obtain and keep in its possession of a valid permit from the County’s Community Development Department, if required.

202.50.2 Schedule. The Contractor shall submit a plan and schedule for demolition and removal of any designated storage tanks on the parcel and shall obtain the Engineer’s approval prior to starting work. The work shall be performed in accordance with the approved plan and schedule unless otherwise approved by the Engineer.

202.50.3 Removal Requirements.

202.50.3.1 Site Inspection. The Contractor shall inspect and become familiar with the proposed work site, conditions and circumstances.

202.50.3.2 Conformance Requirements. Work shall be performed in accordance with industry recommended practices, including the American Petroleum Institute (API) Recommended Practices, and MDNR Underground Storage Tanks (UST) Closure Guidance (Closure Guidance).
202.50.3.3 Groundwater Monitoring Wells. The Contractor shall protect all existing groundwater monitoring wells located within the area of underground storage tanks from damage and contamination, except for wells in an area of contaminated soil removal.

202.50.3.4 Tank Vapor Levels. Vapor levels in each tank shall be checked for explosive potential prior to removing the tank or piping. Non-sparking tools shall be used for gaining access to the tank atmosphere in order to measure the vapor level. If the explosive level is above 20 percent of the lower explosive limit, flammable vapors shall be removed in accordance with methods outlined by API Recommended Practices until the 20 percent level is reached. The Contractor shall purge vapors from a vent pipe. Gasoline tanks shall not be purged during adverse weather conditions where vapors could accumulate at ground level and cause a public health or fire hazard.

202.50.3.5 Tank Dewatering and Removal. The Contractor shall notify the Engineer prior dewatering and removing storage tanks.

202.50.3.6 Residual Material. The Contractor shall remove and dispose of all residual material in the tanks or drums on the site identified as being a regulated quantity of hazardous waste material. All product, sludge, and water in contact with the interior of a petroleum UST will be presumed to be hazardous waste, unless sample test results reporting the requirements of the Toxicity Characteristic Final Rule prove otherwise. Hazardous waste material shall be transported by a hazardous waste transporter licensed in the State of Missouri and manifested as hazardous waste to a Resource Conservation and Recovery Act (RCRA) treatment, storage or disposal facility. The generator's copy of the manifest shall be submitted to the Engineer. The material in tanks or drums identified as being non-hazardous shall be managed properly.

202.50.3.7 Tank Pit Surface Water. Tank pits on the site may contain contaminated surface water or groundwater. The Contractor shall remove, transport and dispose of all contaminated water from the tank pit at an appropriate treatment, storage or disposal facility.

202.50.3.8 Soil Excavation. Soil excavation shall be performed by the Contractor to segregate contaminated soil from uncontaminated soil. Contaminated soil shall be excavated to the limits directed by the Engineer. The Contractor shall use calibrated field instrumentation approved by the Engineer to evaluate approximate levels of contamination remaining in the unexcavated soil.

202.50.3.9 Hauling and Disposal of Contaminated Soil. Contaminated soil shall be hauled from the site and disposed of in a licensed landfill, or as directed by the Engineer. Disposal of contaminated soil shall be in accordance with the Closure Guidance. The Contractor shall provide the Engineer with a copy of a completed MDNR form entitled Disposal of Soil Contaminated With Virgin Gasoline or Virgin Fuel Oil.

202.50.3.10 Use of Uncontaminated Soil. Uncontaminated soil may be reused as backfill at locations approved by the Engineer.

202.50.3.11 Water Accumulated in Excavation. If stormwater accumulates in the excavated area and requires removal prior to backfilling, the Contractor shall obtain an MDNR storm water discharge permit or approval to discharge accumulated water into a sewer system. Disposal of water removed from the excavated area will be at the Contractor’s expense.

202.50.3.12 Sample Analysis. The Contractor’s work will be regulated as follows:

(a) The Contractor shall sample and analyze residual material, tank pit surface water or groundwater, and any stormwater that accumulates in the excavated area as necessary for proper disposal.

(b) The Contractor shall provide the Engineer with the name, location and testing requirements of the disposal facility for the contaminated material.
(c) The Engineer will sample and analyze all soil prior to disposal; prior to beneficial reuse if beneficial reuse is designated in the contract; and prior to backfilling. Sampling and analysis will be done in accordance with the Closure Guidance and requirements of the Missouri Petroleum Storage Tank Insurance Fund.

(d) The Engineer will obtain samples beneath the tank, down-gradient and around pumps and lines in accordance with the Closure Guidance.

(e) The Engineer will determine if remaining soil requires excavation and when clean up levels have been achieved.

202.50.3.13 Backfill. The Contractor shall not begin backfilling operations until directed by the Engineer.

202.50.3.14 Closure Report. The Contractor shall provide copies of all necessary documentation for tank cleaning and disposal, and soil, sludge and wastewater disposal to the Engineer. Documentation shall be in accordance with the Closure Guidance and the Missouri Petroleum Storage Tank Insurance Fund. The Engineer will prepare the underground storage tank closure report in accordance with the Closure Guidance.

202.50.4 Method of Measurement. Measurement of tank removal and disposal will be made per each; residual hazardous material removal and disposal will be measured per gallon; tank pit surface water removal and disposal will be measured per 10 gallons; and hauling and disposing of contaminated soil will be measured per ton based on landfill weight tickets. Measurement of excavation and backfill will be made to the nearest cubic yard, measured from the actual excavation limits to the existing surrounding ground line. A deduction equal to the volume of the tanks removed will be made from the volume measured for payment of contaminated soil excavation when existing tanks are removed from within the limits of the sections measured for determining pay volumes of excavation.

202.50.5 Basis of Payment.

202.50.5.1 The accepted quantities for removal and disposal of storage tanks will be paid for at the contract unit price per each.

202.50.5.2 The accepted quantity of hazardous residual material will be paid for at the contract unit price. Payment will be considered full compensation for sampling and analysis, removal of the material, appropriate containerization and labeling, transportation and treatment or disposal. Payment will not be made until the Engineer receives a Certification of Treatment or Disposal for all material from the RCRA treatment, storage or disposal facility.

202.50.5.3 The accepted quantity of tank pit surface water and groundwater removal and disposal will be paid for at the contract unit price. Payment will be considered full compensation for all sampling and analysis, transportation, disposal fees, and processing of approvals.

202.50.5.4 The accepted quantity for excavation of contaminated soil will be paid for at the contract unit price.

202.50.5.5 The accepted quantity for hauling contaminated soil will be paid for at the contract unit price, based on landfill weight tickets. Payment will be considered full compensation for removal from the site and transportation for treatment or disposal.

202.50.5.6 The accepted quantity for disposal of contaminated soil will be paid for at the contract unit price, based on landfill weight tickets. Payment will be considered full compensation for all landfill fees and processing of landfill approvals.
202.50.5.7 The accepted quantity for backfill will be paid for at the contract unit price and will be considered full compensation for material, transportation and compaction.
203.1 Description. This work shall consist of excavation, disposal, placement and compaction of all materials encountered within the limits of the work not being removed under some other item and any borrow required to construct the roadway. This work shall be performed in accordance with the specifications and in conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans, or established by the Engineer. All excavation will be classified as hereafter described.

203.1.1 Class A Excavation will consist of all roadway and drainage excavation not classified as Class C.

203.1.2 Class C Excavation will consist of the removal of stone in ledges 6 inches or more in thickness. A ledge will be considered to be a continuous deposit of rock that may or may not include thin, interbedded seams of soft material or shale. The vertical limits of each ledge will be determined by beds of soft material or shale more than 12 inches thick. The beds of soft material or shale will be included in the measurement of Class A Excavation only. Boulders or other detached stones each having a volume of 2 1/2 cubic yards or more will be considered as Class C Excavation.

203.1.2.1 Shale, fire clay, chert (joint flint rock) broken by intermittent clayey partings or clay seams, stratified chert cemented with clay seams (hardpan), and plain or bituminous-bound bases or surface courses of macadam, gravel, broken stone, or similar materials will not be considered as Class C Excavation.

203.1.3 Unclassified Excavation will consist of the excavation of all materials of whatever character encountered in the work. All material excavated will be considered as Unclassified Excavation unless the contract specifies classified material.

203.1.4 Embankment in place will be constructed utilizing the material excavated on the project or supplied from an approved borrow area.

203.1.5 Not Used.

203.1.6 Borrow and Waste.

203.1.6.1 This work shall consist of constructing the required embankment from borrow excavation obtained from approved borrow sites furnished by the Contractor and approved by the Engineer.

203.1.6.2 The Contractor shall obtain the necessary environmental clearances per job special provisions prior to using the borrow area for the project. No direct payment will be made for obtaining the required clearances for borrow areas. An adjustment in contract time will be considered for any delay caused by receiving the required clearances.

203.1.6.3 Acceptable soils are designated CL, ML, CL-ML, SP, SW, GP, and GW by American Standards and Testing Materials (ASTM) D 2487 classification. Contractor furnished borrow shall be equal to or better than the materials assumed for design and shall be subject to approval by the Engineer. Approval will be based upon considerations of (1) various soil characteristics and dispersions of test values and (2) comparison with those used for design. Contractor furnished borrow shall meet the above mentioned ASTM classification. Low plastic soils encountered along the proposed roadway alignment may be suitable for use as compacted fill, provided such soils meet the above mentioned ASTM classifications.

Off-site borrow materials shall be evaluated by the Engineer before importing them to the project area. Contractors are advised that proposed sites for Contractor furnished material will be sampled and tested only after award of
the contract and after proof of an agreement, between the property owner and the Contractor authorizing use of any borrow site, has been provided to the Engineer. The Contractor shall be further advised that (1) preliminary subsurface investigations to determine depth to rock, general soil characteristics, etc., will be solely the responsibility of the Contractor; (2) the Engineer shall be notified in writing sufficiently in advance of the proposed use of a borrow site to allow six weeks for sampling under the direction of, and testing by, the Engineer. The Contractor shall furnish equipment suitable for the purpose of soil sampling and shall make all necessary arrangements for performing the work at a time mutually agreeable to the Contractor and the Engineer.

**203.1.6.4** The material in the embankment shall be placed in accordance with this special provision and all applicable provisions of Sec 203.3 of the Standard Specifications and in conformity with the lines, grades, and typical cross sections shown on the plans.

**203.1.6.5** All cohesive structural fill (CL, ML, CL-NE) shall be placed in 8 inch loose lifts and mechanically compacted to a minimum dry density of 90 percent of the maximum dry density as determined by the modified Proctor compaction test (ASTM D 1557). Fills that will be greater than 25 feet in height shall be compacted to a minimum of 92 percent of the modified Proctor test. For all fills designed at an inclination of 2 1/2H: IV, the plasticity index (PI) as determined by the liquid limit (LL) minus the plastic limit (PL) shall be less than or equal to 25. This requirement basically eliminates the use of high plastic clays (CH) for these fills. All non-cohesive or granular structural fill (SP, SW, GP, and GW) shall be placed in 12 inch loose lifts and mechanically compacted to a minimum relative density of 70 percent as determined by the relative density tests (ASTM D 4253 and D 4254). If the granular fill materials exhibit a well-defined moisture-density relationship, such materials shall be compacted to a minimum dry density of 92 percent of the modified Proctor maximum dry density when placed in the road bed, or to a minimum of 95 percent when placed as a base course. Field density tests shall be performed on each lift of fill to verify that property compaction is achieved. In addition to the minimum density requirements, the soil shall be stable (i.e., not pumping) prior to placing additional fill or constructing pavement.

**203.1.6.6** Borrow areas will be given a final dressing and seeding prior to completion of the contract, so as to provide a pleasing appearance to the overall area. Payment for seeding only, for dressing of borrow areas shown on the plans, will be considered incidental to the work, and no direct payment will be made.

**203.1.6.7 Disposal of Excess Material**

**203.1.6.7.1** The Missouri Solid Waste Management Law and its ancillary regulations, 10 CSR 80-1 through 9, provide for the proper disposal of solid waste. The CONTRACTOR must comply with the provision of applicable regulations during highway and bridge construction activities. These activities oftentimes involve the generation of “excess material”, which in many instances can also be considered “solid waste” under the definitions of the Department of Natural Resources (DNR) Solid Waste Management Program.

**203.1.6.7.2** Many types of excess material are not regulated by the DNR’s Solid Waste Management Program. Such “clean fill” includes uncontaminated soil, rock, sand, gravel, concrete, minimal amounts of wood and metal and inert solids as approved by rule or policy by DNR’s Solid Waste Management Program. These materials are basically not considered solid waste, and may be disposed of without prior approval from DNR’s Solid Waste Management Program. Other substances which are not included in this list of materials may require special approval by the DNR’s Solid Waste Management Program prior to disposal in areas other than approved landfills.

**203.1.6.7.3** Disposal of any other material which does not fit this “clean fill” definition must be in accordance with DNR’s (or local) regulations and it shall be the CONTRACTOR’s responsibility to provide appropriate documentation (i.e. landfill receipts or a private OWNER waiver letter or statement from DNR) that the disposal will not violate applicable laws or regulations.

**203.1.6.7.4** No direct payment will be made for any expense incurred by the CONTRACTOR by reason of its compliance with these requirements.
203.2 Construction Requirements.

203.2.1 General. Prior to beginning excavation and embankment operations in any area, all necessary clearing, grubbing, and stripping in that area shall have been performed. The excavation and embankment for roadway, intersections, and entrances shall be made to the designated alignment, grade, and cross section. Side slopes, cuts, and fills shall be finished to a reasonably smooth and uniform surface that will merge with the adjacent terrain without variations readily discernible from the road. Finishing by hand methods will not be required, except that all brush, weeds, excess mud and silt, or other debris shall be removed from culverts and channels within the scope of the work even though such structures are used in place. Areas disturbed by the Contractor outside the limits of construction shall be restored at the Contractor’s expense to a condition similar to that prior to construction operations.

203.2.1.1 Field Stone. Before final project acceptance, all loose field stone greater than 4 inches in size within the limits of the right of way shall be disposed of as directed by the Engineer.

203.2.1.2 Shoulders. Earth shoulders shall be constructed of suitable material to the grade and cross section shown on the plans and shall be compacted by use of a steel wheeled roller weighing not less than 5 tons. The construction of shoulders shall start when sufficient surfacing has been completed and attained satisfactory strength to permit continuous shouldering operations. Equipment that will damage the surfacing will be prohibited from operating on the surfacing during shouldering operations. Surfacing and curbs shall be protected where equipment is crossing or turning.

203.2.2 Maintenance. During construction, the roadway shall be maintained by the Contractor in such condition that it will be passable and well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches, and any other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions. All slides shall be removed and material disposed of as directed by the Engineer.

203.2.2.1 Securing Embankments. All embankments constructed next to open roadways shall be secured by the Contractor. If the proximity of the roadway next to the embankment does not allow for the material to be properly sloped, then the Contractor shall secure the material. The Contractor may use temporary traffic barrier per Sec 617.20, a temporary retaining wall system, or another method approved by the Engineer. Direct payment will not be made for securing the embankment during staged construction, unless otherwise noted in the contract.

203.2.3 Drilled and Dug Wells. The Contractor will notify the Engineer of any wells encountered. All wells within the project limits that are to be closed shall be closed in accordance with MDNR regulations. Direct payment will not be made for the plugging or disposal of wells or cisterns.

203.2.4 Removal of Oversize Material in Subgrade. The Engineer may order subgrade scarifying performed to remove oversized material if the upper 6 inches of the subgrade, as tentatively completed, contains loose rock over 2 inches in size to make the subgrade unacceptable as a roadbed for the proposed type of surfacing in the judgment of the Engineer.

203.2.5 Excavating in Rock. Excavating and undergrading in rock (i.e., material conforming to the description of Class C, whether the contract calls for classified or unclassified excavation) shall be performed in a manner to produce material of such size as to permit being placed in embankments in accordance with the requirements. Rock within the roadbed limits shall be removed to the limits of undergrading insofar as practicable and in such manner as to leave no undrained pockets in the surface. Unless specifically set forth in the contract, the Contractor will be required to obtain the necessary permission from all governmental entities before considering blasting as a means of rock excavation. Care shall be taken to avoid overshooting when blasting. Any loose or shattered rock, overhanging ledges, and boulders above the roadbed that might dislodge shall be removed. When the contract...
provides a specific use for rock from roadway excavation, the work shall be performed in such order and manner as may be necessary to ensure that the desired quantity of such material may be placed as required.

203.2.5.1 The Contractor, at its option, may perform the excavating of rock cuts by the technique of “pre-splitting” on the neat line of the proposed excavation, with the results subject to the approval of the Engineer. Holes for pre-splitting shall be drilled to the full depth of the cut or to a pre-selected bench elevation as shown on the plans or as determined by the Engineer. The spacing and diameter of holes and the amount, type, and spacing of the explosive charges in the holes shall be the full responsibility of the Contractor. Pre-splitting shall be done according to accepted practice to produce a clean face on the excavated cut.

203.2.5.2 Undergrading In Rock. Regardless of whether the contract includes paving, the final surface for the backfilled undergraded areas shall be of a uniform texture and grade suitable to the Engineer for paving.

203.2.5.2.1 Unless specified otherwise, the final surface shall be substantially free of exposed rock exceeding the 2 inch size that would interfere with the final preparation of the base for paving. Areas of required undergrading, except where an aggregate-type surface is specified, shall be backfilled with one of the following materials, with preference in the order given, depending on availability:

(a) The top approximately 2 inches of the rock backfill shall consist of either rock fragments or spalls or a 2 inch granular-type material having a plasticity index not exceeding 10, and a gradation such that at least 50 percent of the material will be retained on the No. 4 sieve.

(b) A 2 inch maximum size granular-type material having a plasticity index not exceeding 10, and a gradation such that at least 50 percent of the material will be retained on the No. 4 sieve.

(c) A material having a low plasticity index and designated by the Engineer as suitable. No material shall exceed 2 inches in size.

203.2.5.2.2 If a roadway to receive an aggregate type surface is specified in the contract, undergraded areas shall be backfilled with material obtained from roadway excavation, and the upper 6 inches shall be free of granular material larger than 4 inches.

203.2.5.3 Overbreak. Overbreak resulting from blasting rock below the limits of undergrading shall be removed and backfilled with spalls or rock fragments at the Contractor’s expense. If spalls are not available and if the Contractor does not elect to use rock fragments, the use of either of the following will be satisfactory.

(a) Material in accordance with Sec 1007.

(b) A granular-type material with a plasticity index not exceeding 10, and a gradation such that at least 50 percent of the material will be retained on the No. 4 sieve.

203.2.6 Unsuitable Subgrade. Where excavation to the finished graded section results in a subgrade or slopes of unsuitable material, the Engineer may require the Contractor to remove the unsuitable material, and backfill to the finished graded section with approved material.

203.2.6.1 Prior to the Engineer classifying an area as unsuitable subgrade, the Contractor shall have performed Compacting in Cut in accordance with Sec 203.3.5. The material in question shall be given a reasonable duration and opportunity, as determined by the Engineer, to achieve optimum moisture prior to reinstalling during the compacting in cut operations. If the compacting in cut work has not improved the stability of the material, the Engineer may classify the material as unsuitable subgrade.
203.2.6.2 The Contractor shall conduct its operations in such manner that the Engineer may make the necessary measurements before the backfill is placed. The Engineer will determine the type of backfill material required based upon the field conditions to provide to a stable foundation for the roadway. The Engineer may order additional excavation beyond the pay limits established for roadway excavation in order to remove material found unsuitable for roadway construction. Measurement for the volume of unsuitable material excavated beyond or outside the limits shown on the plans or established by the specifications for roadway excavation will be made by the Engineer.

203.2.7 Borrow. Borrow material shall not be placed until after material from roadway excavation has been placed in the fill, except as approved otherwise by the Engineer. The Contractor shall not excavate beyond the dimensions and elevations established, and no material shall be removed prior to staking and cross sectioning the site. If the Contractor places more borrow than required and thereby causes a waste of excavation, such waste will be deducted from the borrow volume as measured in the borrow area. All borrow areas shall be bladed and left in such shape as to permit taking the necessary cross sections after excavating has been completed. The finished borrow areas shall be approximately true to line and grade when so specified in the contract, and shall be finished, where practicable, so that no water will collect or stand therein. When necessary to remove fencing in order to obtain borrow material, it shall be replaced in as good condition as it was at the time of removal. The Contractor shall be responsible for confining livestock when a portion of the fence is removed. No direct payment will be made for removing and replacing such fence or for the confining of livestock.

203.2.8 Roadway Obliteration. Obliteration of old roads shall be performed in areas shown on the plans and shall include all grading operations necessary to incorporate the old road into the work. The obliteration shall provide a pleasing appearance. Obliteration of existing pavements will be paid for as Removal of Improvements. The earthwork for obliteration will be paid for as roadway excavation, unless otherwise provided in the contract.

203.2.9 Artifacts. When remains of prehistoric sites or artifacts of historical or archaeological significance are encountered, the excavation operations shall be temporarily discontinued and the Engineer notified. Work shall not resume at that location until authorized by the Engineer.

203.2.10 Embankment Construction. Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed, constructing dikes and berms, placing and compacting approved materials within roadway areas where unsuitable material has been removed, and placing and compacting of embankment material in holes, pits, and other depressions within the roadway area. Only approved materials free of trees, stumps, rubbish, and any other deleterious material shall be used in the construction of embankments and backfills. Rocks, broken concrete or other solid material shall not be placed in embankment areas where piling is to be placed or driven.

203.2.10.1 Embankments requiring surcharges, restricted loading rates, embankment control stakes, or pore pressure measurement devices, shall be constructed to the design template progressively for the full height. Failure of embankments or embankment foundations, or damage to structures which occur when the Contractor fails to observe restricted loading rates, or fails to construct slopes initially to the design template, shall be repaired as directed by the Engineer at the Contractor’s expense.

203.2.10.2 Construction of embankments shall not be started on foundation soil or partially completed embankments having more than 2 inches of frozen soil, nor shall embankment be built of frozen material. When such conditions exist, the surface must be thoroughly broken and mixed with non-frosted material to the satisfaction of the Engineer. No frozen material may be incorporated into the embankment. No material shall be placed on frost layers encountered within 12 inches of the top of the proposed grading section. Frozen material on foundation soil or partially completed embankment not meeting the above requirements shall be removed before placing material for the embankment. The removal of frozen material from the foundation of an embankment, or from any layer of the embankment, and the replacement with satisfactory material shall be at the expense of the Contractor.
203.2.11 Embankment on Hillsides or Against Existing Embankment. When embankment is to be placed on hillsides or when new embankment is to be constructed against existing embankments, the existing slopes that are steeper than 6 to 1 when measured at right angle to the roadway shall be continuously benched in not less than 12 inch rises over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit placing and compacting operations. Each horizontal cut shall begin at the intersection of the ground line and the vertical side of the previous bench. Existing slopes shall also be stepped to prevent any wedging action of the embankment against structures. No direct payment will be made for the material thus cut out or for its compaction along with the new embankment material.

203.2.12 Scalping. Scalping shall be performed in accordance with Sec 201.2.5. Where an embankment less than 4 feet in height is to be made, all sod and vegetable material shall be removed from the surface upon which the embankment is to be placed, and the cleared surface completely broken up by plowing, scarifying, or stepping to a minimum depth of 6 inches. This area shall be compacted in the same manner as that required for the embankment placed on the area. Sod not required to be removed shall be thoroughly disked before construction of embankment. Where an embankment less than 3 feet in height is to be made over a compacted road surface containing bituminous or granular material, the old road surface shall be scarified full depth or to a depth of at least 6 inches when the bituminous surface is less than 6 inches thick. This scarified material shall be recompacted.

203.2.13 Embankment Against Existing Structures. If embankment is deposited on one side only of abutments, wingwalls, piers, or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. Equipment of such weight as may cause damage to culverts of other structures will not be permitted to work over or immediately adjacent to such structures. The fill adjacent to the end bent of a bridge shall not be placed higher behind than in front of end bents until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be so conducted that the embankment is kept at approximately the same elevation on each side.

203.2.14 Surcharged Embankments. Surcharged embankments shall be built in accordance with the plans and shall remain in place for such time as required by the contract. The requirements for placing and compacting will be waived on the surcharge material above the specified completed area.

203.2.15 Excess or Unsuitable Material. All excess or unsuitable excavated material, including rock and boulders that cannot be used in embankments, may be placed on the sideslopes of the nearest embankment in a satisfactory manner or shall be disposed of off the right of way in areas secured by the Contractor. The Contractor shall be responsible for compliance with all federal, state and local laws in the disposal of excess or unsuitable material. Rock or boulders greater than 24 inches shall not be used routinely in constructing sideslope embankments. A distinct shoulder line shall be maintained by keeping all such waste material at least 24 inches below the finished shoulder elevation, and specific density control will not be required.

203.2.16 Placement of Embankment. Roadway embankment shall be placed in layers not exceeding 8 inches, as measured uncompacted, and shall be compacted as specified before the next layer is placed. The layers shall be placed approximately parallel to both the proposed profile grade and to the finished roadbed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. Continuous leveling and manipulating will be required during compacting operations. Construction equipment shall be routed uniformly over the entire surface of each layer. Occasional rocks and boulders greater than 24 inches shall be dispersed to allow for uniform compaction between them.

203.2.16.1 Occasional stones or rock fragments exceeding the thickness of the 8 inch layer shall be disposed of by being incorporated into the embankment outside the limits of the proposed surfaced traffic lanes. The thickness of the layer in these areas may be increased if necessary to accommodate the stones, but shall not exceed 12 inches, an uncompacted measurement. The stones or rock fragments shall be placed such that there is no nesting.
203.2.16.2 Lifts may be increased to a maximum of 12 inches, an uncompacted measurement, for berms, filling of old channels, waste or similar areas, and any roadway or approach for which a granular-type surface is proposed. These areas shall be compacted by uniformly distributing all equipment movements over the entire area, and specific density control will not be required. Compaction performed in these areas will be at the Contractor’s expense.

203.2.17 Rock Embankment. If the excavated material consists predominantly of rock fragments of such a size that the material cannot be placed in layers of the prescribed thickness, such material shall be placed in the embankment in layers having a thickness of the approximate average size of the larger rocks but not exceeding 24 inches. Rocks or boulders too large to permit placing in a 24 inch layer shall be reduced in size as necessary to permit this placement. Rock shall not be dumped in place, but shall be distributed by blading or dozing in a manner to ensure proper placement in final position in the embankment. Construction equipment shall be routed uniformly over the entire surface of each layer. The spalls and smaller stone fragments shall be left on the surface of each layer as formed.

203.2.18 Rigid or Flexible Pavements. Where the specified or proposed surfacing consists of a rigid or flexible type pavement, the top consolidated rock layer for the full width between roadbed slopes shall be finished to the same limits as shown on the plans for undergrading in rock cuts. Any embankment necessary outside the limits of the pavement shall be constructed of suitable earth or as otherwise specified in the contract.

203.3 Compaction of Embankment. All cohesive structural fill (CL, ML, CL-NE) shall be placed in 8 inch loose lifts and mechanically compacted to a minimum dry density of 90 percent of the maximum dry density as determined by the modified Proctor compaction test (ASTM D 1557). Fills that will be greater than 25 feet in height shall be compacted to a minimum of 92 percent of the modified Proctor test. For all fills designed at an inclination of 2 1/2H: IV, the plasticity index (PI) as determined by the liquid limit (LL) minus the plastic limit (PL) shall be less than or equal to 25. This requirement basically eliminates the use of high plastic clays (CH) for these fills. All non-cohesive or granular structural fill (SP, SW, GP, and GW) shall be placed in 12 inch loose lifts and mechanically compacted to a minimum relative density of 70 percent as determined by the relative density tests (ASTM D 4253 and D 4254). If the granular fill materials exhibit a well-defined moisture-density relationship, such materials shall be compacted to a minimum dry density of 92 percent of the modified Proctor maximum dry density when placed in the road bed, or to a minimum of 95 percent when placed as a base course. Field density tests shall be performed on each lift of fill to verify that property compaction is achieved. In addition to the minimum density requirements, the soil shall be stable (i.e., not pumping) prior to placing additional fill or constructing pavement.

203.3.1 Moisture Control. The moisture content of the soil at the time of compaction shall be as herein specified.

203.3.1.1 When necessary to eliminate rubbery condition of the embankment, it may be required that some soils have a moisture content below the optimum during compacting work. Clays, heavy clays, and other Class A materials having liquid limits of 40 or more shall not be placed as embankment when the moisture content of the soil surpasses its optimum moisture by three (3) percent. Existing embankments shall be disced, aerated, or reworked to comply with the moisture requirements of this provision subsequent to the resumption of embankment placement operation.

203.3.1.2 Loessial soils shall have moisture controlled so as not to exceed optimum plus three percentage points when placed in embankments of less than 30 feet in height. Such soils when placed in embankments of 30 feet or more in height shall have moisture controlled so as not to exceed optimum moisture. If wet foundation conditions contribute to the embankment moisture while compacting, the Engineer may waive this specified moisture content for a height not to exceed 3 feet above the embankment foundation. In the event of conflict of provisions of this section with provisions in Sec 203.3.1.1 shall govern.

203.3.2 Top Lift Thicknesses. The upper 18 inches of the earth subgrade extending the full width between roadbed slopes shall be compacted to at least 90 percent of maximum density of a modified proctor compaction test.
203.3.3 Structure Approach. Roadway embankment within 100 feet of each end of a structure on which the top slab or deck is to be used as the riding surface, and the spill fill under such a structure, shall be compacted to not less than 95 percent of maximum density as determined by the modified Proctor compaction test (ASTM D1557).

203.3.4 Rocky Fill. Density requirements will not apply to portions of embankments constructed of material so rocky that the embankment cannot be satisfactorily tested in accordance with AASHTO T 191 or T 205. Material of a gradation having more than approximately 20 percent retained on a 3/4 inch sieve will generally be considered too rocky for satisfactory density testing. In lieu thereof, the compactive effort on rocky material shall consist of making four complete passes on each layer with a tamping-type roller or two complete passes on each layer with a vibratory roller. The tamping-type roller shall have tampers or feet protruding no less than 6 inches from the surface of the drum and shall have a minimum load on each tamper of 250 psi of tamping area. The vibratory roller shall have a manufacturer's rating of 16 to 20 tons compacting power. During compaction, each layer shall have the moisture content controlled such that, in the judgment of the Engineer, any silt and clay fraction is in a plastic state. Simple diagnostic tests to establish such a plastic state will include ability to indent with a thumb or heel or to roll a short thread of soil between the hands. Material that crumbles under pressure will be considered too dry.

203.3.5 Compacting in Cut. Cut compaction, after removal of the roadway excavation material to the required pavement or lowest base course, shall be temporarily exposed for the full width between roadway inslopes. A surface parallel to the pavement slope, 12 inches below the bottom of the pavement or lowest base course, shall be temporarily excavated for the full width between roadway inslopes. The exposed surface material, below the excavated layer, shall be manipulated and compacted to no less than the required density to a depth of 6 inches. The material above this compacted plane shall be spread in layers not exceeding 8 inch loose thickness, each layer being wetted or dried as necessary and compacted to the specified density. The entire volume of material so handled and compacted, including the 6 inch layer compacted in place, will be considered as Compacting in Cut. All Class A material having a liquid limit of 40 or more, including the 6 inch layer compacted in place, shall be compacted at no less than the optimum moisture content.

203.3.5.1 The existing ground for the full width between roadway slopes under embankments of less than 18 inches in height shall be treated in accordance with Sec 203.3.5 to only such depth as to insure having 18 inches of material of the required density and moisture below the top of the finished subgrade.

203.3.5.2 The entire volume of materials so handled and compacted as specified in Sec 203.3.5 and Sec 203.3.5.1, including the 6 inch layer compacted in-place will be considered compacting in cut.

203.3.6 Lift Consistency. Each layer shall be wetted or dried as necessary, and shall be compacted to the required density. Regardless of the type of equipment used, the roadway shall be compacted uniformly and the surface kept reasonably smooth at all times. If large pieces of heavy clay are encountered, the material shall be broken down by suitable manipulation to permit satisfactory embankment construction. If shale is encountered, the shale shall be broken down as much as practical and compacted at or above optimum moisture.

203.4 Compaction of Embankments Not Constructed with Density or Moisture and Density Control. The compactive effort on each layer shall consist of distributing all equipment movements over the entire fill area and of at least three complete coverages with a tamping-type roller over the entire area to be compacted. The tamping-type roller shall have tampers or feet projecting not less than 6 inches from the surface of the drum and shall have a minimum load on each tamper of 250 psi. Compactive effort shall be continued, if necessary, until the tamping feet penetrate not more than 2 inches into the layer of material being compacted. Continuous leveling and manipulating will be required during compacting operations and the moisture content shall be adjusted as is necessary, in the judgment of the Engineer, to permit proper consolidation.
203.4.1 Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until compaction complying with these requirements has been secured. Unstable areas in the embankment shall be removed and replaced with suitable material at the expense of the Contractor.

203.4.2 Each layer of embankment constructed of rock or rocky material shall also be compacted by three complete coverages of the tamping-type roller. A vibratory roller may be used on approval of the Engineer.

203.5 Compaction of Embankments without Specified Compaction Results or Specified Compaction Equipment. Only when specifically designated on the plans, compaction will not be required other than that obtained by distributing equipment movements over the entire fill area.

203.6 Proof Rolling of Subgrade. The Engineer may require the Contractor to proof roll the subgrade prior to the placement of embankment, after the completion of compacting in cut, prior to the placement of aggregate bases or pavements, and when embankments cannot be constructed with density or moisture control. The proof roll shall be with a truck loaded to the maximum single legal axle gross weight of 20,000 pounds or the maximum tandem axle gross weight of 34,000 pounds or as approved by the Engineer. The truck shall be operated at a speed less than 10 mph. A minimum of one pass will be performed in each lane. All proof rolling operations shall be done in the presence of the Engineer.

203.7 Method of Measurement.

203.7.1 Contract Quantity Payment. The quantities of excavation for which payment will be made will be those shown in the contract for the various items, provided the project is constructed essentially to the lines and grades shown on the plans. A partial check of existing ground elevations will be made at the time slope stakes are set, and of the finished work for deviations in the grade, width, or slope from the authorized grade or typical section. Contract quantities will be used for final payment of Class A Excavation, Unclassified Excavation, and Embankment in Place except when:

(a) Errors are found in the original computations.

(b) An original cross section is found to have an average deviation from the true elevation in excess of 1 foot.

(c) An authorized change in grade, slope, or typical section is made.

(d) Unauthorized deviations decrease the quantities on the plans.

(e) Class C Excavation is encountered, unless the contract calls for unclassified excavation.

When the above conditions are encountered the corrections or revisions will be computed and added to or deducted from the contract quantity.

203.7.1.1 When the plans have been altered or when disagreement exists between the Contractor and the Engineer as to the accuracy of the plan quantities of any balance, or the entire project, either party shall have the right to request a recomputation of contract quantities of excavation within any area by written notice to the other party. The written notice shall contain evidence that an error exists in the original groundline elevation or in the original computations which will materially affect the final payment quantity. When such final measurement is required, it will be made from the latest available ground surface and the design section.

203.7.2 Measured Quantities. When payment of excavation is to be made on a measured quantity basis, volumes of authorized excavation will be computed from cross section measurements by the average end area method. When not attributable to carelessness of the Contractor, slides in Class A Excavation and in Unclassified Excavation
will be included in such measurements. Authorized excavation of rock, shale, muck, or other unsuitable material will also be included.

203.7.2.1 Authorized excavation of rock, shale, muck, or other unsuitable material below grade shall consist of that excavation necessary to provide the designated depth of undergrading. If the plane of the designated bottom of excavation falls within a layer or stratum of rock, the below grade excavation to the bottom of the layer, not exceeding 12 inches below the designated limits of undergrading will be considered as authorized and will be measured for payment, provided the overbreak has been removed sufficiently to permit accurate cross sectioning. Rock excavation more than 12 inches below the designated limits of undergrading will not be paid for. No measurement will be made of any material removed from below the design limits of undergrading if the nature of the material, the thickness of the layer or stratum, and the method of operations are such that it is practicable to excavate only to the depth shown on the plans. No measurement will be made for overbreakage or for the disposal of the same when such material is obtained from outside the neat lines of the proposed backslopes in rock excavation except that such overbreakage will be measured as Class A Excavation or Unclassified Excavation, as applicable, when all suitable authorized excavation has been used and the overbreak material is required for completion of the embankment. A maximum tolerance of 1 foot will be permitted for rock protruding or extending within the neat lines of the proposed backslopes.

203.7.2.2 While work involving classified excavation is in progress, the Engineer will fix points of elevation and stationing as required to establish the lines of demarcation between the materials of different classification. These top points will be determined before any Class C Excavation is removed and it shall be the Contractor’s responsibility to notify the Engineer before removing any such material. Any excavation removed before the Engineer has been notified and given 24 hours to establish lines of demarcation will be included in the measurement of Class A Excavation only.

203.7.2.3 Excavation may be encountered in which lines of demarcation between materials of different classifications are impracticable to establish. The quantity of material classified as other than Class A Excavation may be determined by the Engineer on a percentage basis as the work progresses after the limits of determinate classification material have been established. Where vertical or near vertical excavation limits are indicated by the plans, all Class A Excavation material encountered within the actual Class C vertical excavation limits will be included with Class C Excavation quantities.

203.7.2.4 Measured quantities of excavation will be used where the ground elevations shown on the plans are found to be erroneous. No revision of contract quantities will be made when the actual ground elevations are considered to agree generally with the ground line shown on the plans. Where the Engineer authorizes a change in grade, slope, or typical section affecting the volume of excavation allowed for payment in that particular balance or area, the revised volume will be determined by the average end area method on the basis of the revised grade, slope, or typical section. Where unauthorized deviations result in a decrease in the contract quantities, the deviations will be measured and deducted from the contract quantity.

203.7.2.5 The quantity of Class C Excavation will be computed on a measured quantity basis. The volume of Class A Excavation allowed for payment in roadway balances involving rock excavation will be determined by one of the following methods, whichever in the judgment of the Engineer is more applicable.

(a) Measuring and computing both the Class A Excavation and the Class C Excavation within the limits affected.

(b) Deducting the volume of Class C Excavation from the total adjusted volume of roadway excavation, regardless of classification, within the limits affected.

203.7.2.6 Measurements will be made for unsuitable material actually excavated and removed to permit proper compaction in cut sections and in foundations for embankment sections. No measurement will be made of the suitable material temporarily removed, and replaced, to facilitate compaction in cuts or under shallow fills.
203.7.2.7 Borrow quantities will be determined by measuring the borrow area before and after excavating.

203.7.2.8 Only that material placed in accordance with the requirements of Sec 203.3 will be included in the measurement of Compacting Embankment and Embankment in Place. If an error has been found in the original computations or ground elevations, or if there has been an authorized change in grade, slope, or typical section, the plan quantity for Compacting Embankment and Embankment in Place for those areas or balances affected will be adjusted for final payment. All required compaction above the original ground line and all compacting of material placed in undergraded cut sections will be considered as Compacting Embankment and Embankment in Place.

203.7.2.9 Compacting in Cuts will not be the measured for payment and will be considered incidental to the project, unless it is included in the contract. If included in the bid, the volume allowed for payment, to the nearest cubic yard, will be computed for actual areas compacted during construction, to the dimensions shown on the plans, and will include any required compaction of the original ground under shallow fills.

203.7.2.10 Measurement of roadway and drainage excavation, compacting embankments and embankments in place will be made to the nearest cubic yard.

203.8 Basis of Payment. Payment for roadway excavation will be made at the contract unit bid price per cubic yard which price shall be full compensation for the excavating; hauling any distance; placing and forming of embankments; compacting embankment; compacting in cut; preparation of subgrade; shouldering, rounding slopes, obliterating old roadway, finishing of graded earth roadway, picking up and disposing of field stone and other rock; disposal of excess excavation; and any work noted on the plans to be included in the price bid for excavation. No payment will be made for any material used for purposes other than those designated, except as approved by the Engineer.

203.8.1 Payment will be made at the contract unit bid price per cubic yard for the applicable item of Class A Excavation or Unclassified Excavation for each handling of stockpiled excavation approved by the Engineer.

203.8.2 No payment will be made for rock overbreak or for backfilling overbreak areas below the undergrading limits. Payment for the material for backfilling required undergraded areas will be made under an applicable excavation item. No direct payment will be made for backfilling around structures, the excavation for which has been paid for as roadway excavation.

203.8.3 Payment for authorized excavation of unsuitable material, placement of an approved backfill material to create a stable foundation for the pavement, and disposal of the unsuitable material will be made per cubic yard at the fixed contract unit price specified in Sec 109.

203.8.4 Unless the project is let on an unclassified basis, any Class C material encountered during construction will be paid at the fixed contract price for Class C specified in Sec 109, provided there is no unit price for Class C otherwise established in the contract. For projects let with Unclassified Excavation, no additional payment will be made for Class C material encountered.

203.8.5 No direct payment will be made for compacting embankment or compacting in cut. No direct payment will be made for water required in compaction work. Any costs involved in reducing the moisture content in soils will be at the expense of the Contractor.

203.8.6 Payment for finishing a graded earth roadway will be completely covered by the contract unit bid price for the various classes of excavation.

203.8.7 Embankment in Place will be paid for at the contract unit price per cubic yard, and will be considered full compensation for:
(a) Furnishing and transporting material from stockpile sites or from a Contractor-provided source.

(b) Placing and forming embankments.

(c) Compacting embankment or for adding or reducing the water content of the embankment.

(d) Any excavation required to provide the embankment material included under the item of embankment in place, including mulching and seeding a borrow site.

(e) Any work noted on the plans to be included in the contract unit price for embankment in place.

**203.8.8** Payment will be made at the unit bid price for each of the pay items included in the contract.
SECTION 205
MODIFIED SUBGRADE

205.1 Description. This work shall consist of modifying a subgrade to improve stability. This work shall be performed as specified in the contract, at the Contractor’s option with concurrence from the Engineer or at the direction of the Engineer.

205.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows.

205.2.1 The modifying material shall be hydrated lime or other chemical material, a geogrid, a geotextile, or other material approved by the Engineer.

205.2.1.1 If hydrated lime is used, the Contractor shall furnish or require the supplier to furnish with each load certification that the product is in accordance with AASHTO M 216.

205.2.1.2 If chemical modifying material other than hydrated lime is used, the material and application plan shall be approved by the Engineer prior to use.

205.2.2 If a geogrid or geotextile is used the product type and layout plan shall be approved by the Engineer prior to use.

205.3 Construction Requirements.

205.3.1 Application.

205.3.1.1 If not directed by the Engineer or specified in the contract, the Contractor may determine the locations, amount of modifying material and depth of application, within the limits of this specification and subject to concurrence from the Engineer.

205.3.1.2 Where performed, subgrade modification shall be done to all areas uniformly and laterally between outside shoulder points plus 18 inches on each side. When the chemically modified areas are stopped and started, there shall be a longitudinal transition zone at the rate of 30 feet per 6 inches of modified depth. The transition may be made by reducing modifying material or by mixing depth.

205.3.1.3 Chemical modifying material shall be spread in uniform and regular patterns. No material shall be applied if the material is being blown from the work area.

205.3.1.4 The application rate of the chemical modifying material shall be approved by the Engineer.

205.3.2 Compaction. When chemically modified, the subgrade shall be uniformly mixed with the modifying material. Mixing and compaction shall continue until the subgrade is shown to have suitable compaction as demonstrated by the roller equipment. Density and moisture testing will ordinarily be waived for subgrade chemically modified under this specification, except that should compaction not be demonstrated to the Engineer’s satisfaction, the Engineer reserves the right to run such tests as necessary to ensure density. When stabilized with a geogrid or geotextile, the subgrade will require recompaction to the specified density and moisture content only if it is disturbed by the geogrid or geotextile placement.

205.4 Method of Measurement. Measurement of modified subgrade will be made to the nearest square yard, including transition areas. Subgrade meeting all other requirements, suitable for the placing of base material and having modifying material incorporated as specified herein, will be paid for at the contract unit price per square yard except as noted herein.
205.5 Basis of Payment.

205.5.1 If included in the contract, payment for modified subgrade will be made per square yard of modified subgrade at the contract unit price. No direct payment will be made for the required modifying material.

205.5.2 If modified subgrade is not included in the contract and is directed by the Engineer, payment will be made in accordance with Sec 104.3.

205.5.3 Reimbursement for transition areas will be made at the contract unit price per square yard for 1/2 the area of the transition.

205.5.4 Reimbursement will be limited to modified areas, the width of the pavement and shoulders, plus 18 inches on each side.

205.5.5 Only one payment for modified subgrade will be made for any area, regardless of the depth of stabilized material, number of applications or other circumstances.
206.1 Description.

206.1.1 This work shall consist of the necessary excavating for the foundations of all structures, the removing and disposing of all excavated materials, the backfilling around the completed structures, and all related work.

206.1.2 Separate payment will not be made for removing existing structures within the limits of excavation for structures. All removal work which might endanger the new structure shall be completed before any work on the new structure is started. Partial removals of any structure or adjustments of any utility shall be made with care to preserve the value of the retained portions. Work around any live utility shall be done in such manner that uninterrupted service can be maintained.

206.1.3 Excavated material which is unsuitable for backfill and embankments, and excess material not required for either, shall be disposed of. It shall not be dumped into the channel of a stream without the written authorization of the Engineer.

206.2 Depth of Excavation. The elevation of the bottoms of footings as shown on the plans shall be considered an approximate elevation, and the Engineer by written order may make such changes in plan elevations and dimensions of footings as may be necessary to secure a satisfactory foundation.

206.2.1 When blasting is approved in accordance with Sec 203.2.5, the lower limit of blasting allowed will be 18 inches above the bottom of footing elevation. In the event that over fracturing of the underlying rock below bottom of footing occurs, the removal of loose rock and the backfilling of the resultant void with fill concrete will be at the Contractor’s expense.

206.3 Foundation Stabilization and Tests. The Contractor shall furnish and place sand, rock, gravel, or other suitable backfill material to replace unsuitable material encountered below the foundation elevation of the structures. The Contractor shall stabilize suitable foundation material or form the bottom of pile footings if necessary, to obtain a stable foundation. The contractor shall furnish assistance in driving sounding rods or drilling test holes to permit an adequate inspection of the foundation. The depth of the excavation, the character of the material, and the condition of the foundation shall be approved by the Engineer before any concrete is placed in the footing.

206.4 Construction Requirements.

206.4.1 Foundation Excavation Protection. Methods shall be used in excavating for foundations of structures that will insure maintaining the stability of the material adjacent to the excavation. Sheeting, cribbing, timbering, or bracing shall be placed by the Contractor where indicated on the plans and wherever considered necessary. The Contractor will be held responsible for the adequacy of all sheeting, cribbing, timbering, or bracing used. Shop drawings prepared, sealed and signed by a Professional Engineer registered in the State of Missouri showing bracing or cribbing to be employed by the Contractor must be submitted for approval prior to any installation on the project.

206.4.2 Foundation Key. Foundations for structures and retaining walls shall be free of loose, shelly, or disintegrated rock, and the footing shall be placed on undisturbed material. Footings shall be keyed not less than 6 inches into hard, solid rock and not less than 18 inches into soft rock or shale or other suitable material specified for spread footings. Excavation in rock or shale for the key shall be made as near as practicable to the size of the footing, or of the key as shown on the plans. When placing the footing, the key portion shall be cast against the vertical, undisturbed face of the rock or shale. When side forms are necessary for footings, they will be adequately braced and they shall be removed approximately 24 hours after placing the concrete, and the excavation shall immediately be backfilled to the top of the footing. All cavities or crevices or low areas below the bottom of footing
elevation shall be cleaned out and filled with concrete in accordance with Sec 703.3.9, or spanned with a reinforced concrete beam, as directed by the Engineer.

206.4.3 Foundation Subgrade. Care shall be taken to avoid disturbing the material below the bottom of the footings when the structure is founded on material other than rock, and final removal of grade shall not be made until just prior to placing concrete. Where foundation piles are required, the excavation of each pit shall be completed before the piles are driven, and after the driving is completed all loose and displaced material shall be removed.

206.4.4 Culverts on Rock. If rock is encountered under a portion of the bottom slab of a concrete box-type structure, the rock shall be removed to at least 6 inches below the bottom of the slab and curtain walls, and backfilled with material similar to that under the remainder of the structure.

206.4.5 Footing Construction. Concrete footings for structures shall be placed on reasonably dry foundation material. The Contractor shall perform all draining, bailing, or pumping operations, drive any sheeting, and construct any cofferdams or cribs necessary to obtain this condition. Pumping from the interior of any foundation enclosure shall be done in a manner to preclude the possibility of the movement of water, or other fluids or semi-fluids, through any fresh concrete. If necessary, the footing form shall be made watertight and shall be sealed around the bottom, and all pumping done between the footing form and the wall of the enclosure.

206.4.6 Footing Drainage. All holes, pits, or sumps resulting from excavating operations shall be kept drained or pumped out until the completion of the work. No ponding of water around footings on other than rock will be permitted.

206.4.7 Cofferdams. Cofferdams shall, in general, be carried well below the bottom of the footings, and shall be well braced and as watertight as practicable. The interior dimensions of cofferdams shall provide sufficient clearance for the construction of forms and ample room for a sump and for pumping outside the footing forms. Cofferdams which have been tilted or moved laterally during the process of sinking shall be corrected to provide the necessary clearance. They shall be constructed to protect the work against damage from sudden rising of the stream and to prevent damage to the foundation by erosion. Cofferdams, with all sheeting and bracing, shall be removed after the completion of the substructure unit, unless specific authority is given for them to be left in place. The Contractor shall submit drawings showing its proposed method of cofferdam construction and other details open to its choice or not fully shown on the plans.

206.4.8 Temporary Shoring. When temporary shoring is required by the contract documents, the Contractor shall provide temporary shoring as needed, consisting of sheet piling or alternate methods for the construction of roadway fills, mechanically stabilized earth walls or structures. The Contractor shall submit the proposed method of temporary shoring construction to the Engineer prior to beginning work.

206.4.9 Seal Courses. Seal courses will be required if indicated on the plans or if conditions are encountered that, in the judgment of the Engineer, render it impractical to dewater the foundation area. The dimensions of the seal course shall be adequate to seal the foundation area. Pumping will not be permitted while excavating, pile driving or placing the seal course, and not until, by determination of the Engineer, the seal course has attained sufficient strength to withstand the hydrostatic pressure. If seal courses are shown on the plans, and the Engineer determines that the footings may be satisfactorily placed without sealing, the Contractor shall dewater any completed excavation for investigation purposes. The seal course designs shown on the plans are based on the use of sheet piling in construction of the cofferdams at the indicated water elevations. If the Contractor’s proposed alternate method includes cofferdams that are to be constructed with seal courses, the Contractor shall prepare construction plans that are properly designed for the site conditions and water elevations that may be encountered during footing construction. These plans shall be signed and sealed by a professional Engineer licensed in the State of Missouri and shall be provided to the Engineer for review a minimum of two weeks prior to the beginning of actual footing construction. The Contractor is responsible for the safety and performance of the Contractor’s proposed system.
206.4.10 Backfill. Backfill material shall be of an acceptable quality and shall be free from large or frozen lumps, wood, or other extraneous material. All trenches within the right of way shall be backfilled with granular material in accordance with Sec 726. All spaces excavated and not occupied by the new structure or by porous backfill shall be refilled with earth to the original ground surface or to the finished ground lines shown on the plans. All backfill shall be thoroughly compacted and its top surface neatly graded. The backfill at end bents, walls, or other units which falls within the limits of the roadbed shall be placed in successive 6 inches layers and compacted to the same density required for the adjacent roadbed. Dry footings at interior bents shall be backfilled and compacted to no less than the density of the adjacent undisturbed material. Large rock, broken concrete, asphalt or other solid material shall not be used as backfill within 18 inches of the fill face of culverts, retaining walls or end bents. Special precaution shall be taken to prevent any wedging action against the masonry. The slope bounding the excavation, if steeper than six horizontal to one vertical, shall be stepped or serrated. Backfill placed around culverts and piers shall be kept at approximately the same elevation on opposing sides. Drains consisting of 5 cubic feet of coarse aggregate shall be placed at weepholes except where porous backfill is required. Backfill material shall not be placed against end bents or bridges, sides of box culverts, or back of retaining walls until the concrete has attained the strength specified in Sec 703.3.2.10.4. Backfill material shall not be placed higher behind than in front of end bents until the superstructure is in place. Until the grade is in place, drainage shall be maintained away from the end bent backwall by constructing a 6 to 1 or steeper slope away from the backwall for a minimum distance of 3 feet and providing a lateral path for all water to flow off of the roadbed section.

206.4.11 Porous Backfill. Porous backfill meeting the requirements of Sec 1009 shall be placed back of abutments, wings, and retaining walls where specified and shown on the plans. It shall be 18 inches thick and shall extend from the bottom of weep holes or other drainage devices to within 2 feet of the finished ground line. The remaining 2 feet shall be backfilled with earth. Porous backfill shall be so placed and consolidated in successive 12 inches layers that it will not become mixed with other backfill material.

206.4.12 Flowable Backfill. Flowable backfill will be required when indicated on the plans. The Contractor may, with approval from the Engineer, use flowable backfill as an alternate to compacted backfill for structures, pipes or utility cuts. Flowable backfill intended for any other use by the Contractor shall also be approved by the Engineer. If the Contractor uses flowable backfill as an alternate to compacted backfill, the Contractor shall be responsible for any additional costs. Flowable backfill shall not be used to surround drainage systems such as vertical drains or edge drains. Flowable backfill shall be in accordance with Sec 621.

206.4.13 Excavation Classification. Unless otherwise shown on the plans, excavation for structures will be classified as Class 1 Excavation, Class 1 Excavation in Rock, Class 2 Excavation, Class 2 Excavation in Rock, Class 3 Excavation, Class 3 Excavation in Rock, Class 4 Excavation and Class 4 Excavation in Rock. In general, Class 1 Excavation and Class 2 Excavation will apply to excavation for bridges and large retaining walls. Class 3 Excavation will apply to excavation for pipe culvert installations, utilities, retrofit pipe culverts, drop inlets, and manholes. Class 4 Excavation will apply to excavation for box culverts, small retaining walls and other miscellaneous structures. Class 1 Excavation will include all excavation above a specified elevation indicated on the plans while Class 2 Excavation will include all excavation below this specified elevation. The classification of excavation for all structures will be shown on the plans. Any material excavated in cleaning out culverts which are used in place will be paid for at the contract price per each structure. However, only the initial excavation will be paid for, and any subsequent cleaning required prior to final acceptance shall be done at the Contractor's expense.

206.5 Method of Measurement.

206.5.1 There will be no field measurement for Class 1, Class 2, Class 3, or Class 4 excavation. Plan quantities will be used to determine the volume of excavation.

206.6 Basis of Payment.
206.6.1 There will be no direct payment for Class 3 or Class 4 excavation. The cost of Class 3 or Class 4 excavation shall be included in the cost of construction/installation for the bridge, sewer, small retaining wall or other miscellaneous structures.

206.6.2 Not Used

206.6.3 Payment will not be made for removal or replacement of foundation material which became unsuitable because of improper methods of construction by the Contractor. Payment for removal of inherently unsound material for foundation stabilization will be made at the contract unit price for unclassified excavation. No payment will be made for any costs involved in replacing the volume below grade, except that the Contractor will be reimbursed for the delivered material cost if a granular type material is specified by the Engineer. Increased payment will be made only in cases where the presence of Class C Excavation material was not identified in information available under Sec 102.5 pertaining to soundings for spread footings.

206.6.3.1 If Class C Excavation material, as defined by Sec 203, is encountered in Class 1 Excavation, and no pay item for Class 1 Excavation in Rock is included in the contract, payment for that material will be made per cubic yard at the fixed contract unit price specified in Sec 109.

206.6.3.2 If Class C Excavation material, as defined by Sec 203, is encountered in Class 2 Excavation and no pay item for Class 2 Excavation in Rock is included in the contract, payment for that material will be made per cubic yard at the fixed contract unit price specified in Sec 109.

206.6.3.3 If Class C Excavation material, as defined by Sec 203, is encountered in Class 3 Excavation and no pay item for Class 3 Excavation is included in the contract, payment for that material will be made per cubic yard at the fixed contract unit price specified in Sec 109.

206.6.3.4 If Class C Excavation material, as defined in Sec 203, is encountered in Class 4 Excavation and no pay item for Class 4 Excavation in Rock is included in the contract, payment for that material will be made per cubic yard at the fixed contract unit price specified in Sec 109.

206.6.4 No direct payment will be made for placing porous weepholes, as required by Sec 206.4.10, or for backfilling the structure.

206.6.5 The accepted quantities of excavation for structures and porous backfill will be paid for at the unit price for each of the pay items included in the contract.

206.6.6 All costs for furnishing material, labor or equipment, construction, dewatering, drainage, and any other incidental work necessary to complete cofferdam construction; and subsequent removal of any cofferdams, berms, diversions, and any other features constructed for cofferdams as identified by the Engineer will be considered completely covered in the contract unit price per lump sum per bent, regardless of construction method. Payment for Class 1 Excavation and/or Class 2 Excavation will be limited to the volume defined in Sec 206.5. No additional payment for excavation will be made for a Contractor proposed method of cofferdam construction.

206.6.7 All costs for furnishing material, labor, equipment, construction, drainage and other incidental work necessary to complete temporary shoring construction; and subsequent removal of any temporary shoring, berms, diversions, and any other features as identified by the Engineer will be considered completely covered in the contract unit price per lump sum regardless of construction method.

206.6.8 No direct payment will be made for removing existing structures within the limits of excavation for structures. Existing headwalls or culvert concrete to be removed will be paid for as removal of improvements for roadway culverts or partial removal of culvert concrete for bridge culverts.
206.6.9 Payment for seal courses other than those on the plans will be made only with written authorization from the Engineer.

206.6.10 Any material excavated in cleaning out box culverts to be used in place will be paid for at the contract unit price. However, only the initial excavation will be paid for, and any subsequent cleaning required prior to final acceptance shall be done at the Contractor's expense.
207.1 Description. This work shall consist of that grading work necessary to bring the roadway to the required grade and cross section within reasonable tolerances. It shall also include:

(a) The construction of all inlet and outlet ditches and ditch blocks within the linear grading limits unless otherwise provided for in the contract.

(b) The construction of entrances and approaches.

(c) The breaking up and satisfactorily removing or incorporating into the roadway of all gravel, macadam, or bituminous surfaces.

(d) Compaction of the roadway subgrade within linear grading limits, according to Sec 203.

All linear grading will be classified as hereafter described.

207.1.1 Linear Grading shall be unclassified and shall consist of grading where the topography is such that the excavation necessary to bring the roadway to the designated cross section will approximately make the nearby fills with a minimum of drifting or hauling.

207.2 Construction Requirements.

207.2.1 The roadway shall be brought to the required grade and cross section by backsloping, ditching, removing stone and boulders from the roadbed surface, or any other work necessary, including drifting and hauling of any excavated material.

207.2.2 Stumps, roots, rubbish, or any other deleterious material shall not be placed in embankments. Where an embankment of less than 2 feet in height is to be constructed, all vegetable matter shall be cut and removed from the surface upon which the embankment is to be placed. The cut-over surface shall be thoroughly broken. All ditches including inlet and outlet ditches shall be cut to grades that will properly drain. The required cross section for inlet and outlet ditches leading to or from structures shall be of a width not less than the width of the floor or the diameter of the structure being served. Finishing operations shall continue until the roadbed is free from sharp breaks in alignment and grade, and until it has been shaped to the required cross section. Material considered unsuitable for the subgrade shall be disposed of on nearby slopes or as otherwise directed by the Engineer.

207.2.3 If obliteration of old roads is designated in the contract to be performed on a linear grading basis, such obliteration shall include all grading operations necessary to fill the ditches and blend the old road with the natural ground to provide a pleasing appearance.

207.3 Method of Measurement. Measurement of Linear Grading will be made to the nearest 0.1 station.

207.4 Basis of Payment. The accepted quantities of linear grading will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 209
SUBGRADE PREPARATION

209.1 Description. This work shall consist of preparing the earth subgrade upon which a base course is to be constructed or a surfacing placed.

209.2 Equipment. A self-propelled steel wheel roller weighing not less than 10 tons shall be used in preparing any subgrade for flexible type surfacing and weighing not less than 5 tons when preparing any subgrade for Portland cement concrete base course or pavement.

209.3 Construction Requirements. The earth subgrade shall be substantially uniform in density throughout its entire width. It shall conform to the lines, grades, and typical cross sections shown on the plans, or as established by the Engineer. The earth subgrade shall be constructed to drain surface water to the side ditches and all ditches shall be kept open by the Contractor. Where hauling results in ruts or other objectionable irregularities, the Contractor shall reshape and reroll the earth subgrade before the base or surfacing is placed. If an old traveled roadway comprises any part of the roadbed, the Contractor shall loosen the compacted portions to a depth of at least 6 inches and shall reshape the roadbed.

209.3.1 All earth subgrades, except those for aggregate type surfacing, shall be rolled. The earth subgrades shall be checked after rolling in accordance with Sec 209.3.5, and if not at the proper elevation at all points, sufficient material shall be removed or added and compacted to bring all portions of the subgrade to the required elevation and density. The moisture content of the top 6 inches of the finished earth subgrade at the time the base is placed, or at the time the pavement is placed if no base is provided under the pavement, shall be not less than the minimum specified for compacting in Sec 203. If the moisture content has not been maintained, the earth subgrade shall be scarified, wet to the required moisture content, and compacted. An occasional maximum deviation of 1/2 inch from the required elevation will be permitted on the surface of the finished earth subgrade. The extent of acceptable areas of deviation will be determined by the Engineer.

209.3.2 Prior to laying base or setting paving forms on projects where grading and paving are included in the same contract, the subgrade shall conform to the density requirements for compaction. The earth subgrade shall be proofed rolled in accordance with Sec 203.6. Soft spots and unsuitable material shall be removed to a depth determined by the Engineer and backfilled with approved stable material in accordance with Sec 203.2.6. It is the intent of this specification that the required backfill be provided to furnish a stable foundation for the roadway. The Engineer may order additional excavation beyond the pay limits established for roadway construction. 2 inches or greater clean stone shall be used as backfill for such excavations. The gradation of the material will be determined by the Engineer.

209.3.3 The earth subgrade for Portland cement concrete pavement shall be compacted, and brought to true shape by an approved subgrade machine. Any material added shall be satisfactorily incorporated and compacted. Before the concrete is placed, a true subgrade shall be shaped by an approved subgrade planer rolling on the forms and any resulting loose material on the earth subgrade behind the planer shall be recompacted with the 5-ton steel wheel roller. The planer shall be adjustable to produce earth subgrade of the exact elevation and cross section. After all grading or planing operations have been completed and immediately before the concrete is placed, the earth subgrade shall be checked with an approved heavy metal template which shall be rolled on the forms. Scratch templates with spikes or teeth will not be permitted. A taut line across the top of side forms and a ruler may be used in lieu of a template for checking the subgrade on irregular areas or variable widths. Extreme care shall be taken in forming the crown and shaping the subgrade to assure that the specified thickness of concrete will be attained in the finished pavement.

209.3.3.1 The finished earth subgrade at the time of paving shall be moist, but sufficiently firm to resist rutting or deforming under construction traffic.
209.3.4 In the event the Contractor elects to use slip forming method for pavement construction, additional earth subgrade preparation will be in conformance to specifications heretofore; however, no direct payment will be made for such additional earth subgrade preparation requirements.

209.3.5 Grade Checking. Prior to placing aggregate base, the Contractor shall demonstrate to the Engineer, that the earth subgrade conforms to the profile and cross-sectional grades per the plans. The frequency of the grade checking will be determined by the Engineer to ensure conformance to the plans. Grade checking maybe performed by one of the following methods:

   (a) pulling a string line across surveyed points and checking the difference between the string line and earth subgrade, with the edge of pavement and/or the centerline surveyed at a minimum of every 50 feet;

   (b) use of GPS surveying equipment; or

   (c) other approved method by the engineer.

209.4 Method of Measurement. Measurement for the volume of unsuitable material excavated beyond or outside the limits shown on the plans or established by the specifications for roadway excavation will be made by the Engineer to the nearest cubic yard.

209.5 Basis of Payment. No direct payment will be made for earth subgrade preparation. No direct payment will be made for water necessary for earth subgrade preparation. Payment for authorized excavation of unsuitable material will be in accordance with Sec 203.
SECTION 210
SUBGRADE COMPACTION

210.1 Description. This work shall consist of compacting earth subgrade that is yielding or not substantially uniform in density or which does not contain the proper moisture content in the top 6 inches. This item of work shall be performed when (1) the subgrade density, following the use of the roller required by Section 209.2 is less than that required under Section 203 or (2) the moisture content is less than the minimum specified in Section 203. Subgrade Compaction is defined as compaction of the subgrade for a width extending not less than 18 inches beyond the edge of the pavement.

210.1.1 The Contractor shall perform this work on the subgrade at all locations specified by the Engineer. Tentative locations of subgrade compaction may be shown on the plans, but the Engineer will specify all locations and depths of this work by written order. Any overrun, or partial or complete underrun, shall not be a basis for claim.

210.2 Construction Requirements.

210.2.1 The subgrade shall be scarified to a depth of at least 6 inches, and the scarified material brought to a uniform moisture content either by drying or by adding water, and manipulating with suitable equipment. At the Contractor’s option, the upper 6 inches of soil may be removed and replaced with satisfactory material, or removed and manipulated with suitable equipment before replacing. The material shall be compacted to produce a subgrade having a density not less than the density required and within the moisture contents specified under Section 203 by the use of approved equipment producing satisfactory results.

210.2.2 When it is determined that the required subgrade density cannot be obtained by moisture control and compaction of the upper 6 inches, the unsuitable material shall be excavated to a depth not to exceed 18 inches, and replaced with satisfactory material in layers not to exceed 6 inches, except as otherwise permitted by the Engineer. Each 6 inches layer shall be processed, wetted or dried as necessary and compacted to the required density.

210.2.3 If the Contractor’s operations cause an unsatisfactory subgrade, the Contractor shall restore the subgrade to a satisfactory condition at the Contractor’s expense.

210.3 Method of Measurement and Basis of Payment. No direct measurement or payment will be made for subgrade compaction. All costs associated with subgrade compaction shall be considered incidental to the unit bid item Embankment in Place.
SECTION 211
SUBGRADE SCARIFYING

211.1 Description. This work shall consist of loosening the surface of the roadbed and removing all rocks larger than 4 inches. Tentative locations of subgrade scarifying will be shown on the plans, but the Engineer will specify all locations of this work by written order.

211.2 Construction Requirements. The Engineer will specify areas where subgrade scarifying is to be performed. The Contractor shall perform all specified work necessary to loosen the surface of the roadbed over the full width to a depth of 6 inches below the finished grading section, and to remove all rocks larger than 4 inches. Oversized material shall be disposed of as directed by the Engineer. After all oversized material has been removed; the roadbed shall be brought back to a satisfactory grade and cross section by the addition of extra material, if needed, without rocks exceeding 4 inches.

211.3 Method of Measurement and Basis of Payment. No direct measurement or payment will be made for subgrade scarifying. All costs associated with subgrade scarifying shall be considered incidental to the unit bid item Embankment in Place.
SECTION 212
SUBGRADING AND SHOULDERING

212.1 Description.

212.1.1 Subgrading and Shouldering, Class 1, shall consist of preparing the earth subgrade for surfacing and shoulders by fine-grading, and shaping the existing roadbed of a previously graded roadway and shaping fill slopes, inslopes and ditches as required to complete a finished roadway in accordance with the typical section shown on the plans.

212.1.2 Subgrading and Shouldering, Class 2, in addition to the above, shall include the construction and final shaping of earth shoulders.

212.2 Construction Requirements.

212.2.1 Subgrading and Shouldering will normally be restricted to the roadway from ditch to ditch or to the roadbed and upper portions of fill slopes. All ditches shall be graded to drain. The median, if any, shall be shaped to conform to the typical section. No work will be required on backslopes except that necessary to blend the lower portion of the existing backslope with the regraded ditch. The work on fill slopes shall be confined to the upper 10 feet of the slope, measured along the slope line. Minor drifting of excavated material to bring the subgrade, shoulders, and ditches to proper grade and section is to be expected. Minor drifting shall be considered the moving of material that one 10 cubic yards scraper can shift without delay to normal subgrading operations.

212.2.2 When the subgrade as prepared in accordance with Sec 209, Subgrade Preparation, has less density than that required under Sec 203.3, the Engineer may order the item of Subgrade Compaction to be performed. When lack of satisfactory density results from improper maintenance by the Contractor, the subgrade density shall be restored at the Contractor’s expense. Earth shoulders shall be constructed in accordance with the requirements of Sec 203.2.

212.2.3 Finishing of ditches, side slopes, cuts, and fills shall be to a reasonably smooth and uniform surface that will merge with the adjacent slopes. Finishing by hand methods will not be required, except that all brush, weeds, excess mud and silt, or other debris shall be removed from all channels and culverts within the scope of the work even though such structures are used in place.

212.2.4 Any additional material required to complete the subgrade or shoulders to proper grade and section shall be obtained from within the right-of-way limits as directed by the Engineer. Direct payment will not be made for minor drifting of excavated material, or for any additional material required; nor will overhaul be allowed for such operations. Excess excavation shall be used for widening shoulders on fill sections or wasted within the limits of the right-of-way as directed.

212.3 Method of Measurement. Measurement of Subgrading and Shouldering, Class 1 and Class 2 will be made to the nearest 0.1 station along the center line of each roadbed, regardless of width.

212.3.1 Subgrading and Shouldering, Class 1 and Class 2 will apply only to those sections that have been specifically designated as such on the plans and the class will not be subject to change during construction.

212.3.2 The accepted quantity of Subgrading and Shouldering will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 214
ROCK FILL

214.1 Description. This work shall consist of constructing fill of rock or broken concrete for protection of embankment.

214.2 Material. The material for rock fill shall be durable stone or broken concrete containing a combined total of no more than 10 percent of earth, sand, shale and non-durable rock. The material shall be similar to quarry run stone graded from coarse to fine with a minimum of voids. The coarse stone shall be as large as can be conveniently handled, but at least 25 percent of the material shall be of pieces having a volume of one cubic foot or more. Acceptance of quality and size of material may be made by visual inspection at the job site.

214.3 Construction Requirements. Successive horizontal layers of stone or broken concrete not exceeding 24 inches thick shall be spread over the area of the rock fill. The larger pieces shall be well distributed and the voids filled with smaller pieces. Each layer shall be spread in accordance with Sec 203.2.16. Where rock fill is placed as a portion of embankment with controlled density, the material shall be compacted in accordance with Sec 203.3.4. The fill shall conform to the elevations and dimensions shown on the plans, and the slopes shall present a dense, finished appearance free from segregation with a proportionate quantity of the large pieces exposed.

214.4 Method of Measurement. Measurement will be made to the nearest cubic yard of material in place in the completed fill.

214.5 Basis of Payment.

214.5.1 County Furnished Rock Fill. If shown on the plans that the material for rock fill is to be obtained from the right of way or other source furnished by the County, the excavating, including all breaking, loading and hauling, regardless of haul distance, will be paid for and considered completely covered under the contract items of Class A Excavation, Class C Excavation, Unclassified Excavation, Excavation for Structures or other applicable items. If payment is made under these conditions, separate payment for furnishing rock fill will not be made.

214.5.1.1 If the rock fill from the right of way or other sources furnished by the County is made unsuitable or unattainable by the Contractor’s operations, the Contractor shall provide suitable material and dispose of any surplus material at the Contractor’s expense.

214.5.1.2 If all or part of the required quantity of acceptable material is not actually available and was not made unacceptable by the Contractor’s operations, payment will be made per cubic yard at the fixed unit price specified in Sec 109 for such additional rock fill material that the Contractor is required to furnish and haul.

214.5.2 Contractor Furnished Rock Fill. If the plans do not provide for a source of material, the Contractor shall provide the material and all costs of securing the source, quarrying, excavating, breaking and hauling the material to the site will be paid for at the contract unit price per cubic yard for furnishing rock fill.

214.5.3 Placing Rock Fill. Payment for placing rock fill will be made at the contract unit price per cubic yard.
SECTION 215
SHAPING SLOPES

215.1 Description. This work shall consist of grading and shaping existing slopes to eliminate shoulder drop off conditions as shown on the plans or as directed by the Engineer.

215.1.1 Shaping Slopes, Class I, shall consist of shaping slopes where, in general, the material required to bring the roadway to the designated cross section can be obtained or disposed of within 1000 feet on the right of way as directed by the Engineer.

215.1.2 Shaping Slopes, Class II, shall consist of shaping slopes where it may be necessary to haul in excess of 1000 feet or go outside the limits of the right of way for additional material to construct the slopes to the designated cross section or where it may be necessary to dispose of waste material outside the limits of the right of way. The Contractor shall provide the Engineer with an acceptable written agreement with any property owner from whose property additional material is to be obtained or on which excess excavation is to be disposed.

215.1.3 Shaping Slopes, Class III, shall consist of providing fill material and shaping slopes to construct additional shoulder width for the installation of guardrail and Type A crashworthy end terminals. Material used shall be Type 1, 5, or 7 Aggregate Base, or other granular material approved by the Engineer. Any excess material shall be disposed of outside the limits of the right of way.

215.1.3.1 In lieu of aggregate base, earth material may be used for Shaping Slopes, Class III. When earth material is used, an approved seed mixture shall be applied in accordance with Sec 805, mulch shall be applied in accordance with Sec 802 and erosion and sediment control shall be utilized in accordance with Sec 806. All cost for seeding, mulching, and erosion control shall be incidental to the cost of Shaping Slopes, Class III.

215.2 Construction Requirements. Slope areas to be shaped by the addition of material shall be scarified to allow bonding with the added material. Density shall be obtained from reasonable compactive efforts consisting of no less than three passes with a roller or other methods approved by the Engineer. The Contractor will not be required to excavate any classified rock excavation under this item.

215.2.1 Benching of the existing slope may be necessary to provide stability to the additional shoulder width constructed by Shaping Slopes, Class III. All costs for benching shall be included in the cost of Shaping Slopes, Class III.

215.3 Method of Measurement. Final measurement will not be made except where appreciable errors are found in the contract quantity.

215.3.1 Where required, measurement will be made to the nearest 1/10 station separately for each length of slope measured along the centerline of the traveled way and totaled to the nearest 100 feet for the sum of all segments.

215.3.2 Shaping Slopes, Class I, Class II, or Class III will apply only to those sections that have been specifically designated as such on the plans.

215.4 Basis of Payment. The accepted quantity of shaping slopes will be paid for at the contract unit price for each of the pay items included in the contract. If Shaping Slopes, Class I, Class II, or Class III is not provided but is required, payment will be in accordance with Sec 104.3. No direct payment will be made for any additional material required for shaping slopes.
SECTION 216
REMOVALS FOR BRIDGE STRUCTURES

SECTION 216.10 REMOVAL OF BRIDGES

216.10.1 Description. This work shall consist of removing and disposing of existing bridge structures as shown on the plans or as directed by the Engineer.

216.10.2 Removal Requirements. The entire structure, including all substructure units, shall be removed to an elevation 2 feet below the finished ground line or streambed. Any portion of an existing structure below the ground line that interferes with the construction of the new structure shall be removed. Existing structures used for handling temporary traffic shall not be removed until the replacement structure is open to traffic. Notification of demolition shall be made in accordance with Sec 202.40.1.1.

216.10.3 Method of Measurement. No measurement will be made for removal of bridges.

216.10.4 Basis of Payment. Removal of bridges will be paid for at the contract lump sum price.

SECTION 216.20 SCARIFICATION OF BRIDGE DECKS.

216.20.1 Description. This work shall consist of scarifying the bridge deck to the depth shown on the plans or as directed by the Engineer.

216.20.2 Removal Requirements. The bridge deck shall be uniformly scarified to the depth as shown on the plans. Excessive tearing of the deck surface shall require immediate correction. Over areas of half-sole repair and full depth repair, the scarified removal depth may be coincidental with the repair removal operation. The scarification shall produce a very rough texture that is acceptable to the Engineer as a bondable surface for the new concrete wearing surface or as a starting profile for total surface hydro demolition. The scarifying process shall not produce a polished or slick surface. Any epoxy patches encountered shall be completely removed to sound, natural concrete.

216.20.3 Method of Measurement. Final measurement of scarification of bridge decks will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, scarification of the bridge decks will be measured to the nearest square yard based on measurement longitudinally from end of slab to end of slab and transversely from roadway face of curb to roadway face of curb. The revision or correction will be computed and added to or deducted from the contract quantity.

216.20.4 Basis of Payment. Scarification of bridge decks will be paid for at the contract unit price.

SECTION 216.30 SEAL COAT AND WEARING SURFACE REMOVAL.

216.30.1 Description. This work shall consist of the complete removal and disposal of the unbonded seal coat, bonded seal coat, asphalt wearing surface or concrete wearing surface from the bridge deck as shown on the plans or as directed by the Engineer.

216.30.2 Removal Requirements.

216.30.2.1 All material and residue shall be removed. Staining will be permitted. The equipment and procedures used for removal shall be such that no damage will be done to the existing concrete deck. Any epoxy patches encountered shall be completely removed to sound, natural concrete. Excessive tearing of the deck surface shall require immediate correction.
When a concrete wearing surface is to be installed, the removal of the wearing surface plus the amount of deck as shown on the plans shall produce a very rough texture that is acceptable to the Engineer as a bondable surface for the new concrete wearing surface or as a starting profile for total surface hydro demolition. The removal process shall not produce a polished or slick surface.

**216.30.3 Method of Measurement.** Final measurement of the seal coat and wearing surface removal will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, removal of bonded seal coat, asphalt wearing surface and concrete wearing surface will be measured to the nearest square foot based on measurement longitudinally from end of slab to end of slab and transversely from roadway face of curb to roadway face of curb. The revision or correction will be computed and added to or deducted from the contract quantity. No measurement will be made for removal of unbonded seal coat.

**216.30.4 Basis of Payment.** Seal coat and wearing surface removal will be paid for at the contract unit price, except that all costs incurred by the Contractor while removing the unbonded seal coat will be considered completely covered in the contract unit price for other items.

**SECTION 216.40 Not Used.**

**SECTION 216.50 REMOVAL OF EXISTING BRIDGE DECKS.**

**216.50.1 Description.** This work shall consist of removing and disposing of existing bridge rails, curbs, slab, expansion devices and any other items necessary to reconstruct the bridge deck as shown on the plans or as directed by the Engineer.

**216.50.2 Removal Requirements.**

**216.50.2.1** The existing bridge deck shall be removed by methods such that the girders, stringers or floor beams that are to remain in place are not damaged. Any damage to the girders, stringers and floor beams resulting from the Contractor’s operations shall be repaired or replaced as directed by the Engineer, at the Contractor’s expense. Notification of demolition shall be made in accordance with Sec 202.40.1.1.

**216.50.2.2** The contact surfaces of all existing structural steel, including any shear connectors, exposed by removal of the bridge deck shall be cleaned, including the removal of stratified rust, with a minimum of SSPCSP- 3 surface preparation. Any tightly adhered concrete remaining after the surface preparation may be left in place. The area, including the welded connection between the shear connector and the top flange, shall be coated with one coat of gray epoxy-mastic primer (non-aluminum) in accordance with Sec 1081 to produce a dry film thickness of no less than 3 mils. SSPC Certified Contractor QP qualification will not be required for the coating of the top flanges prior to placement of the new concrete deck. Overspray on other areas of the shear connector will be considered acceptable. The gray epoxy-mastic primer (non-aluminum) shall be compatible with concrete.

**216.50.3 Method of Measurement.** Final measurement of removal of the existing bridge decks will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, removal of the existing bridge decks will be measured to the nearest square foot based on measurement longitudinally from end of slab to end of slab and transversely from out to out of the bridge deck. The revision or correction will be computed and added to or deducted from the contract quantity.

**216.50.4 Basis of Payment.** Removal of the existing bridge deck will be paid for at the contract unit price.

**SECTION 216.60 PARTIAL REMOVAL OF EXISTING BRIDGE DECKS.**
216.60.1 Description. This work shall consist of removing and disposing of the existing curbs, rails, slab and any other items necessary to reconstruct the bridge deck as shown on the plans or as directed by the Engineer.

216.60.2 Removal Requirements.

216.60.2.1 Concrete shall be removed by conventional hand/mechanical equipment in accordance with Sec 704. A removal line shall be established with the joint sawed to a depth of one inch with a vertical face. In no case shall existing reinforcement be cut or damaged by the sawing operation.

216.60.2.2 The existing reinforcing steel shall be stripped, cleaned, straightened and extended into or utilized in the new concrete as shown on the plans. Care shall be taken to prevent damage to the reinforcement or the reinforcement bond to the concrete. If any reinforcement is damaged or deteriorated, the Engineer shall be notified. Cut or broken bars or bars having 10 percent or more cross-sectional area lost shall be spliced 24 diameters on each side of the damage.

216.60.2.3 The existing bridge deck shall be removed by methods such that the girders, stringers and floor beams that are to remain in place are not damaged. Any damage to the girders, stringers and floor beams resulting from the Contractor’s operations shall be repaired or replaced as directed by the Engineer at the Contractor’s expense.

216.60.2.4 The contact surfaces of all existing structural steel, including any shear connectors, exposed by partial removal of the bridge deck shall be cleaned and coated in accordance with Sec 216.50.2.2.

216.60.3 Method of Measurement. Final measurement of the partial removal of existing bridge decks will not be made except for authorized changes during construction or where appreciable errors are found in the contact quantity. Where required, partial removal of existing bridge decks will be measured to the nearest square foot based on measurement longitudinally from end of slab to end of slab and transversely from outside edge of the existing slab to the line shown on bridge plans. The revision or correction will be computed and added to or deducted from the contract quantity.

216.60.4 Basis of Payment. Partial removal of existing bridge decks will be paid for at the contract unit price.

SECTION 216.70 PARTIAL REMOVAL OF CULVERT AND SUBSTRUCTURE CONCRETE.

216.70.1 Description. This work shall consist of removing and disposing of existing culvert wings and slab or substructure concrete as shown on the plans or as directed by the Engineer.

216.70.2 Material. The qualified special mortar shall be in accordance with Sec 704.2.

216.70.3 Removal Requirements.

216.70.3.1 Any excavation required during the removal of concrete shall be backfilled after the new concrete is poured and cured. Any part of the roadway that is removed or damaged and any part of the remaining structure damaged during the removal of the existing concrete shall be repaired or the material replaced, at the Contractor’s expense, as directed by the Engineer.

216.70.3.2 Concrete removal shall be in accordance with Sec 216.60.2.1. The concrete to be removed will not be included in the excavation volume. Areas exposed by removal of concrete and not covered by new concrete shall be coated with a qualified special mortar.

216.70.3.3 Existing reinforcing steel utilized in the new concrete shall be prepared in accordance with Sec 216.60.2.2. Existing reinforcing steel not utilized in the new concrete shall be cut off one inch into the concrete. Any holes outside the limits of new concrete shall be filled with a qualified special mortar.
216.70.4 Method of Measurement. No measurement will be made for partial removal of culvert and substructure concrete.

216.70.5 Basis of Payment. Partial removal of culvert and substructure concrete will be paid for at the contract lump sum price.

SECTION 216.80 CURB REMOVAL.

216.80.1 Description. This work shall consist of removing and disposing of existing curbs, rails and end posts as shown on the plans or as directed by the Engineer.

216.80.2 Material. Qualified special mortar shall be in accordance with Sec 704.2.

216.80.3 Removal Requirements.

216.80.3.1 Concrete removal shall be in accordance with Sec 216.60.2.1. Areas exposed by removal of concrete and not covered by new concrete shall be coated with a qualified special mortar.

216.80.3.2 Existing reinforcing steel utilized in the new concrete shall be prepared in accordance with Sec 216.60.2.2. Existing reinforcing steel not utilized in the new concrete and existing rail post bolts shall be cut off one inch into the concrete. Any holes outside the limits of new concrete shall be filled with a qualified special mortar.

216.80.4 Method of Measurement. Final measurement of curb removal will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, curb removal will be measured to the nearest linear foot based on measurement from end of curb to end of curb. The revision or correction will be computed and added to or deducted from the contract quantity.

216.80.5 Basis of Payment. Curb removal will be paid for at the contract unit price.

SECTION 216.90 REMOVAL OF EXISTING EXPANSION JOINTS AND ADJACENT CONCRETE

216.90.1 Description. This work shall consist of any excavation, backfill, removal and disposal of the existing expansion joint system, curb plates and adjacent concrete as shown on the plans or as directed by the Engineer.

216.90.2 Material. Qualified special mortar shall be in accordance with Sec 704.2.

216.90.3 Removal Requirements.

216.90.3.1 Any excavation required during the removal of concrete shall be backfilled after the new concrete is poured and cured. Any part of the roadway that is removed or damaged and any part of the remaining structure that is damaged during the removal of the existing concrete shall be repaired or the material replaced as directed by the Engineer at the Contractor’s expense.

216.90.3.2 Concrete removal shall be in accordance with Sec 216.60.2.1. The concrete to be removed will not be included in the excavation volume. Areas exposed by removal of concrete and not covered by new concrete shall be coated with a qualified special mortar.

216.90.3.3 Existing reinforcing steel utilized in the new concrete shall be prepared in accordance with Sec 216.60.2.2. Existing reinforcing steel not utilized in the new concrete shall be cut off one inch into the concrete. Any holes outside the limits of new concrete shall be filled with a qualified special mortar. Any reinforcement that interferes with the installation of the new expansion joint system shall be called to the attention of the Engineer.
and may be shifted, cut or removed as directed by the Engineer. Any reinforcing steel removed that was to remain in place shall be replaced with bars of like size and shape, Grade 60, in accordance with Sec 706 or Sec 710 and spliced 24 bar diameters as directed by the Engineer.

**216.90.3.4** The contact surfaces of all existing structural steel exposed by removal of the existing expansion joints and adjacent concrete shall be cleaned and coated in accordance with Sec 216.50.2.2.

**216.90.4 Method of Measurement.** Final measurement of the removal of existing expansion joints and adjacent concrete will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, removal of the existing expansion joint system and adjacent concrete will be measured to the nearest linear foot based on measurement from roadway face of curb to roadway face of curb along centerline of the existing joint. The revision or correction will be computed and added to or deducted from the contract quantity. Portions of the joint extending past the roadway face of curbs will not be measured for payment.

**216.90.5 Basis of Payment.** Removal of existing expansion joints and adjacent concrete will be paid for at the contract unit price for each of the items included in the contract.

SECTION 216.100 REMOVAL OF EXISTING EXPANSION JOINT SEAL OR SEALANT.

**216.100.1 Description.** This work shall consist of removing and disposing of existing expansion joint seals or sealant, curb plates and any partial removal of concrete as shown on the plans or as directed by the Engineer.

**216.100.2 Material.** Qualified special mortar shall be in accordance with Sec 704.2.

**216.100.3 Removal Requirements.**

**216.100.3.1** Concrete removal shall be in accordance with Sec 216.60.2.1. Areas exposed by removal of concrete and not covered by new concrete shall be coated with a qualified special mortar. Any damage to the remaining structure resulting from the Contractor’s operations shall be repaired or replaced, at the Contractor’s expense, as directed by the Engineer.

**216.100.3.2** Existing reinforcing steel utilized in the new concrete shall be in accordance with Sec 216.60.2.2. Existing reinforcing steel not utilized in the new concrete shall be cut off one inch into the concrete. Any holes outside the limits of new concrete shall be filled with a qualified special mortar. Any reinforcement that interferes with the installation of the new expansion joint seal or sealant shall be called to the attention of the Engineer and may be shifted, cut or removed as directed by the Engineer. Any reinforcing steel removed that is to remain in place shall be replaced with bars of like size and shape being Grade 60.

**216.100.4 Method of Measurement.** Final measurement of removal of existing expansion joint seal or sealant will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, removal of the existing expansion joint seal and sealant will be measured to the nearest linear foot based on measurement from roadway face of curb to roadway face of curb along centerline of the existing joint. The revision or correction will be computed and added to or deducted from the contract quantity. Portions of the joint extending past the roadway face of curbs will not be measured for payment.

**216.100.5 Basis of Payment.** Removal of existing expansion joint seal or sealant will be paid for at the contract unit price.
Division 300

BASES AND AGGREGATE SURFACE
SECTION 302
STABILIZED PERMEABLE BASE

302.1 Description. This work shall consist of furnishing and placing a stabilized permeable base material. The mixture shall be placed, spread and compacted as shown on the plans or as directed by the Engineer.

302.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate for Drainage</td>
<td>1009</td>
</tr>
<tr>
<td>Asphalt Binder (PG 64-16, PG 64-22, PG 70-22, PG 76-22)</td>
<td>1015</td>
</tr>
<tr>
<td>Cement</td>
<td>1019</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

302.2.1 General. Stabilized permeable base shall be either asphalt binder or Portland cement stabilized at the option of the Contractor. All stabilized permeable base shall use Grade 4 drainage aggregate meeting the requirements of Sec 1009.

302.2.2 Asphalt Stabilized Permeable Base. Mixtures shall be composed of the base aggregate and 2.5 percent asphalt binder by weight of the total mixture. PG 64-22, PG 70-22 or PG 76-22 asphalt binder shall be used. All proportioning, mixing and transporting shall be in accordance with Sec 404.

302.2.3 Cement Stabilized Permeable Base. Cement stabilized base mixtures shall be composed of the base aggregate with a cement factor of 2.5 sacks per cubic yard. All proportioning, mixing and transporting shall be in accordance with Sec 501. Fly ash and ground granulated blast furnace slag shall not be used.

302.3 Construction Requirements.

302.3.1 Contamination. Contamination of the finished base material that affects the drainage capability of the product will not be permitted. Any areas determined to be contaminated shall be completely removed without disturbing the adjacent or underlying material and replaced at Contractor’s expense.

302.3.2 Displacement. Rutting or other displacement of the permeable base or the underlying base will not be permitted. If displacement occurs, which could result in ponding or a non-uniform, non-draining thickness of permeable base, the material shall be completely removed without disturbing the adjacent or underlying material and shall be replaced at the Contractor’s expense.

302.3.3 Asphalt Stabilized Permeable Base. Applicable portions of Sec 404 will apply, except as noted herein. The final mixture, when discharged from the pugmill or drum, shall be 250-300°F. A minimum of three passes of a 5 to 10-ton steel wheel roller shall be made, compacting the material until no further displacement is noted. Compaction shall begin as soon after spreading the mixture as the mixture is able to bear the weight of the roller without undue displacement and shall be completed before the temperature of the mixture drops below 100°F. The approximate compacted thickness of a single lift shall be a maximum of 4 inches.

302.3.4 Cement Stabilized Permeable Base. Applicable portions of Sec 502 will apply, except as noted herein. Segregation of the mixture shall be minimized. Normal concrete pavement consolidation equipment such as vibrators or vibrating pans will be considered adequate, provided the mixture can be satisfactorily compacted. The mixture shall be cured for a minimum of 48 hours in accordance with Sec 502.6, except that white pigmented membrane or straw shall not be used. A fine water mist may be applied several times each day for the 48-hour period as needed to maintain moisture. The water application shall not be heavy enough to wash away the cementitious material or mortar.
302.4 Method of Measurement. Final measurement of the completed permeable base will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement of permeable base, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

302.5 Basis of Payment. The accepted quantities of permeable base of the thickness specified will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be considered full compensation for all labor, equipment and material, including the stabilizing agent, to complete the described work.
SECTION 304
AGGREGATE BASE COURSE

304.1 Description. This work shall consist of furnishing and placing one or more courses of aggregate on a prepared subgrade in accordance with these specifications, and as shown on the plans or as directed by the Engineer. The type of aggregate to be used will be specified in the contract.

304.2 Material. Material for Type 1, 5 and 7 aggregate bases shall be crushed stone or reclaimed asphalt or concrete which meet the requirements of Sec 1007.

304.3 Construction Requirements.

304.3.1 Not Used.

304.3.2 Subgrade. All work on that portion of subgrade on which the base is to be constructed shall be completed in accordance with Sec 209.3.1 prior to placing any base material on that portion. Aggregate base shall not be placed on frozen subgrade.

304.3.3 Placing. The Contractor shall place base material on the roadbed as shown in the contract documents. The maximum compacted thickness of any one layer shall not exceed 6 inches. If the specified compacted depth of the base course exceeds 6 inches, the base shall be constructed in two or more layers of approximately equal thickness.

304.3.3.1 Spreading and Placement. Types 1 and 5 aggregate base used for shoulders adjacent to rigid or flexible type pavement, including pavement resurfacing, shall be simultaneously deposited and spread on the subgrade. Aggregate shall not be deposited on the pavement and bladed or dozed into place.

304.3.3.2 Slip-Form Construction. If the Contractor elects to construct concrete pavement by slip-form methods, the width of aggregate base shown on the plans may be increased to provide a 3 feet width outside the edge of the pavement being placed with no additional payment for the extra width in excess of plan quantity.

304.3.3.3 Excess Material. The Contractor shall be responsible for placing the correct quantity of base material on the roadbed to construct a base conforming to the contract. Excess material shall be hauled ahead and reused, or loaded into trucks and measured or weighed (measured or the mass determined) over scales furnished by the Contractor. Only material incorporated in the completed base will be included in the quantity allowed for payment.

304.3.3.4 Subdrains and Geotextile Filter Fabric. Reclaimed aggregate base materials shall not be placed around or intersect with pavement subdrains or geotextile fabric to avoid potential leachate from blinding the fabric or clogging the drainage system.

304.3.4 Shaping and Compacting. Each layer shall be compacted to the specified density or dynamic cone penetration index value before another layer is placed.

304.3.4.1 Segregated surface areas constructed of Type 1 aggregate base may be corrected by adding and compacting limestone screenings of such gradation and quantity as required to fill the surface voids, and firmly bind the loose material in place. Screenings used in correcting segregated surface areas will be measured and paid for as base material. Type 5 and Type 7 aggregate bases are intended to provide some drainage and shall not be segregated. Trimmed Type 5 and 7 aggregate base may not be reused until the material is verified as meeting the required specifications. Base material contaminated to the extent that the material no longer complies with the specifications shall be removed and replaced with satisfactory material at the Contractor’s expense.

304.3.4.2 Type 1 aggregate base used for shoulders shall be compacted to a minimum 95 percent of modified maximum density. Type 1 aggregate base used on other than shoulders shall be compacted to a minimum 95
percent of modified maximum density. Type 5 aggregate base under both roadway and shoulders shall be compacted to a minimum 95 percent of modified maximum density. The Compaction Test will be made in accordance with Modified AASHTO T-180 Compaction Test (ASTM-1557). Field density will be determined in accordance with AASHTO T 191, using the total material or AASHTO T 238, Method B Direct Transmission, for wet density. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. If nuclear density test methods are used, moisture content will be determined in accordance with AASHTO T 239, except that a moisture correction factor will be determined for each aggregate in accordance with MoDOT Test Method T-35. In lieu of the density requirements for Types 1 and 5 aggregate used for shoulders with thicknesses less than 4 inches, the aggregate shall be compacted by not less than three complete coverages with a 5-ton roller. Rolling shall be continued until there is no visible evidence of further consolidation. During shaping and compacting operations, the moisture content of the base shall be maintained at the level necessary for compaction by wetting or drying as required. Final rolling shall be accomplished by a self-propelled smooth-wheeled roller weighing not less than 5 tons.

304.3.4.3 Shaping of the completed surface of the aggregate base for flexible type surfacing shall be continued until the deviation from the required elevation does not exceed an occasional maximum deviation of 1/4 inches. The surface of aggregate base for rigid type surfacing shall be brought to proper crown and elevation in accordance with the requirements of Sec 502.4.4. Allowable deviation in final subgrade template will not rescind the Contractor’s responsibility of placing concrete in accordance with Sec 502.11.5. The aggregate base surface shall be inspected in accordance with Sec 304.3.4.7.

304.3.4.4 If at any time the compacted aggregate base or subgrade becomes unstable, the Contractor, at the Contractor’s expense, shall restore the earth subgrade and the aggregate base to the required grade, cross section and density.

304.3.4.5 When measurement of aggregate base course by area, complete in place, is specified, thickness of the aggregate base will be determined from measurements through the finished base at approximately 100 feet intervals. When the measurement indicates the thickness is deficient in excess of 1/2 inches from the plan thickness, additional measurements will be taken at 25 feet intervals parallel to centerline ahead and back of the affected location until the extent of the deficiency has been determined. It will be assumed that each measurement is representative of the base thickness for a distance extending one-half the distance to the next measurement, measured along centerline, or in the case of a beginning or ending measurement, the distance will extend to the end of the base section. Any deficient areas shall be corrected by reworking and adding material within the limits of the deficiency.

304.3.4.6 Type 7 aggregate base under both roadway and shoulders shall be compacted to achieve an average dynamic cone penetration index value through the base lift thickness less than or equal to 0.4 inches per blow, as determined by a standard dynamic cone penetrometer (DCP) device with a 17.6 lb hammer meeting the requirements of ASTM D6951.

304.3.4.6.1 Water shall be applied to the Type 7 base material during the mixing and spreading operations so that at the time of compaction the moisture content is not less than 5 percent of the dry weight.

304.3.4.6.2 Type 7 base shall be tested with the DCP within 24 hours of placement and final compaction.

304.3.4.7 Grade Checking. Prior to placing concrete or bituminous pavements, the Contractor shall demonstrate to the Engineer that the aggregate base conforms the profile and cross-sectional grades per the plans. The frequency of the grade checking will be determined by the Engineer to ensure conformance to the plans. Grade checking maybe performed by one of the following methods:

(a) Pulling a string line across surveyed points and checking the difference between the string line and aggregate base. The edge of pavements and/or the centerline shall be surveyed at a minimum of every 50 feet,
(b) The Contractor can use GPS surveying equipment,

(c) or another approved method by the Engineer.

304.3.5 Aggregate Base for Temporary Pavements. If available, the Contractor may substitute bituminous pavement cold millings or crushed recycled concrete in lieu of aggregate base for any temporary pavement, regardless of the type or thickness of aggregate shown on the plans. If this option is exercised, the Contractor shall notify the Engineer at least two weeks prior to using the millings or recycled concrete and shall identify the location from where the millings or concrete will be removed. The millings or recycled concrete shall be installed to the same dimensions shown on the plans for the aggregate base. Millings or recycled concrete shall be placed in maximum 4 inch lifts, and each lift shall be compacted by a minimum of three passes with a 10-ton roller. All temporary aggregate bases shall be removed along with the temporary pavement.

304.3.6 Maintenance. The Contractor shall maintain, at the Contractor’s expense, the required density and surface condition of any portion of the completed aggregate base until either the prime coat or a succeeding course or pavement is placed. If a prime coat is specified in the contract, the Contractor will be required to apply the prime coat on any completed portion of the aggregate base as soon as practical, or as otherwise specified. The Contractor will not be permitted to apply prime if the moisture in the top 2 inches of the Type 1 or 5 aggregate base exceeds the higher of either:

(1) the average of the optimum moisture as determined by the Modified Compaction Test and the absorption of the plus No. 4 fraction, or

(2) two-thirds of the optimum moisture as determined by the Modified Compaction Test.

304.4 Material Testing. The Contractor shall control operations to ensure the aggregate base, in place, meets the specified requirements for density, thickness, gradation, deleterious, and plasticity index. Testing for density, thickness, gradation, deleterious, and plasticity index will be performed by the Engineer, and shall be taken at frequencies and locations determined by the Engineer.

304.5 Method of Measurement. Final measurement of the completed aggregate base course will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Measurement will include aggregate course placed under curb and gutter. Where required, measurement of aggregate base course, complete in place, will be made to the nearest square yard, except that the area of additional material required by Sec 304.3.3.2 will not be included. Where the aggregate base course extends to the inslope of the shoulder, the pay limit of the aggregate base course will be measured from the mid-point of the sloped portion. The revision or correction will be computed and added to or deducted from the contract quantity.

304.6 Basis of Payment. The accepted quantities of aggregate base course of the thickness and type specified will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be considered full compensation for hauling, placing, and for water used in performing this work.

304.6.1 When bituminous pavement cold millings or recycled crushed concrete are substituted for aggregate base, payment will be made for the aggregate base quantity provided in the plans, regardless of whether millings, recycled crushed concrete or the aggregate base is used. Payment will be considered full compensation for hauling of millings, cold milling operations, and all other material or labor necessary to substitute bituminous pavement millings for aggregate base.
SECTION 309
PORTLAND CEMENT CONCRETE BASE

309.1 Description. This work shall consist of constructing a Portland cement concrete base, with or without reinforcement as specified, on a prepared subgrade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

309.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsified Asphalt (SS-1, SS-1H, CSS-1, or CSS-1H)</td>
<td>1015</td>
</tr>
<tr>
<td>Steel Wire Fabric for Concrete Pavement</td>
<td>1036.4</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
</tbody>
</table>

309.2.1 All material, proportioning, air-entraining, mixing, slump and transporting for Portland cement concrete shall be in accordance with Sec 501, as applicable to Portland cement pavement concrete.

309.3 Equipment. Except as revised in Sec 309.4, the equipment requirements of Sec 502 shall apply to the construction of this work. Approved sliding form construction methods may be used at the Contractor's option.

309.4 Construction Requirements. The construction of concrete base shall be performed in accordance with the requirements of Sec 502 with the following modifications:

(a) Belting, brooming or mechanical floating will not be required for the surface finish. The surface of the base shall be finished so that it will not vary more than 1/4 inch from a 10 foot straightedge.

(b) Membrane curing shall not be used. In addition to any of the other methods permitted by Sec 502.6, emulsified asphalt may be used to cure the concrete base if the surface course is to be of a bituminous type.

(c) Sawed joints may have a minimum width of 1/8 inch and shall not be sealed with joint sealing material.

(d) Widening an existing pavement. Either mechanical or approved manual methods may be used in preparing the subgrade and for grading and tamping the forms. The type and spacing of transverse joints will be designated in the contract. A batch-type mixer having a rated capacity of not less than 10 cubic feet of mixed concrete may be used if approved by the Engineer. Either manual or mechanical methods may be used for finishing the concrete after thorough compaction by tamping or vibrating.

309.5 Base Thickness. The base concrete shall be tested for thickness in accordance with Sec 502.11.5.

309.6 Method of Measurement. Final measurement of the completed concrete base will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. Concrete base areas will be computed to the nearest 1/10 square yard.

309.7 Basis of Payment.

309.7.1 The contract unit price for Portland cement concrete base will be considered as full compensation for all material and other items including reinforcement entering into the construction of the base, and no additional compensation will be allowed for any excess thickness. No direct payment will be made for liquid asphalt used as a curing agent.
309.7.2 The accepted quantities of Portland cement concrete base will be paid for at the contract unit price per square yard, with proper allowance made for any deductions for deficiency in thickness, according to Sec 502.11.5.4 and Sec 502.11.5.5.
310.1 Description. This work shall consist of furnishing and placing chat, gravel or crushed stone surfacing in the quantity shown in the contract, or as directed by the Engineer.

310.2 Material. All material shall conform to Division 1000, Material Details, and specifically to Sec 1006. The type and gradation of the surfacing material to be used will be specified in the contract.

310.3 Construction Requirements.

310.3.1 The Contractor shall furnish, haul and spread surfacing material on the subgrade at the designated rate. The rate of application may be varied at the discretion of the Engineer, depending upon the nature of the soil encountered in the subgrade. The Contractor shall be responsible for the uniform unloading and distribution of the required quantity of material throughout each station. The subgrade shall be prepared as specified in Sec 209 and any work done in reshaping the subgrade before placing surfacing material shall be at the Contractor's expense. When it is determined by the Engineer to be to the County's advantage, hauling may be done over surfacing material previously spread, otherwise, all hauling will be over the subgrade.

310.3.2 The material shall be deposited on one shoulder on tangents and on the high shoulder of curves. Material shall be spread to a uniform thickness over the subgrade within 24 hours after being deposited on the roadbed, unless the condition of the subgrade is such that additional time should elapse. Surplus material shall be left on one shoulder on tangents and on the high shoulder of curves in a neat and symmetrical windrow, leaving openings for all approaches and for the drainage of low points.

310.3.3 After being compacted under traffic, the material shall be shaped and ruts filled by blading the roadbed as frequently as is necessary to prevent cutting through the surfacing material into the subgrade. Irregularities which develop and which are not filled by blading shall be filled by adding more material from the windrow. The material shall be shaped until it conforms to the cross section indicated in the contract, and until it is free from ruts and waves. Maintenance of the surface shall continue until acceptance is made.

310.3.4 Stockpiling Aggregate Surfacing Material. Material shall be stockpiled at points specified by the Engineer and in the approximate quantity shown in the contract.

310.3.5 Salvaged Surfacing. Designated areas shall be scarified to the full depth of the existing surfacing and such material pulverized to a maximum size of approximately 2 inches. Approximately 75 percent of the material shall be removed from the roadbed and placed in stockpiles or spread at locations designated. Salvaged surfacing material shall be maintained as free as practicable of dirt, vegetation or other objectionable material. Salvaging shall not be performed until approved by the Engineer.

310.4 Method of Measurement. Measurement of aggregate surface complete in place will be made to the nearest square yard. Final measurement of the completed aggregate surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity.

310.5 Basis of Payment. The accepted quantities of aggregate surface will be paid for at the unit price for each of the pay items included in the contract.
SECTION 401
PLANT MIX BITUMINOUS BASE AND PAVEMENT

401.1 Description. This work shall consist of a bituminous mixture placed, spread and compacted as shown on the plans or as directed by the Engineer.

401.2 Material.

401.2.1 The grade of asphalt binder will be specified in the contract. When the plasticity index on individual aggregate fractions with 10 percent or more passing the No. 30 sieve exceeds 3, a moisture susceptibility test shall be required in accordance with Sec 401.4.5 during the mix design process. If the plasticity index exceeds that of the material approved for the mix design, additional testing may be required. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate</td>
<td>1004.2</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1002.3</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1002.4</td>
</tr>
<tr>
<td>Hydrated Lime</td>
<td>1002.5</td>
</tr>
<tr>
<td>Asphalt Binder, Performance Graded (PG)</td>
<td>1015</td>
</tr>
</tbody>
</table>

401.2.2 Reclaimed Asphalt. Reclaimed Asphalt may be obtained from Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS). The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. A correction factor for use during production may be determined for binder ignition by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction. The use of reclaimed asphalt shall be limited to one of the following options with the exception of bituminous base. For bituminous base the limits specified may be increased according to the recycled materials used as follows; 10% for RAP only, 5% for RAS only and 10% for the appropriate RAP and RAS combination.

<table>
<thead>
<tr>
<th>Binder</th>
<th>Percent Effective Virgin Binder Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RAP</td>
</tr>
<tr>
<td>Contract Grade Virgin Binder shall be used</td>
<td>0 - 20</td>
</tr>
<tr>
<td>Virgin Binder shall be Softened One Grade(a)</td>
<td>21 - 40</td>
</tr>
<tr>
<td>Blend Chart(b)</td>
<td>0 - 100</td>
</tr>
<tr>
<td>Extraction and Grading of Binder from final Mixture(c)</td>
<td>0 - 100</td>
</tr>
</tbody>
</table>

\(a\) The virgin binder shall have a low temperature grade 6 degrees lower than the binder grade specified in the contract. Lowering the high temperature of the virgin binder is not required; however, if lowered, the virgin binder shall have a high temperature grade no lower than 6 degrees below the binder grade specified in the contract. (Ex. Contract grade PG 64-22; virgin binder could be either PG 58-28 or PG 64-28). The Pressure Aging Vessel (PAV) test temperature (AASHTO M320) shall be tested at 19°C, regardless of the high temperature grade of the selected virgin binder.

\(b\) Testing in accordance with AASHTO M323 including raw data shall be included with the mix design which demonstrates that the grade of the combine mixture meets the contract requirements.

\(c\) Testing in accordance with AASHTO M323 including raw data shall be included with the mix design which demonstrates that the grade of the combine mixture meets the contract requirements.
Testing in accordance with either AASHTO T319, or AASHTO T164 and R59 along with grading in accordance with AASHTO M320 including raw data shall be included with the mix design which demonstrates that the grade of the combine mixture and rejuvenator, if applicable, meets the contract requirements.

**401.2.2.1 Reclaimed Asphalt Pavement.** Reclaimed Asphalt Pavement (RAP) may be used in any Sec 401, Plant Mix Bituminous Base and Pavement. All RAP material, except as noted below, shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Aggregate shall have the asphalt coating removed either by extraction or binder ignition during production. The material shall be tested in the Micro-Deval apparatus at a frequency of once per 1500 tons. The percent loss shall not exceed the Micro-Deval loss of the combined virgin material by more than five percent. Micro-Deval testing will be waived for RAP material obtained from MoDOT or St. Charles County roadways. All RAP material shall be in accordance with Sec 1002 for deleterious and other foreign material. The aggregate specific gravity shall be determined by performing AASHTO T 209 and calculating the G_{se} to which a 0.98 correction factor will be applied in order to determine G_{sb} as follows:

\[
G_{se} = \frac{100 - P_b}{100 - \frac{P_b}{G_{nm}} G_b}
\]

\[
RAP\ G_{sb} = RAP\ G_{se} \times 0.98
\]

See Sec 401.4.4.1 for mixes containing more than 40% effective binder replacement from reclaimed asphalt.

**401.2.2.2 Reclaimed Asphalt Shingles.** Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22 in accordance with AASHTO PP 53. In addition, shingles shall be ground to 3/8 inch minus. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post-consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post-consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The bulk specific gravity of RAS used in the job mix formula shall be 2.600.

\[
RAS\ G_{ub} = 2.600
\]

See Sec 401.4.4.1 for mixes containing more than 40% effective binder replacement from reclaimed asphalt. The gradation of the aggregate may be determined by solvent extraction of the binder or using the following as a standard gradation:

<table>
<thead>
<tr>
<th>Shingle Aggregate Gradation</th>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/8 in.</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>No. 4</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>No. 8</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>No. 16</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>No. 30</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>No. 50</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>No. 100</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>No. 200</td>
<td>25</td>
</tr>
</tbody>
</table>

**401.2.2.3 Rejuvenators.** Rejuvenators may be used in any asphalt mixture containing recycled material. When a rejuvenator is used for the purpose of softening the binder grade, the requirements for the Extraction and Grading of Binder from Final Mixture option in Sec 401.2.2 must be satisfied.
401.3 Composition of Mixtures. Aggregate sources shall be from the specific ledge or combination of ledges within a quarry, or processed aggregate from a particular product, as submitted in the mix design. The total aggregate prior to mixing with asphalt binder shall be in accordance with the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
</tr>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>85-100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>60-90</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>---</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-65</td>
</tr>
<tr>
<td>No. 8</td>
<td>25-50</td>
</tr>
<tr>
<td>No. 16</td>
<td>---</td>
</tr>
<tr>
<td>No. 30</td>
<td>10-35</td>
</tr>
<tr>
<td>No. 200</td>
<td>4-12</td>
</tr>
</tbody>
</table>

401.4 Job Mix Formula. At least 30 days prior to placing any mixture on the project, the Contractor shall submit a mix design for verification and approval by the Engineer. The mixture shall be designed in accordance with Asphalt Institute Publication MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types. The mixture shall be compacted and tested at a minimum of three asphalt contents separated by a maximum of 0.5 percent in accordance with AASHTO T 245, except as herein noted. The test method shall be modified by short-term aging the specimens in accordance with AASHTO R 30. A detailed description of the mix design process shall be included with the job mix formula. Representative samples of each ingredient for the mixture shall be submitted with the mix design. Aggregate fractions shall be in accordance with the same proportions as the proposed job mix formula. A minimum of 150 pounds will be required for any individual fraction. The amount of each ingredient submitted shall be as follows for each mix design to be verified:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Minimum Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate</td>
<td>300 lbs.</td>
</tr>
<tr>
<td>Hydrated Lime, Mineral Filler and/or Baghouse Fines</td>
<td>20 lbs.</td>
</tr>
<tr>
<td>Asphalt Binder</td>
<td>10 gal.</td>
</tr>
</tbody>
</table>

401.4.1 Mixture Design. Laboratories that participate and achieve a score of 3 or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 209, T 308 and T 245 or T 312 will have the mixture verification process waived. The mix design shall be submitted to the Engineer for approval at least seven days prior to mixture production.

401.4.2 Required Information. The mix design shall include raw data from the design process and shall contain the following information:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number(s) if applicable, gradation, and percent chert of each aggregate fraction.

(c) Plasticity index of each aggregate fraction which has 10 percent or more passing the No. 30 sieve.

(d) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including all raw data, or in accordance with TM 81.
(e) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(f) Percentage of each aggregate component.

(g) Combined gradation of the job mix.

(h) Percent of asphalt binder, by weight, based on the total mixture.

(i) Bulk specific gravity ($G_{mb}$) by AASHTO T 166, Method A of a laboratory compacted mixture.

(j) Percent air voids ($V_a$) of the laboratory compacted specimen.

(k) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA).

(l) Theoretical maximum specific gravity ($G_{mm}$) as determined by AASHTO T 209 after the sample has been short-term aged in accordance with AASHTO R 30.

(m) Mixing temperature and molding temperature.

(n) Bulk specific gravity ($G_{mb}$) of the combined aggregate.

(o) Percent deleterious content of the combine aggregate.

(p) Baghouse fines added for design. Provide the combine gradation with and without the baghouse percentage.

**401.4.3 Mixture Approval.** No mixture will be accepted for use until the job mix formula for the project is approved by the Engineer. The job mix formula approved for each mixture shall be in effect until modified in writing by the Engineer. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new job mix formula may be required. In lieu of a new laboratory design, mixtures requiring adjustment beyond the limits allowed in Sec 401.8.2.1 may be designed in the field based on characteristics of plant-produced mixture in accordance with Sec 401 and verified by the Engineer, which may require new aggregate characteristics.

**401.4.4 Mixture Characteristics.**

**401.4.4.1** Base, BP-1, BP-2 and BP-3 mixtures shall have the following properties, when tested in accordance with AASHTO T 245 or AASHTO T 312. The number of blows with the compaction hammer shall be 35 or the number of gyrations shall be 35 with the gyratory compactor. BP-1 and BP-2 mixtures shall have between 60 and 80 percent of the VMA filled with asphalt binder and dust to effective binder ratio of 0.8 to 1.6. BP-3 mixtures shall be compacted with the gyratory compactor to 35 gyrations and shall have a minimum 75 percent of the VMA filled with asphalt binder and dust to effective binder ratio of 0.9 to 2.0.

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Percent Air Voids</th>
<th>AASHTO T245 Stability</th>
<th>Voids in Mineral Aggregate (VMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>3.5</td>
<td>750</td>
<td>13.0a</td>
</tr>
<tr>
<td>BP-1</td>
<td>3.5</td>
<td>750</td>
<td>13.5</td>
</tr>
<tr>
<td>BP-2</td>
<td>3.5</td>
<td>750</td>
<td>14.0</td>
</tr>
<tr>
<td>BP-3</td>
<td>3.5</td>
<td>750</td>
<td>15.0</td>
</tr>
</tbody>
</table>
a Bituminous base mixtures that would require 12.0 percent VMA following Asphalt Institute MS-2 will have a minimum 12.0 percent requirement.
b If the effective virgin binder replacement from any combination of RAP and RAS is greater than 40 percent; then the minimum VMA required shall be increased by 0.5.

401.4.4.2 When specified in the contract as BP-3NC, BP-3 mixtures containing limestone aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the criteria of crushed noncarbonate material. The A.I.R. shall be determined on the minus No. 4 sieve. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Minimum Non-Carbonate by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
<td>20% Minus No. 4</td>
</tr>
<tr>
<td>Dolomite</td>
<td>No Requirement</td>
</tr>
</tbody>
</table>

401.4.5 Moisture Susceptibility. When required moisture susceptibility shall be tested in accordance with AASHTO T 283. The mixture shall have a tensile strength ratio (TSR) of 70 percent or greater when compacted to 3.7 inches with 7 ± 0.5 percent air voids. An approved anti-strip additive may be added to increase retained strength to a passing level.

401.4.6 Time Limit. A mix design may be transferred to other projects for a period of three years from the original approval date provided satisfactory results are obtained during production and placement.

401.5 Gradation and Deleterious Content Control. The Engineer shall be notified as soon as possible, but no later than 24 hours if a change is made to the cold feed settings, hot bin settings or the binder content. The Engineer shall determine the mixture gradation at the frequency stated in Sec 401.8.2. The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP gradation from the ignition or extraction residual aggregate. Mixtures as produced shall be subject to the following tolerances and controls:

(a) The maximum variations from the approved job-mix formula shall be within the tolerances as shown in the table below:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tolerance</td>
</tr>
<tr>
<td>No. 8</td>
<td>± 5.0</td>
</tr>
<tr>
<td>No. 200</td>
<td>± 2.0</td>
</tr>
</tbody>
</table>

Use No. 16 sieve for BP-3

(b) The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1004.2.

(c) The quantity of asphalt binder introduced into the mixer shall be the quantity specified in the job mix formula. No changes shall be made to the quantity of asphalt binder without written approval from the Engineer. The quantity of asphalt binder determined by tests on the final mixture shall not vary by more than -0.3 to +0.5 percent from the job-mix formula.

401.5.1 Sample Location. The gradations of the total aggregate will be determined from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. The deleterious content of the total aggregate shall be determined from samples taken from the composite cold
feed belt. When required, samples for plasticity index shall be taken from the stockpile. The RAP shall be sampled from the RAP feeding system on the asphalt plant. Samples for asphalt content determination may be taken at the plant.

401.5.2 Not Used.

401.5.3 Commercial Mixture. If specified in the contract that an approved commercial mixture may be used, the Contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture proposed to be furnished. The statement shall include:

(a) The types and sources of aggregate, percentage range of each, and range of combined gradation.

(b) The percent and grade of asphalt binder.

(c) The mixing time and range of mixture temperature.

The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. It will not be necessary for the plant to meet the requirements of Sec 404. A field laboratory will not be required. If the proposed mixture and plant are approved by the Engineer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truckload of each day's production, a certification that the material and mixture delivered are in conformance with the approved mixture. Upon completion of the work, a plant certification shall be furnished by the supplier for the total quantity delivered. The mixture shall be transported, placed and compacted in accordance with Sec 401.7. Without specific contract designation, an approved commercial mixture may be used in lieu of plant mix bituminous pavement or base course mixtures for work that is considered temporary construction and is to be maintained at the Contractor's expense. Temporary construction will be defined as work that is to be removed prior to completion of the contract.

401.5.4 Moisture Content. The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture.

401.5.5 Contamination. The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

401.6 Not Used.

401.7 Construction Requirements.

401.7.1 Weather Limitations. Bituminous mixtures shall not be placed:

(1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below the temperature restrictions in the chart below,

(2) on any wet or frozen surface,

(3) when weather conditions prevent the proper handling or finishing of the mixture, or

(4) between November 1 and March 1 except when authorized by the Engineer. Placement within these dates will be permitted only when it is to the County's advantage to do so. Temperatures are to be obtained in accordance with MoDOT Test Method T20.

<table>
<thead>
<tr>
<th>Mix Design</th>
<th>Temperature Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>Below 40°F</td>
</tr>
</tbody>
</table>
401.7.1.1 Cold Weather Paving. Cold weather paving will only be authorized when it is to the advantage of the County. When on-site ambient temperatures at the time of paving are less than 50°F, surface mixtures will require the use of an approved warm mix admixture, at no additional cost to the County.

401.7.2 Bituminous Mixing Plants. Bituminous mixing plants and preparation of material and mixtures shall be in accordance with \textit{Sec 404}.

401.7.3 Subgrade or Surface Preparation. The subgrade upon which the bituminous mixture is to be placed shall be prepared in accordance with \textit{Sec 209} and primed as specified in the contract in accordance with \textit{Sec 408}, as applicable. All material requirements of a tacked surface shall be in accordance with \textit{Sec 407}.

401.7.3.1 Base Widening. For base widening work, the bottom of the trench shall be compacted until further consolidation is not visually evident, by use of a trench roller having a weight of no less than 300 psi of width of rear roller, or by mechanical tampers or other methods approved by the Engineer. Suitable excavated material may be used in shouldering operations. On the outside of curves, the design depth of trench at the beginning of the superelevation transition shall be varied gradually to the minimum depth at the end of the superelevation transition. Slight transitioning of the width of the base widening will be necessary to permit the indicated angle of repose or shear angle outside of the ultimate edge of surface. The bottom of the trench shall in no case be less than 3 inches below the surface of the existing pavement. All surplus excavated material shall be disposed of by the Contractor in areas to be secured by the Contractor beyond the right of way limits. An acceptable written agreement with the property owner on whose property the material is placed shall be submitted to the Engineer.

401.7.3.2 Application of Prime or Tack. The prime coat, if specified, shall be applied in accordance with \textit{Sec 408}. A tack coat is required on all existing pavement and shoulder surfaces that will be overlaid with a bituminous mixture. All construction requirements of a tacked surface shall be in accordance with \textit{Sec 407}, and specified herein. The tack coat shall be applied uniformly and shall completely cover the surface upon which the bituminous mixture is to be placed. Placement of a bituminous mixture shall not be placed upon a tacked surface that is not uniformly covered or surfaces that have experienced excessive loss of tack due to tracking. Re-application of tack due to excess tracking or non-uniform coverage shall be at the Contractor’s expense.

401.7.4 Hauling Equipment. Trucks used for hauling bituminous mixtures shall be in accordance with \textit{Sec 404}.

401.7.5 Spreading. The base course, primed surface or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the bituminous mixture. When placed on the roadbed, the mixture shall have a temperature of not less than 260°F. It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The paver shall be operated at a speed that will give the best results. The rate of delivery of the mixture to the paver shall be coordinated so as to provide, where practicable, a uniform rate of placement without intermittent operation of the paver. The compacted thickness of a single layer shall not exceed 2 inches for the surface course and 4 inches for the leveling course. On small areas and areas which are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods when permitted by the Engineer.

401.7.5.1 Irregularities. The mixture shall be spread without tearing the surface and struck off such that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with a suitable mixture at the Contractor’s expense. Irregularities shall be corrected by adding or removing mixture
before compacting. In situations where there is a dispute in the existence of segregation, the area in question will be tested in accordance with MoDOT Test Method TM 75. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixtures shall be removed and replaced to the limits determined by the Engineer.

401.7.5.2 Leveling Course. If required by the contract, a leveling course consisting of a layer of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface. Spot-leveling operations over small areas, with feather-edging at high points and ends of spot areas, may be required prior to placing the leveling course. Rigid control of the placement thickness of the leveling course will be required. The mixture shall be practically free from segregation.

401.7.5.3 Base Widening. The specified total thickness of base widening shall be completed to the adjacent traveled way elevation as shown on the plans. Additional thickness of base widening may be placed as required prior to coldmilling, at the Contractor's expense, and shall subsequently be coldmilled to the same elevation as the traveled way, if conducive to expedite operations. On small areas, and on areas that are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the Engineer. At least one lane of the existing pavement and the adjacent shoulder shall be kept open to traffic at all times during construction, except for short intervals when the movement of the Contractor's equipment will seriously hinder the flow of traffic. Intervals during which the Contractor will be allowed to halt traffic shall be as designated by the Engineer. The Contractor shall not open more trenches ahead of the first layer of the base widening than is necessary for placing that layer in one half a day's operations. The first layer of the base widening shall not be placed for a greater distance ahead of the second layer than is necessary for placing the second layer in one half a day's operations. The second layer shall not be placed for a greater distance ahead of the final layer than is necessary for placing the final layer in one day's operation. Any changes in these lengths shall be made only with written permission from the Engineer.

401.7.5.4 Multiple Lifts. The Contractor shall keep the traffic off the asphaltic concrete until it has cooled sufficiently to prevent flushing of the asphalt to the surface, marking or distorting the surface, or breaking down the edges, and in any case until the temperature of the asphaltic concrete is 140°F or below. When the asphaltic concrete construction consists of more than a single layer, each layer shall be compacted as specified and allowed to cool to the ambient temperature before the next layer is placed. The final surface layer shall be laid in a continuous sequence over the entire project unless otherwise approved by the Engineer.

401.7.5.5 Edge Differential. For roadways constructed under traffic, no pavement edge differential shall be left in place for more than seven days, unless approved by the Engineer.

401.7.6 Joints. The minimum density of all traveled way pavement within 8 inches of a longitudinal joint, shall be no less than 2.0 percent below the specified density. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the layer. When a transverse vertical edge is to be left in place and opened to traffic, a temporary depth transition shall be constructed as approved by the Engineer. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches. The joints in the final surface layer shall be at the lane lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint. Each side of the joint shall be flush and along true lines.

401.7.7 Surfaced Approaches. At locations designated in the contract or as specified by the Engineer, approaches shall be primed in accordance with Sec 408 and surfaced with a plant mix bituminous mixture. The bituminous surface shall be placed as shown on the plans or as directed by the Engineer. Approaches shall not be surfaced before the surface course adjacent to the entrance is completed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

401.7.8 Compaction. The compacted mixture shall have a minimum density of 92 percent of the theoretical maximum specific gravity. In lieu of density requirements, mixtures used for wedging, transitions, existing shoulder
overlays, new shoulders constructed on a sub-grade or base that does not specify density control, temporary bypasses to be maintained at the expense of the Contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverage's over the entire area with either a pneumatic tire roller weighing no less than 10 tons, a tandem-type steel wheel roller weighing no less than 10 tons or an approved vibratory roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation.

401.7.8.1 Minimum Compacting Temperatures. Rollers operating in the vibratory mode shall not be operated when the mixture is below 225°F or when the warm mix technology mixture is below 200°F. Rolling shall be continued until all roller marks are eliminated and before the PG64-22 binder mixture is below 185°F, the warm mix technology modified mixture or the PG70-22 or PG76-22 binder mixture is below 200°F (or as recommended by the manufacturer), except as otherwise specified.

401.7.9 Safety Edge. An approved longitudinal shoulder wedge system shall be used to create a beveled edge at the edge of pavement for a roadway without a paved shoulder, or at the edge of shoulder for pavement with a paved shoulder up to and including 4 feet in width. The shoulder wedge system shall result in a bevel measuring 30 degrees from horizontal and extending laterally from the edge of traveled way to the point of intersection with the inslope. The construction tolerance shall be plus or minus 5 degrees. The shoulder wedge system shall maintain contact between the device and road shoulder surface and allow automatic transition to cross roads, driveways and obstructions. The device must be removable or be able to be lifted when not in use. All shoulder wedge systems to be used for the purpose of creating a safety edge must be approved by the Engineer. The device must be designed to constrain the material, increase the consolidation of the extruded profile, and provide a smooth wedged surface. The use of a conventional single plate strike-off is not permitted. There will be no direct payment for compliance with the requirements of this specification.

401.8 Material Testing.

401.8.1 Mixture Testing. The Engineer will randomly test the mixture within the following frequencies. The gradation and the asphalt content shall be determined at least once every 1,000 tons of production or a minimum of once per day. Deleterious content shall be determined once per 5,000 tons unless quality concerns dictate more frequent testing as directed by the Engineer. Gradation and asphalt content of RAP shall be determined once every 10,000 tons of production. If RAP is used and AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77. At the Engineer’s discretion, testing may be waived when production does not exceed 200 tons per day.

401.8.1.1 Failing Test. If a deleterious content or asphalt content test result falls outside of the specification tolerances, a review or adjustment of the plant settings and production shall be made and another sample shall be immediately taken. If the second test falls outside of the specification tolerances, production shall be immediately ceased until the mixture can be brought back into specification. If a gradation test falls outside of the specification tolerances, adjustments to plant shall be made and another gradation shall be taken immediately. Plant production for the following day shall not resume until the mixture is brought back into specification when the final gradation for the day is not within tolerance.

401.8.2 Pavement Testing. During construction, the Engineer will designate as many tests as necessary to ensure that the course is being constructed of proper thickness, composition and density.

401.8.2.1 Density. The maximum theoretical density shown on the job mix formula shall be used for this determination.

401.8.2.1.1 Density Testing. Density will be determined by the direct transmission nuclear method in accordance with MoDOT Test Method TM 41 unless otherwise specified. The Engineer will determine the testing frequency to ensure proper density is being achieved. If the County specifies the specific gravity method for determining density,
testing as noted in Sec 401.8.2.1.1.2 will be required. In such cases, the Contractor may elect to test the pavement by the direct transmission nuclear method in accordance with MoDOT Test Method TM 41 for their own information, at no additional cost to the County.

**401.8.2.1.1 Direct Transmission Nuclear Method.** The theoretical maximum specific gravity, D (Big D), shall be used for the maximum density entered into the nuclear testing gauge. The theoretical maximum specific gravity, D (Big D) will be determined by:

\[ D = G_{mn} \times 62.4 \text{ lb/ft}^3 \]

**401.8.2.1.2 Specific Gravity Method.** When the specific gravity method is specified, samples will be obtained by drilling a 4 inch diameter core at locations will be determined randomly by the Engineer. The Contractor shall cut samples of the compacted mixture and deliver them to the Engineer in good condition. The surface from which samples have been taken shall be restored by the Contractor not later than the next day of plant operations. When the Contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.

**401.8.2.1.2.1 Unconfined Joint Cores.** An unconfined joint density core shall be taken from the same transverse cross section as the mat core and alternate sides. The joint cores taken to evaluate this area shall be centered 6 inches from the longitudinal joint. If no deficient cores are found in the first 25 percent of production, the established rolling procedure may be used, at the direction of the Engineer, in lieu of density tests provided no changes in the material, typical location or temperatures are made. Pay adjustments due to longitudinal joint density shall apply to the full width of the lane paved. Adjustments due to joint density shall apply to the day’s production from which the cores are obtained.

**401.8.2.1.2 Compensation for Density Deficiencies.** Pavement will be tested for compliance with Sec 401.7.8. Density values for each lift of bituminous concrete will be determined. Pavement, which is not compacted to the minimum density requirement specified, shall be removed and replaced. If in the judgment of the Engineer the inadequately compacted pavement would not seriously impair traffic service, penalties may be assessed for low-density results in lieu of the removal and replacement of pavement. Density penalties will be assessed at the County Engineer's option in accordance with this section.

**401.8.2.1.2.1 Density Adjustment.** Payment for mixture placed at or below the required minimum density will be adjusted as follows:

<table>
<thead>
<tr>
<th>Field Density Percent of Maximum Theoretical Density</th>
<th>Percent of Contract Unit Price(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>92.0 or above</td>
<td>100%</td>
</tr>
<tr>
<td>91.5 to 91.9, inclusive</td>
<td>90%</td>
</tr>
<tr>
<td>91.0 to 91.4, inclusive</td>
<td>80%</td>
</tr>
<tr>
<td>90.5 to 90.9, inclusive</td>
<td>70%</td>
</tr>
<tr>
<td>90.0 to 90.4, inclusive</td>
<td>60%</td>
</tr>
<tr>
<td>Below 89.9</td>
<td>0%</td>
</tr>
</tbody>
</table>

\(^a\) When adjustments are necessary, the lower percent of the contract unit price of either the pavement or unconfined joint density adjustment will apply.

**401.8.2.1.2.2 Representative Area.** It will be assumed that each test is representative of the pavement density for a distance extending one-half the distance to the next test location, measured along centerline, or in the case of a beginning or ending test, the distance will extend to the end of the pavement section.
401.8.2.2 Pavement Thickness. For the purpose of determining the constructed thickness of the pavement, cores will be taken at random intervals in each traffic lane at the rate of four (4) cores per 1000 feet. Cores taken for determining density may also be used for determining thickness. Additional cores will be taken at 30 foot interval parallel to the centerline ahead and back of all locations where core measurements indicate a deficiency of 0.25 inches or greater from the plan thickness until such time a deficiency in excess of or equal to 0.25 inches are no longer found. Deductions for thickness deficiencies will be in accordance with Sec 401.8.2.2.

401.8.2.2.1 The Engineer can require additional cores be drilled at all locations where thickness measurements taken during construction indicate a thickness deficiency.

401.8.2.2 The Contractor shall obtain samples for total compacted thickness of all layers, including any bituminous base or leveling courses, at locations designated by the Engineer. Each sample shall consist of one 4 inch diameter core taken the full depth of bituminous construction. The surface from which samples have been taken shall be restored by the Contractor not later than the next day of plant operations.

401.8.2.3 Compensation for Thickness Deficiencies. If any core measurement is less than the thickness indicated on the plans, the Contractor will have the option of either removing and replacing the pavement at its sole expense or accepting the monetary deduction for the deficiency in accordance with the schedule below. The choice of penalty for the greater than 0.75 inches deficiency shall be at the sole discretion of the County.

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Percent Deduction in Unit Price per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.25 in.</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 0.25 in. to ≤ 0.50 in.</td>
<td>25%</td>
</tr>
<tr>
<td>&gt; 0.50 in. to ≤ 0.75 in.</td>
<td>50%</td>
</tr>
<tr>
<td>&gt; 0.75 in.</td>
<td>100%, or remove and replace</td>
</tr>
</tbody>
</table>

401.8.2.4 Representative Area. It will be assumed that each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section. The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of bituminous pavement, may be waived by the Engineer. In this case the designed thickness will be considered as the measured thickness.

401.9 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement shall be thoroughly tested for smoothness by profiling or straightedging in accordance with Sec 610.

401.10 Defective Mixture. Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with a satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.

401.11 Pavement Marking. If the Contractor’s work has obliterated or otherwise obscured the existing traffic striping on resurfacing projects open to through traffic, and the surface course has not been completed at the time work is suspended for any extended period, temporary striping will be placed by the Contractor when necessary in the judgment of the Engineer. Payment for temporary striping placed by the Contractor will be made in accordance with Sec 620.

401.12 Conversion Factors. The following conversion factors will be used to convert bituminous tonnages to cubic yards on projects bid by the square yard:

<table>
<thead>
<tr>
<th>Asphaltec Concrete Mixture</th>
<th>Conversion of Compacted Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 401.13 Method of Measurement

The weight of the mixture will be determined from the batch weights if a batch-type plant is used, and will be determined by weighing each truck load on approved scales if other types of plants are used.

**401.13.1 Measurement of asphalt binder and mineral aggregate will not be separately made. Measurement of asphalt pavement shall include both asphalt binder and mineral aggregate and will be made to the nearest 0.1 ton for the total tonnage used in the accepted work.**

### 401.14 Basis of Payment

The accepted quantities of plant mix bituminous pavement will be paid for at the unit price for the pay item included in the contract. The unit price will be modified by smoothness per Sec 610, by density per Sec 401.8.2.1.2.1, and by thickness per Sec 401.8.2.2.2. Payment for obtaining and delivering samples of compacted mixture from the pavement and replacing the surface will not be made, as all such sampling requirements shall be considered incidental.

**401.14.1 The contract unit price for all mixes, except wedge or level course, shall be adjusted based on smoothness as measured on the surface course. Payment for smoothness will be based on Sec 610. Constant width acceleration and deceleration lanes shall be considered as mainline pavements.**

| Bituminous Pavement Mixture PG64-22 (Base) | 1.943 Ton/yd³ |
| Bituminous Pavement Mixture PG64-22 (BP-1) | 1.948 Ton/yd³ |
| Bituminous Pavement Mixture PG64-22 (BP-2) | 1.934 Ton/yd³ |
| Bituminous Pavement Mixture PG64-22 (BP-3) | 1.893 Ton/yd³ |
SECTION 404
BITUMINOUS MIXING PLANTS

404.1 Description. This specification covers the requirements for mixing plants and equipment used in the production of bituminous mixtures.

404.2 Requirements for All Plants.

404.2.1 Aggregates. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the combined cold feed belt. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

404.2.2 Asphalt Binder. An asphalt binder storage tank shall be provided at the proportioning and mixing plant. If more than one storage tank is used to deliver asphalt binder to the proportioning unit, piping and valve arrangements shall permit material to be used from any one of the tanks without using from another at the same time.

404.2.2.1 Storage. Each tank used for storage from which asphalt binder is delivered to the proportioning unit shall be equipped for heating the material under effective and positive control at all times to the temperature requirements set forth in Sec 1015. Heating shall be by steam or oil coils, electricity, or other means such that no flame shall come in contact with the heating tank. The Contractor shall furnish a tank capacity chart calculated in increments suitable for verifying quantities used during a normal production period.

404.2.2.2 Circulation. A circulating system of adequate capacity shall provide proper and continuous circulation of the asphalt binder between storage tank and proportioning units during the entire operating period. The discharge end of the circulating pipe shall be maintained below the surface of the asphalt binder in the storage tank to prevent discharging into the open air. All pipe lines and fittings shall be steam or oil-jacketed or otherwise properly insulated to prevent heat loss.

404.2.2.3 Binder Sampling. The Contractor shall provide a sampling outlet in the asphalt binder feed lines connecting the plant storage tanks to the proportioning or injection system. The sampling outlet shall be installed in a readily accessible location such that representative samples may be withdrawn safely and slowly at any time during plant operation. A drainage receptacle shall be provided for flushing the outlet prior to sampling. When all of the chemical admixtures are added to the plant storage tank prior to use, the Engineer may allow the Contractor to sample the asphalt binder from the storage tanks located at the mixing facilities. Sampling procedures shall be approved by the Engineer prior to samples being taken.

404.2.3 Cold Aggregate Feeder. The plant shall be provided with an accurate mechanical means for uniformly feeding the aggregate into the drier to provide uniform production and temperature. A synchronized method of proportioning the aggregate at the cold feeder shall be provided.

404.2.3.1 Cold Feed Calibration. For all plants producing bituminous mixtures composed of more than one fraction of aggregate, the aggregate cold feeds shall be calibrated as required by the Engineer. On the basis of the calibration, aggregate cold feeds shall be adjusted to ensure the proper percentage of the various aggregate fractions of the mix, as required by the job mix formula.

404.2.3.2 Aggregate Sampling. Safe, adequate and convenient facilities shall be provided for obtaining representative aggregate samples from the full width and length of the discharge flow of the combined cold feed, or from each hot bin on batch-type plants.

404.2.4 Drier. A drier of any satisfactory design for drying and heating the aggregate shall be provided. The drier shall be capable of drying and heating the aggregate to a temperature within the limits of the range specified in Sec
for the grade of asphalt binder used, without leaving any visible unburned oil or carbon residue on the aggregate. The mixture may be tested for contamination. Absorbed moisture in the aggregate shall be reduced to such a quantity that there is no visible segregation of asphalt binder resulting from escaping water vapor in the prepared mixture.

404.2.5 Dust Collector. An efficient dust collecting system shall be provided to prevent the loss of fine material into the surrounding environment. The material collected may be returned to the mixture at a uniform rate through a metering device or the dust may be wasted.

404.2.6 Filler Storage. If mineral filler or hydrated lime, or both, are required, adequate dry storage shall be provided and provisions shall be made for accurate proportioning.

404.2.7 Asphalt Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper quantity of asphalt binder. Metering pumps for asphalt shall deliver accurately to within plus or minus 2.0 percent of the required quantity when tested for accuracy. Asphalt scales shall be in accordance with Sec 404.3.4. If the quantity of asphalt binder is controlled by metering, provisions shall be made whereby the delivery meter may be readily checked by actual weight.

404.2.8 Thermometric Equipment. A thermometer of suitable range shall be fixed in the asphalt feed line at a suitable location near the discharge at the mixer unit. The thermometer included in the asphalt metering unit shall be displayed in a location readily accessible to the Engineer. An approved recording thermometer, pyrometer or other recording thermometric instrument shall be installed in plants in such manner that the temperature of the heated mixture or aggregate is automatically registered and recorded. The terminal shall be maintained free of accumulated mixture or aggregate to ensure accuracy. The thermometric instrument shall be installed in the discharge chute of drum mix plants and in at least one hot aggregate bin of batch plants. The terminals shall be located where the hot material will flow around the terminals during the proportioning operation and shall not be located near the corners of the bins or at points where the material will collect or pack around the terminals. This instrument shall be located in clear view of the plant operator. A chart shall continuously record both time and temperature. The smallest interval of time shall be a maximum of 15 minutes and the temperature graduations shall be no more than 10°F. The chart shall be furnished to the Engineer at the end of each day's operation.

404.2.9 Plant Calibration. Personnel, scales and equipment necessary for calibrating the plant and for verifying the accuracy of proportions shall be furnished by the Contractor and shall be available at all times. All scales used in the final measurement of the mixture shall be in accordance with Sec 310. Records of all calibration shall be provided to the Engineer.

404.2.10 Safety Requirements. A conveniently located, easily opened gate or door shall be provided in the mixer cover for observation of pugmill mixing operations. Adequate and safe stairways to the pugmill mixer platform and sampling points shall be provided. Guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the Engineer to obtain samples and mixture temperature data. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the pugmill mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

404.2.11 Surge Bins. Surge bins used in the production of bituminous mixtures shall maintain the temperature of the mixture within 25°F of the Contractor’s designated temperature. Mixture shall not be stored more than 8 hours.

404.2.12 Automatic Ticket Printer. The asphalt plant shall be equipped with an automatic ticket printer connected to the weighing system in such a manner that the printer automatically detects and prints the weight determined
by the system. The printer shall store and recall the tare weight when the operator enters the vehicle identification. The weight shall be shown to at least the nearest 20 pounds or nearest one-hundredth of a ton.

404.2.13 Ticket Information. The printer shall be capable of keeping and printing cumulative totals for each project for each type of bituminous mixture. The printer shall produce a ticket in triplicate to accompany each load delivered to the project and shall be furnished to the Engineer. The ticket shall show the following: (as a minimum)

(a) Gross, tare and net weights.

(b) Identification of the vehicle.

(c) Current date and time.

(d) County job mix number.

(e) Job mix percent asphalt binder.

(f) Unique ticket number (may be preprinted on the ticket).

(g) Project number, job number, street/road.

404.2.13.1 Net Weight. The gross and tare weights will not be required when the net weight of bituminous mixture is determined by batch weights.

404.2.13.2 Gross Weight. When the net weight of bituminous mixture is determined from the gross weight of the loaded delivery vehicle, the empty delivery vehicle weight shall be determined daily or from time to time during the day as directed by the Engineer.

404.2.13.3 Daily Total. At the end of each day's operation, the Contractor shall furnish to the Engineer a total tonnage of mixture produced by the asphalt plant in sufficient detail to determine the amount of asphalt binder used in that day's operation.

404.2.13.4 Printer Failure. In the event of automatic ticket printer failure, the Contractor may be permitted, without approval from the Engineer, to furnish manually written tickets to complete that day's operation.

404.3 Requirements for Batch-Type Plants.

404.3.1 Automatic Batching. For all contracts having not more than 10,000 tons of bituminous mixture, standard manual batching methods, approved by the Engineer, will be permitted. For contracts having more than 10,000 tons of bituminous mixture, required by Sec 401, batching plants shall be equipped to operate automatically to the extent that the only manual operation required for the proportioning of all ingredients for one batch shall be a single actuation of a switch or starter. The equipment shall include devices capable of automatically proportioning each ingredient of the mixture in the selected sequence and quantity. Interlocks shall be provided which will hold or delay the automatic batch cycling whenever the batched quantity of any ingredient is not within the specified tolerance. The weight setting and timing controls shall be suitably equipped so they may be locked when specified by the Engineer. Manual operation will not be permitted beyond 24 hours after breakdown in the automatic equipment, except by written approval of the Engineer.

404.3.2 Aggregate Scales. Scales for weighing aggregate and mineral filler or hydrated lime, or both, may be beam, springless dial or electronic digital weigh meter type, and shall be of standard make and design having tolerances on overregistration and underregistration not exceeding 0.4 percent of the indicated weight when tested for accuracy. Each aggregate fraction shall be measured within one percent of the total batch weight of the mixture.
Mineral filler or hydrated lime, or both, shall be measured within 0.5 percent of the total batch weight of the mixture. The total weight of the batch shall be within 2.0 percent of the desired batch weight. The change in load required to change the position of the rest of the indicating element or elements of a nonautomatic indicating scale an observable amount shall be no greater than 0.1 percent of the nominal scale capacity. If manual batching methods are used, beam-type scales shall be equipped with a device to indicate to the operator that the required load is being approached. This device shall indicate at least the last 5 percent of the load weighed on any beam, except that this increment will not be required to be greater than 200 pounds. Multiple beam-type scales shall be equipped with a tare beam and a separate beam for each size of aggregate. Dial scales shall be equipped with adjustable pointers for marking the weight of each material to be weighed (incorporated) into the batch. Graduation intervals for either beam or dial scales shall be no greater than 0.1 percent of the nominal scale capacity. Quantity indicators necessary for batching shall be in full view of the operator.

404.3.3 Asphalt Bucket. If a bucket is used for weighing the asphalt binder, the filling system and bucket shall be of such design, size and shape that asphalt will not overflow, splash or spill outside the confines of the bucket during filling and weighing.

404.3.4 Asphalt Scales. Scales for weighing asphalt binder shall be in accordance with Sec 404.3.2, except a device to indicate at least the last 20 pounds of the approaching total load shall be provided. Asphalt binder shall be measured within 0.1 percent of the total batch weight of the mixture. Beam-type scales shall be equipped with a tare beam or adequate counter-balance for balancing the bucket and compensating periodically for the accumulation of asphalt on the bucket. Springless dial scales used for weighing asphalt binder shall have a tare beam and a dial graduated in increments not to exceed 0.1 percent of the nominal scale capacity and the maximum dial capacity shall be no more than 15 percent of the nominal capacity of the mixer.

404.3.5 Mixer Unit. The plant shall be capable of producing a uniform mixture. The mixer shall be heated and shall have a minimum capacity of 2000 pounds per batch. The mixer shall be constructed to prevent leakage of the contents and the mixer box shall be equipped with a hood to prevent loss of dust.

404.3.5.1 Time Lock. The mixer shall have an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer until the closing of the mixer gates at the completion of the cycle. The time lock shall lock the asphalt bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods.

404.3.5.2 Mixer Rating Plate. A rating plate designating the manufacturer’s rated capacity shall be attached to the mixer. The quantity of mixture produced per batch shall not exceed the manufacturer’s rated capacity.

404.3.5.3 Mixing Times. The mineral aggregate for mixtures specified in Sec 401 shall be mixed dry for at least 10 seconds. The dry mixing period shall start when all of the mineral aggregate has been charged into the mixer, and end when the introduction of the asphalt binder begins. After dry mixing, the asphalt binder shall be charged into the mixer in a manner that will uniformly distribute the asphalt over at least 3/4 of the full length of the mixer. The time required to add the asphalt binder shall not exceed 15 seconds. Wet mixing shall begin at the introduction of the asphalt binder and shall continue for at least 30 seconds, or longer if necessary, to produce a complete and uniform coating of the particles and a thorough distribution of the asphalt binder throughout the aggregate. The wet mixing period shall end when the discharge gate is opened.

404.4 Requirements for Drum Mix Plants.

404.4.1 Drum Plant. The plant shall be specifically designed for drum mixing and shall be capable of satisfactorily heating, drying and mixing bituminous mixtures. Heating shall be controlled to prevent damage to the aggregate or the asphalt binder. The temperature of the mixture when discharged from the mixer shall be within the range specified in Sec 1015 for the grade of asphalt binder being used. The rate of flow through the drum shall be controlled such that the bituminous material and aggregate shall be mixed until a homogeneous mixture with all
particles uniformly coated is obtained, and in no case shall the quantity of mixture produced exceed the manufacturer's rated capacity.

404.4.2 Feed Indicators. Each feeding orifice shall have an adjustable gate with an indicator provided to reference the opening setting. A device shall be installed on each aggregate feeder to indicate when the flow of material from the bin is below the point where accurate proportioning through the feeder gates can be accomplished. These indicators shall be positive in action and shall actuate a clearly visible or audible signal to the plant operator, or stop the flow of material to the drum when the level of material in the bin is too low for accurate proportioning. A scalping screen mounted independent of other proportioning or weighing equipment shall be provided if directed by the Engineer. The total daily asphalt binder quantity numbers for the project shall be provided to the Engineer.

404.4.3 Asphalt Meter. Asphalt binder shall be introduced through a continuously registering cumulative indicating meter by a pump specifically designed for drum mix plants. The meter shall be located in the asphalt line so that the meter will continuously register the asphalt discharge to the mixer and such that the discharge through the meter can be readily diverted into a container for measurement. The meter shall be equipped with a nonsetback register and shall have an accuracy within 2 percent by weight of the material actually being measured in any given period of time. The nonsetback register shall register only the asphalt discharged to the mixer and shall not record asphalt circulated back to the storage tank. A device shall be provided in the asphalt storage tank to indicate when the supply of asphalt to the pump and metering device is such that accurate proportioning is not accomplished. The accuracy of the pump and meter shall be verified at periodic intervals as designated by the Engineer. The total daily asphalt binder quantity number for the project shall be provided to the Engineer.

404.4.4 Mineral Filler. If mineral filler or hydrated lime, or both, are used, a separate bin and feeder for each material shall be furnished and each material shall be dispensed by weight by continuous batching device. The batching device shall have a continuous weight display in clear view of the plant operator. The delivery system shall be variable speed and interlocked with the aggregate weigh belt so the total dry aggregate weight, including mineral filler or hydrated lime, or both, is indicated to the asphalt proportioning system. A continuously registering, cumulative, nonsetback register shall record the quantity of mineral filler or hydrated lime, or both, discharged into the mixer. Mineral filler and hydrated lime shall be introduced and uniformly dispersed into the drum mixer at the point of introduction of the asphalt binder without loss to the dust collection system. The mineral filler and hydrated lime proportioning and delivery system shall have an accuracy of 10 percent by weight of the material actually being measured in any given period of time. The total daily mineral filler and hydrated lime quantity numbers for the project shall be provided to the Engineer.

404.4.5 Belt Scales. Positive weight measurement of the combined cold feed aggregate shall be by use of belt scales. The combined cold feed aggregate shall be continuously recorded on a nonsetback register. The belt scale shall have an accuracy within 2 percent by weight of the material actually being measured in any given period of time. The accuracy of the belt scales shall be verified at periodic intervals as directed by the Engineer. The total daily aggregate quantity numbers for the project shall be provided to the Engineer.

404.4.6 Reclaimed Asphalt Pavement Weighing. Positive weight measurement of reclaimed asphaltic pavement shall be by use of belt scales in accordance with Sec 404.4.5.

404.4.7 System Interlocks. The aggregate feed system, reclaimed asphaltic pavement feed system if recycling is permitted, mineral filler or hydrated lime, or both if specified, and the asphalt flow shall be interlocked by a blending system which will automatically regulate the asphalt binder, mineral filler, hydrated lime and reclaimed asphaltic pavement flow, and shall cause synchronized corrections for variations in aggregate flow. The blending system shall include a moisture-compensating device to correct for moisture in the aggregate passing over the belt scales. Moisture determinations shall be made periodically during each day's operation. The blending system shall include a device to correct for changes in the specific gravity of the asphalt binder.
404.4.8 Sampling. Safe, adequate and convenient facilities shall be provided for obtaining representative samples of asphalt binder, cold aggregate and bituminous mixture. The plant shall be equipped with sampling devices capable of providing a sample of sufficient size from the full width of the combined aggregate flow and from the full width of the mixer discharge flow. Sampling devices shall be designed such that samples may be taken while the plant is operating at normal production rates.

404.4.9 Calibration. Safe, adequate and convenient facilities shall be provided for calibrating or verifying the asphalt binder, mineral filler, hydrated lime, reclaimed asphaltic pavement and the aggregate nonsetback registers. The manufacturer's recommendations shall be followed for calibration unless specified otherwise. The quantities of aggregate and asphalt binder measured in any given period of time shall vary no more than 2.0 percent by weight from the required quantity of each.

404.5 Stone Matrix Asphalt Mixtures. A homogeneous mixture shall be produced.

404.5.1 Fibers in Batch Plants. For batch plants, fibers shall be added to the mineral aggregate either in the weigh hopper or in the pugmill. The fibers shall be accurately added by weight, either manually by bag or other measure, or by an approved weight metering device. If fibers are added in the weigh hopper, no fiber shall be added until mineral aggregate from at least one hot bin has been placed in the weigh hopper. If fibers are added in the pugmill, the fiber shall be added immediately after the mineral aggregate and before the asphalt binder is added.

404.5.1.1 Dry Mixing. The mineral aggregate and the fibers shall be dry mixed for at least 20 seconds.

404.5.1.2 Wet Mixing. The wet mixing time shall be no less than 35 seconds to allow the cellulose fibers to expand and to ensure adequate distribution of the fibers and asphalt binder.

404.5.1.3 Uniformity. Dry and wet mixing times and batch mixing temperatures shall be adjusted as necessary to achieve a uniform mixture.

404.5.2 Fibers in Drum Plants. For drum plants, fibers shall be introduced into the plant in either loose or pelletized form.

404.5.2.1 Metering. Equipment for metering fibers into the plant shall ensure a consistent, uniform blending of the fibers into the mixture. The metering system shall be variable speed, shall proportion the fibers by weight, shall be accomplished as specified by the equipment manufacturer and be to the satisfaction of the Engineer.

404.5.2.2 Pelletized Fibers. If used in a drum mix plant, pelletized fiber shall be added directly into the drum mixer through the recycle asphalt inlet.

404.6 Liquid Anti-Strip Additive Systems. Type I liquid anti-strip additives shall be blended into the asphalt binder. Type II additives shall be sprayed on the combined cold feed aggregate. Both shall be incorporated in a consistent and uniform manner.

404.6.1 Calibration. The method of adding an additive into the mix shall be accurate to within ± 10 percent of the amount to be added. Calibration of the blending system shall be provided to the Engineer.

404.6.2 Flow Interruption. The feed system shall be equipped with a flow meter that signals if the additive is or is not being added. It shall be interlocked so that the operation will cease if the additive flow is interrupted or not within the allowable limits.

404.6.3 Interlock. The rate of application shall be interlocked with the plant to coincide with plant production rates when the additive is incorporated during mixture production.
404.6.4 Type I Addition. For Type I liquid anti-strip additive used in drum mix plants, the blending system shall add the material into a static in-line mixer between the asphalt binder storage tank and the asphalt binder flow meter. For batch plants, the blending system shall add the material into a static in-liner mixer between the asphalt binder storage tank and the mixing plant injection point. Controls shall be in place so that blended material is not permitted to recirculate back to the asphalt binder storage tank.

404.6.5 Type II Addition. For Type II liquid anti-strip blending systems, the blending system shall uniformly apply the material to the cold feed prior to the drum for continuous, batch and drum plants.

404.7 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds that have been thinly coated with a minimum quantity of lime solution or an approved bituminous mixture release agent in accordance with Sec 1071 to prevent the mixture from adhering to the beds. The release agent shall not be diluted less than the minimum rate specified by the manufacturer and shall be applied with equipment recommended by the manufacturer. Use of diesel fuel, fuel oil or other detrimental products as a bed coating or dilution agent will not be permitted. Each truck shall have a cover of canvas or other suitable material of such size to protect the mixture from the weather. The cover shall be securely fastened over all sides of the truck bed. Truck beds shall be insulated, when necessary, such that the mixture will be delivered on the road at the specified temperature.
SECTION 407  
TACK COAT

407.1 Description. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material, in accordance with these specifications.

407.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsified Asphalt or Performance Graded Asphalt Binder</td>
<td>1015</td>
</tr>
</tbody>
</table>

407.3 Equipment. The Contractor shall provide a system for heating and applying the bituminous material. The system shall be designed, equipped, maintained and operated such that emulsified asphalt or liquid asphalt, at even heat, may be applied uniformly on variable widths of surface up to 15 feet with uniform pressure and an allowable variation from any specified rate of ±0.01 gallon per square yard. The system shall include a calibrated tank and a thermometer for measuring temperature of tank contents. The system shall be equipped with instrumentation that continuously verifies application rates. The calibration of the system shall be approved by the Engineer prior to use, and the Contractor shall furnish all equipment, material and assistance if calibration is required.

407.4 Construction Requirements.

407.4.1 Preparation of Surface. The existing surface shall be free of all dust, loose material, grease or other foreign material at the time the tack is applied.

407.4.1.1 Coldmilled Surface. All coldmilled surfaces shall be in accordance with Sec 622.10, except modified herein. Coldmilled surfaces shall be swept or vacuumed prior to tack coat application. The sweeping or vacuuming requirement may be waived, if traffic is allowed onto the coldmilled surface and is considered clean by the Engineer.

407.4.1.2 Pre-wetting. Existing surfaces may be pre-wetted just prior to the tack coat application. Pre-wetting shall consist of misting the surface with controlled spraying equipment to achieve a damp condition with no standing water or shiny appearance.

407.4.2 Asphalt Emulsion Application. Asphalt emulsion shall be applied uniformly with a pressure distributor or spray paver at the target rates indicated in the following table. Upon approval by the Engineer, the target application rate may be varied by +/- 0.02 gal/sy in the field, based upon the existing pavement condition. The tack coat material shall be heated at the time of application to a temperature in accordance with Sec 1015. When an asphalt emulsion is applied through a pressure distributor, the tack coat shall be properly set and the tacked surface shall be clean of all dirt before the next course is placed.

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Tack Coat Application Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target Application Rate;</td>
</tr>
<tr>
<td></td>
<td>Undiluted (gal/yd²)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>New Asphalt Surfaces</td>
<td>0.05</td>
</tr>
<tr>
<td>Existing Asphalt or Concrete Surfaces</td>
<td>0.08</td>
</tr>
<tr>
<td>Coldmilled Asphalt or Concrete Surfaces</td>
<td>0.10</td>
</tr>
</tbody>
</table>

407.4.2.1 Dilution of Asphalt Emulsions. Water may be added only by the tack coat manufacturer and shipped to the jobsite. No dilution shall be allowed in the field. When water is added to the asphalt emulsion, the resulting mixture shall contain no more than 20 percent of added water. The Contractor shall notify the Engineer of the use of a diluted emulsion. The exact quantity of added water shall be indicated on the manufacturer’s bill of lading,
manifest or truck ticket. The target application rate shall be adjusted to the diluted target application rate as specified in the table under Sec 407.4.2.

407.4.2.2 Performance Graded (PG) Asphalt Binder. Hot applied PG graded asphalt binders may be used as tack coat in lieu of emulsified asphalt. The PG graded binders shall be applied uniformly with a pressure distributor to provide complete coverage of the preceding course or layer. Safety procedures of hot applied asphalt shall be addressed in the Contractor’s safety plan. A pre-construction meeting shall be held to address all safety procedures and protocols of hot applied asphalt prior to tack coat application.

407.4.3 Tack. When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. A bituminous mixture shall not be placed upon a tacked surface that is not uniformly covered or surfaces that have experienced excessive loss of tack due to tracking. Re-application of tack due to excess tracking or non-uniform coverage shall be at the Contractor’s expense. All exposed tack coat shall be covered with bituminous mixture prior to opening to traffic.

407.4.4 Weather Limitations. Tack coat shall not be applied: (1) when either the air temperature or the temperature of the surface to be tacked is below 40°F, (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing, or (4) unless authorized by the County Engineer during critical temperature periods (below 40°F). Temperatures are to be obtained in accordance with MoDOT Test Method T20.

407.5 Method of Measurement. Measurement of asphalt emulsion to the nearest gallon will be made in accordance with Sec 1015. If water is added to asphalt emulsion, the quantity to be paid for will be determined prior to the addition of water.

407.6 Basis of Payment. The accepted quantity of tack coat will be paid for at the contract unit price. No direct payment shall be made for water added to the asphalt.
SECTION 408
PRIME COAT

408.1 Description. This work shall consist of preparing and treating an existing surface with bituminous material in accordance with these specifications, as shown on the plans or as directed by the Engineer.

408.2 Material. The type and grade of bituminous material will be specified in the contract. Liquid asphalt may be changed one grade by the Engineer during construction at no change in the contract unit price. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type RC Liquid Asphalt</td>
<td>1015</td>
</tr>
<tr>
<td>Type MC Liquid Asphalt</td>
<td>1015</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td>1015</td>
</tr>
</tbody>
</table>

408.2.1 Aggregate used for sanding primer shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature, or fines manufactured from igneous rock, chert gravel, limestone or flint sand.

408.3 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. This equipment shall meet the requirements of Sec 408.4.3.

408.4 Construction Requirements.

408.4.1 Weather Limitations. Bituminous material shall not be applied: (1) when either the air temperature or the temperature of the surface to be primed is below 40°F, (2) on any wet or frozen surfaces, (3) when weather conditions prevent the proper handling or finishing, or (4) unless authorized by the County Engineer during critical temperature periods below 40°F. Temperatures are to be obtained in accordance with MoDOT Test Method T20.

408.4.2 Preparation of Surface. The surface to be primed shall be shaped to the required grade and cross section, shall be free from all ruts, corrugations, segregated material or other irregularities, and shall be uniformly compacted by rolling. The surface shall be firm and slightly damp when primer is applied. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface.

408.4.3 Application. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. The application rate shall be as specified in the contract or as revised by the Engineer between 0.2 and 0.5 gallons per square yard. The primer shall be heated at the time of application to a temperature specified by the Engineer in accordance with the limits provided in Sec 1015, or as specified in the contract.

408.4.3.1 Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified quantity. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of. Pools of primer material remaining on the surface after the application shall be removed.

408.4.3.2 When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be routed to the treated portion and the remaining width of the section shall be primed.

408.4.3.3 The primer shall be properly cured for a minimum of 12 hours, and the primed surface shall be cleaned of all dirt and surplus sand before the next course is placed.
408.4.4 Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate and the roadbed must be used by traffic, sand blotter material shall be spread in the quantity required to absorb any excess bituminous material.

408.5 Method of Measurement. Measurement of prime coat shall be made to the nearest 10 gallons.

408.5.1 No measurement of material for sanding primer will be made.

408.6 Basis of Payment. The accepted quantity of prime coat will be paid for at the contract unit price.

408.6.1 No direct payment will be made for furnishing or applying any water required for dampening the surface to be primed. No direct payment will be made for sanding primer.
SECTION 409
SEAL COATS

SECTION 409.10 BITUMINOUS SEAL COAT

409.10.1 Description. This work shall consist of the application of bituminous material followed by the application of cover coat material in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

409.10.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate for Seal Coats</td>
<td>1003</td>
</tr>
<tr>
<td>The grade of aggregate will be specified in the contract.</td>
<td></td>
</tr>
<tr>
<td>Aggregate for Polymer Modified Asphalt Seal Coats</td>
<td>1003</td>
</tr>
<tr>
<td>Aggregate for polymer modified asphalt seal coats shall be crushed stone, Grade 3, 4, 5 or 7; or porphyry, Grade 3.</td>
<td></td>
</tr>
<tr>
<td>Liquid Asphalt (RC-3000) or (MC-3000)</td>
<td>1015</td>
</tr>
<tr>
<td>Asphalt Binder (PG 46-28)</td>
<td>1015</td>
</tr>
<tr>
<td>Emulsified Asphalt (RS-2, CRS-2, RS-1 or CRS-1)</td>
<td>1015</td>
</tr>
<tr>
<td>Unless otherwise specified in the contract, the type of bituminous material and grade of liquid asphalt or asphalt binder may be selected by the Contractor from any of those specified above. The grade of emulsified asphalt will be designated by the Engineer after examination of the aggregate the Contractor proposes to furnish.</td>
<td></td>
</tr>
<tr>
<td>Polymer Modified Asphalt Emulsion</td>
<td>1015</td>
</tr>
<tr>
<td>Unless otherwise specified in the contract, the grade of polymer modified asphalt emulsion shall be either CRS-2P or EA-90P.</td>
<td></td>
</tr>
</tbody>
</table>

409.10.2.1 In addition to these requirements, the aggregate and bituminous material shall show satisfactory adhesion when tested for stripping in accordance with MoDOT Test Method T12. Consideration will be given to use of bituminous material to which an anti-stripping agent has been added.

409.10.3 Equipment. The following equipment or its equivalent will be required:

(a) Heating and applying bituminous material, measuring temperature of tank contents and continuously verify application rates. The calibration of the system shall be accomplished by the Contractor and approved by the Engineer prior to use. The Contractor shall furnish all equipment, material, labor and supervision necessary to perform this calibration. Equipment shall be calibrated subsequent to any repair that may affect calibration.

(b) A rotary power broom.

(c) A minimum of one oscillating-type pneumatic-tire roller. The pneumatic-tire roller shall be self-propelled, weighing from 5 to 8 tons. Pneumatic-tire rollers shall be operated at a speed not to exceed 5 miles per hour.

(d) A self-propelled aggregate spreader of approved design. The aggregate spreader shall be equipped with a means of applying the larger cover aggregate to the surface ahead of the smaller cover aggregate and with positive controls so that the required quantity of material will be deposited uniformly over the full width of the bituminous material. Other types of aggregate spreaders may be used only with written approval of the
409.10.4 Construction Requirements.

409.10.4.1 Weather Limitations. Bituminous material shall not be applied when either the air temperature or the temperature of the surface to be sealed is below 70°F. Bituminous material shall not be applied on a wet surface or when weather conditions would prevent the proper construction of the seal coat. Temperatures are to be obtained in accordance with MoDOT Test Method T20.

409.10.4.2 Preparation of Surface. The surface to be treated shall be thoroughly cleaned and swept to remove all mud, matted earth, dust and other foreign material.

409.10.4.3 Application of Bituminous Material. Bituminous material shall be applied by means of a pressure distributor in a slow, uniform, continuous spread, without missing or overlapping, at a truck speed consistent with the placement of the cover aggregate. Unless otherwise provided, the bituminous material shall be applied to one half the width of the surface at a time, with the center lap of the application placed at the lane line of the traveled way and kept as narrow as is practicable. The other side of the roadbed shall be left open to traffic. The application on one lane shall not exceed that on the adjacent lane by more than 3 miles. The bituminous material shall be within the temperature range specified by the Engineer in accordance with the limits provided in Sec 1015, except that asphalt binder shall be between 315 and 350°F. The actual quantity of bituminous material to be used per square yard shall be as specified by the Engineer. The rate of application is based on the specified minimum residual binder content as it applies directly to asphalt binder. The rate of application of liquid asphalt and emulsified asphalt shall be such that the residual binder content is equivalent to asphalt binder.

409.10.4.3.1 The angle of the spray nozzles and the height of the spray bar shall be set to provide a triple coverage fan pattern. The frame of the distributor shall be blocked or snubbed to the axle of the truck to maintain a constant height of the spray bar above the road surface during discharge of the load. An alternate method of maintaining constant spray bar height may be approved.

409.10.4.3.2 To ensure uniform application of the bituminous material at the beginning of each distributor load, a portion of the roadbed surface shall be covered with building paper. The area covered by the building paper shall be used as the starting point for each distributor load or each part of a load after a temporary delay. If the cut-off is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed when the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to ensure a smooth riding surface. The application of bituminous material on adjacent Portland cement or asphaltic concrete pavements, curbs, bridges or any areas not specified to be sealed shall be avoided.

409.10.4.3.3 If the seal coat is to be constructed on a bituminous surface in which the binder material was other than asphalt binder, the placing of the seal coat will not be permitted until the underlying bituminous course has cured from 15 to 30 days, as directed by the Engineer.

409.10.4.4 Application of Cover Aggregate. In general, the cover aggregate shall be placed within two minutes following the application of the bituminous material. Operations shall not proceed in such manner that bituminous material will be allowed to chill, set up, dry or otherwise impair retention of the cover aggregate. The cover aggregate shall be spread by means of a self-propelled mechanical spreader accurately measuring and uniformly spreading the aggregate. The actual quantity of cover aggregate to be used per square yard shall be as specified by the Engineer. Spreading shall be accomplished in a continuous manner, without stopping between trucks, and in such manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material. All portions of the surface not covered by mechanical spreaders shall be hand spotted so that the entire surface will be uniformly covered. Light hand brooming may be necessary to distribute excessive aggregate.
409.10.4.4.1 If liquid asphalt or asphalt binder is used, cover aggregate shall be surface dry when applied to the bituminous material. Surface dry shall be that condition when no visible film of water exists on the aggregate. If emulsified asphalt is used, the moisture content of the aggregate shall not exceed 5 percent by weight. If specified by the Engineer, the cover aggregate shall be moistened with water to enhance cohesive properties of the emulsion.

409.10.4.4.2 Rolling shall begin immediately behind the spreader and shall consist of two complete coverages with the pneumatic-tire roller. All rolling shall be completed the same day the cover aggregate is applied.

409.10.4.4.3 After the embedded aggregate has set, the surface shall be lightly broomed or otherwise maintained as directed for a period not to exceed four days. Maintenance of the surface shall include the distribution of cover aggregate over the surface to absorb any free bituminous material, and the removal of excess aggregate. Generally, the maintenance shall be confined to the cooler hours of the day and shall be conducted so as not to displace embedded material. The surface shall be free of excess aggregate at the time of acceptance of the work.

409.10.5 Traffic Control. No traffic shall be permitted on the seal coat until all rolling has been completed. The Contractor shall control traffic by means of flagging operations or pilot vehicles, which will be determined by the Engineer or project specifications. Pilot vehicles shall operate at maximum speed of 20 miles per hour. The Contractor's supply trucks shall observe these traffic controls. Pilot vehicles or flagging operations shall also be used to maintain one-way traffic through areas of placing and rolling, and for at least two hours after the completion of rolling.

409.10.6 Method of Measurement. Measurement of bituminous material, to the nearest 10 gallons, will be made as specified in Sec 1015.

409.10.6.1 Measurement of cover aggregate will be made in accordance with the applicable requirements of Sec 310.4.

409.10.7 Basis of Payment. The accepted quantities of bituminous seal coat will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for anti-stripping agent added to the bituminous material. If liquid asphalt or emulsified asphalt is used, the quantity for payment purposes will be reduced by dividing the actual gallons of bituminous material used by the following factors:

(a) 1.25 for RC-3000 and MC-3000 Liquid Asphalts.

(b) 1.82 for RS-1, 1.59 for RS-2, 1.67 for CRS-1 and 1.54 for CRS-2 Emulsified Asphalts.

(c) 1.54 for CRS-2P and EA-90P Polymer Modified Asphalt Emulsion.

409.10.7.1 Any overrun or underrun from the contract quantity shall not be a basis for claim.

SECTION 409.20 ASPHALT CEMENT SEAL COAT

409.20.1 Description. This work consists of an application of Polymer Modified asphaltic cement followed with an application of graded aggregate surfacing material. The work performed under this contract shall consist of furnishing all labor, equipment, traffic control devices and materials to construct a single-layer aggregate surface treatment over existing asphaltic concrete pavements.

409.20.1.1 The Polymer Modified asphalt seal coat shall be constructed in accordance with these specifications and in conformity to the lines, grades, thickness and cross sections shown on the plans or established by the Engineer.

SECTION 409.30 PRECOATED AGGREGATES FOR COVER MATERIAL
409.30.1 Description. This specification covers pre-coated aggregate for cover material to be used for bituminous sealing. The type of cover material aggregate to be furnished is as follows.

409.30.2 Requirements for Composition. Aggregate for cover material shall be lightweight aggregate. Lightweight aggregate shall be expanded shale.

409.30.2.1 Quality Requirements. The aggregate shall meet the following quality requirements

<table>
<thead>
<tr>
<th>Aggregate Quality Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soundness, minimum</td>
</tr>
<tr>
<td>Wear, maximum Lightwear aggregate</td>
</tr>
</tbody>
</table>

409.30.2.2 Product Control. Material produced for use under this specification shall meet the following requirements.

409.30.2.3 Size Requirements. The size requirements for the various cover material types shall be as shown in Table 1. The gradation factor shall comply with the requirements of Table 1.

<table>
<thead>
<tr>
<th>TABLE 1 – GRADATION REQUIREMENTS FOR AGGREGATES FOR COVER MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>CM-L</td>
</tr>
</tbody>
</table>

409.30.2.4 Pre-Coating of Aggregate. The above specified lightweight expanded shale aggregate shall be pre-coated with 1 to 2% AC 64-22 through a hot mix asphalt plant.

409.30.2.5 LIQUID/AC15-5TR

409.30.2.5.1 Specifications as follows:

<table>
<thead>
<tr>
<th>Test Properties</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration @ 25°C, 100g 5sec</td>
<td>75-125</td>
</tr>
<tr>
<td>Viscosity @ 60°C, poise</td>
<td>1500 min</td>
</tr>
<tr>
<td>Viscosity @ 135°C, centistokes</td>
<td>2000 max</td>
</tr>
<tr>
<td>Elastic Recovery @ 25°C, 20 cm elongation, 5 cm/min % recover after 1 hour</td>
<td>55% min</td>
</tr>
<tr>
<td>Softening Point @ 45°C</td>
<td>45 min</td>
</tr>
<tr>
<td>Phase Separation, 163°C, 48 hours, % difference between top and bottom</td>
<td>4.0% max</td>
</tr>
<tr>
<td>Retained Penetration Ration, 25°C. 100g 5 secs, Orig</td>
<td>60%</td>
</tr>
<tr>
<td>Solubility (ASTM D-5546)</td>
<td>98% min</td>
</tr>
</tbody>
</table>

409.30.2.5.2 Typical Application criteria for “hot applied” chip seal using AC15-5TR are as follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt application temperature</td>
<td>325 to 350°F</td>
</tr>
<tr>
<td>Application rates of AC15-5TR</td>
<td>0.3 to 0.35 Gal/S.Y.</td>
</tr>
</tbody>
</table>
409.30.3 Equipment. The following equipment or its equivalent will be required:

409.30.3.1 Distributor. The CONTRACTOR shall provide a computerized, hydrostatic distributor, capable of transverse rate application for heating and applying bituminous materials that meets the requirements of Section 4.3. The tachometer shall be readily visible to the operator and have a dial reading registering gallons per minute passing through the nozzle. The thermometer well shall not be in contact with a heating tube. A hose and spray nozzle attachment shall be provided for applying asphalt material to patches and areas inaccessible to the spray bar. The distributor shall be provided with heaters that can be used to bring the asphalt materials to spray application temperature. The distributor shall be equipped with a bitumeter with a dial gauge registering feet of travel per minute and shall be visible by the driver.

409.30.3.1.1 The width of application of the spray bar shall be 16 feet with provision for lesser width when necessary.

409.30.3.1.2 The distributor shall be provided with a full circulatory system that includes the spray bar.

409.30.3.1.3 The distributor shall be cleaned of foreign contaminants before it is used.

409.30.3.2 Broom. A vacuum type power broom shall be used for removing loose material from the surface to be treated and for removing loose aggregate after work is completed. The broom shall have a minimum suction area of 150 square inches and air velocity in the nozzles of 175 mph. The broom must also be equipped with plastic bristles.

409.30.3.3 Rollers. A minimum of two oscillating-type pneumatic-tire rollers shall be required to roll aggregate after spreading. The pneumatic-tire rollers shall be self-propelled with smooth-tread pneumatic tires of equal size staggered on the axles at such spacings and overlaps as will provide uniform pressure to seat the cover aggregate into the bituminous material without fracturing the aggregate particles. The pneumatic-tire rollers shall weigh from 5-8 tons, shall be operated at a speed not to exceed 5 mph, shall have a contact pressure of 60 psi to 80 psi and shall have a total compacting width of not less than 60 inches.

409.30.3.4 Aggregate Spreader. The aggregate spreader shall be self-propelled, computerized rate control spreader, equipped with computerized controls capable of uniformly distributing a 16-foot wide band of aggregate at a prescribed rate in a single-pass operation over the surface to seal. Spreaders shall be calibrated before operation on the project.

409.30.3.5 Hauling Equipment. Hauling equipment shall be operated in a prudent manner and at moderate speeds that will not damage the new chip seal or create a hazard to the traveling public. Trucks that transport aggregate shall be legally licensed, in good working condition and be equipped with the safety devices required by the United States Department of Transportation.

409.30.4 Construction Requirements

409.30.4.1 Weather Limitations. Polymer Modified asphalt shall not be applied when the pavement or air temperature is below 70°F. The seal coat shall be applied when the pavement surface is dry, and when the weather is not foggy or rainy. The placing of AC15-5TR polymer modified asphalt seal coat will not be allowed before May 1 or after September 30.

409.30.4.2 Preparation of Surface. Immediately before applying the AC15-5TR polymer modified asphalt, any loose material, grease, and other petroleum distillates, dirt, clay or other objectionable organic or inorganic materials shall be removed from the surface to be sealed. Cleaning shall be performed by sweeping or other means necessary
to remove all objectionable material from the pavement surface. Materials removed from the surface shall not be mixed with cover aggregate. The surface should be clean and dry as approved by the Engineer.

409.30.4.2.1 The CONTRACTOR shall be responsible for furnishing and placing masking materials over all sewer, utility and traffic control device covers and inlet grates located in the roadways to be treated. All such materials shall be removed and disposed of after the surfacing material has cured.

409.30.4.3 Application of AC15-STR polymer modified asphalt. The AC15-STR polymer modified asphalt shall be applied by means of a computerized pressure distributor in a slow, uniform, continuous spread, without missing or overlapping, at a truck speed consistent with the placement of the cover aggregate. Unless otherwise provided, the AC15-STR polymer modified asphalt shall be applied to one-half the width of the surface at a time, with the center lap of the application placed at the lane line of the traveled way and kept as narrow as practicable. The other side of the roadbed shall be left open to traffic. Polymer modified asphalt shall not be applied a greater distance than can be immediately covered by aggregate or as approved by the Engineer.

409.30.4.3.1 The application rate of AC15-STR polymer modified asphalt for the chip seal shall be within the limits in Section 3.2. A minimum of 200 gallons of AC15-STR polymer modified asphalt shall remain in the distributor tank at all times except for the last shot on the project. The AC15-STR should be uniformly applied through the pressure distributor at a temperature and transverse rate as specified by the Engineer between 325 and 375°F. The temperature used for spraying at a given spray bar pressure should not be that which causes fogging when the asphalt material leaves the spray bar.

409.30.4.3.2 The angle of the spray nozzles and the height of the spray bar shall be set to provide a triple coverage fan pattern. The frame of the distributor shall be blocked or snubbed to the axle of the truck to maintain a constant spray bar height above the road surface during discharge of the load.

409.30.4.3.3 To insure uniform application of the AC15-STR polymer modified asphalt at the beginning of each distributor load, a portion of the roadbed surface shall be covered with building paper. The area covered by the building paper shall be used at the starting point for each distributor load or each part of a load after a temporary delay. If the cut-off is not positive on the distributor, the use of paper shall be required at the end of each spread. For the next application, the leading edge of the paper is placed within ½ inch of the cut off line of the previously laid treatment. The paper shall be removed and disposed of in an approved manner. The distributor shall be moving forward at proper application speed when the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to insure a smooth riding surface. The application of AC15-STR polymer modified asphalt on adjacent Portland cement or asphaltic concrete pavements, curbs, bridges, or any areas not specified to be sealed, shall be avoided. The CONTRACTOR shall immediately clean up any such spills to the satisfaction of the Engineer.

409.30.4.3.4 If the seal coat is to be constructed on a bituminous surface in which the binder material was other than asphalt cement, the placing of seal coat would not be permitted until the underlying bituminous course has cured from 15 to 30 days as directed by the Engineer.

409.30.5 Application of Cover Aggregate

409.30.5.1 In general, the cover aggregate shall be placed within 30 seconds following the application of the AC15-STR asphalt. Operations shall not proceed in such a manner that the AC15-STR asphalt will be allowed to chill, set up, dry or otherwise impair retention of the cover aggregate. The cover aggregate shall be spread by means of computerized rate control self-propelled spreader accurately measuring and uniformly spreading the aggregate.

409.30.5.2 The quantity of cover aggregate to be used per square yard may be approximately 27 pounds per square yard but will depend on the actual Specific Gravity of the material used. The Engineer shall determine the exact rate. Aggregates shall be dry or surface damp (Saturated Surface Dry-SSD) at the time of application. SSD shall be
considered the condition when no visible film of water exists on the aggregate. The moisture content of the aggregate shall not exceed 2% by weight. The Engineer may require that the cover aggregate be moistened with water to enhance cohesive properties of the asphalt. Spreading shall be accomplished in a continuous manner, without stopping between trucks and in such manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied asphalt. All portions of the surface not covered by computerized rate control spreaders shall be hand spotted so that the entire surface will be uniformly covered. Light hand brooming may be necessary to distribute excessive aggregate.

409.30.3 Rolling. Rolling shall begin immediately behind the spreader and shall consist of at least two complete coverages with the pneumatic-tire roller. Initial rolling shall consist of one complete coverage and shall begin immediately behind the spreader. Initial rolling shall be completed within 15 minutes of the time that the aggregate was spread. AC15-5TR asphalt and aggregate shall not be spread more than 1,000 feet ahead of the completion of initial rolling operations. The second roller shall be used for the second complete coverage to smooth and adequately seat the aggregate. Rolling shall continue until a smooth, thoroughly compacted, surface is obtained. All rolling shall be completed the same day as the cover aggregate is applied. Rolling shall proceed in a longitudinal direction, beginning at the outer edges of the treated surface and working toward the center. Each pass by the roller shall overlap the previous pass by one-half the width of the front wheels.

409.30.6 Traffic Control

409.30.6.1 Traffic Control and Safety. No traffic shall be permitted on the seal coat until all rolling has been completed. On roads where the posted speed limit is above 15 mph, the CONTRACTOR shall control traffic by means of pilot vehicles to a maximum speed of 20 mph. Pilot vehicles will not be required during sealing operations on shoulders. The CONTRACTOR’S supply trucks shall observe these traffic controls. The CONTRACTOR will be required to cover existing speed limit signs with “20 MPH” plates.

409.30.6.2 The beginning and end of the work zone shall have the following signs posted: “Flagger Ahead”, “Fresh Oil” and “Road Construction Ahead.” All side streets shall have “Road Construction Ahead” signs placed as directed by the Engineer and all signs shall conform to Sec 1042 Roadway Sign Material. All signs shall be installed on permanent holding frames, no less than one foot above ground and shall remain in place at each job site until all sweeping operations are complete. Sign shall be safely installed so not to block vehicle or pedestrian line of sight and shall be resistant to wind gusts.

409.30.6.3 In accordance with Sec 616.5.2, when traffic cannot be detoured, flaggers equipped with 2-way hand-held radios shall assist traffic and pilot cars through the project in a manner that provides safety for the traveling public, workmen, and equipment while imposing minimal interruption of the work. When applying seal coat to arterial roads and intersection, lanes shall be cordoned off for safety and traffic control during daylight hours.

409.30.6.4 Safety precautions shall be used at all times during progress of the work. Workmen shall be equipped as required by the Manual on Uniform Traffic Control Devices.

409.30.6.5 The CONTRACTOR shall be responsible for prior notification of residents regarding access restrictions and for no parking on streets during seal coat operations. In cases where on-street parking exists, the CONTRACTOR shall furnish and install “No Parking” notices a minimum of 24 hours in advance of seal coat operations. All such signs shall clearly indicate the duration of the parking restriction.

409.30.6.6 On roads designated as arterials, rush hour restrictions will be enforced. No seal coat work will be permitted on these roadways from 7:00 a.m. to 9:00 a.m. and from 4:00 p.m. to 6:00 p.m. on weekdays.

409.30.7 Pre-Construction Conference. Engineer shall schedule a Pre-Construction Conference prior to Contractor commencing work. Contractor shall submit a work schedule at the meeting showing all work to be completed within the stipulated time.
409.30.7.1 Prior to start of construction, and periodically during construction, the Contractor shall have a materials testing firm furnish to the County Engineer the absorption rate of the aggregate stockpiled and used for this work and the percent of liquid asphalt to be used in the design mix. A certification by a Professional Engineer is to be provided to the County Engineer that the percent of liquid asphalt to be used for the design mix adequately takes into account the absorption rate of the aggregate, and if the absorption rate changes, the appropriate adjustment in the amount of liquid asphalt used must be made.

409.30.7.2 The Contractor is hereby notified that problems such as surface spalling and stripping cannot be tolerated and if it does occur, the County Engineer may require complete removal and replacement at no cost to the County.

409.30.8 Method of Measurement.

409.30.8.1 Final measurement for aggregate in the completed seal coat will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity.

409.30.8.2 Where required, measurement of seal coat, complete in place, will be made to the nearest square yard for aggregate.

409.30.8.3 Final measurement for binder will be made to the nearest gallon in accordance with Sec 1015. Any revision or correction will be computed and added to or deducted from the contract quantity.

409.30.9 Basis of Payment. The accepted quantities of seal coat aggregate and binder, in place, will be paid for at the contract unit price. No separate payment will be made for pre-coating aggregate, fog sealing, dust control, or for providing and installing contract information signs. If the binder application rate includes a correction factor, it is included in the plan quantities. With seal coat contracts, no direct payment will be made for traffic control or placing and removing “No Parking” signs.
SECTION 413
SURFACE TREATMENTS

SECTION 413.10 MICRO-SURFACING

413.10.1 Description

413.10.1.1 This work shall consist of the application of micro-surfacing material to asphaltic pavement surfaces. The micro-surfacing shall consist of a mixture of cationic natural latex modified asphaltic emulsion, mineral aggregate, Portland cement, set-control additives and water. The micro-surfacing material shall be properly transported, proportioned, mixed and evenly spread on the asphaltic pavement surface in strict accordance with the plans, these specifications and as directed by the Engineer. In some cases, more than one lift may be required to obtain the specified thickness.

413.10.1.2 The cured slurry shall have a uniform and homogeneous appearance, substantially fill all cracks, and adhere firmly to the existing surface. The mix shall be capable of being spread in varying thickness cross-sections (wedges, wheel path depressions, scratch courses and surfaces) which, after curing and initial traffic consolidation, resists compaction throughout the entire design tolerance range of bitumen content and varying thickness to be encountered. The end product shall maintain a friction resistant surface (high wet friction coefficient) throughout the service life of the micro-surfacing.

413.10.1.3 The completed mixture shall be such that the micro-surfacing mixture has proper workability during lay down and will permit straight running traffic on 1/2 inch thick micro-surfacing within one hour after placement at 75°F or greater and 50% or lower humidity. Micro-surfacing shall be placed without the occurrence of bleeding, raveling, separation or other distress.

413.10.1.4 Unless otherwise stated, specification section references are from the current edition of the Saint Charles County Standard Specifications for Highway Construction and its supplements. Work shall be performed in accordance with the current edition of "Recommended Performance Guidelines for Polymer-Modified Micro-Surfacing" A143 (revised) published by the International Slurry Surfacing Association (ISSA), ASTM D 6372-99a Standard Practice for Design, Testing and Construction of Micro-Surfacing, with the modification specified herein.

413.10.1.5 The Contractor or listed subcontractor shall be experienced and familiar with the application of micro-surfacing.

413.10.2 Application Rate.

413.10.2.1 Micro-surfacing material shall be applied in one lift of 18 pounds per square yard of the dry mass of the combined mineral aggregate and wheel rut depression micro-surfacing shall be applied at a rate specified in Sec 413.10.13.

413.10.2.2 On roads carrying large volumes of traffic, micro-surfacing material shall be applied in two (2) lifts of 15 pounds per square yard of the dry mass of the combined mineral aggregate and wheel rut depression micro-surfacing shall be applied at a rate specified in Sec 413.10.13.

413.10.2.3 The Engineer will make the final determination for the appropriate application rate.

413.10.3 Not Used

413.10.4 Materials
### 3.10.4.1 Natural Latex Modified Asphalt Emulsion

#### 3.10.4.1.1
The asphalt shall be a natural latex modified grade CSS-1h (cationic) emulsified asphalt. The grade CSS-1h shall be modified with an approved natural latex.

#### 3.10.4.1.2
The approved natural latex shall be milled into the asphalt emulsion prior to the emulsification process. The asphaltic emulsion manufacturer shall certify that the emulsion contains 3.0% to 5.0% natural latex solids based on the mass of asphalt (asphalt residual) within the emulsion.

#### 3.10.4.1.3
The emulsified asphalt content shall be 6.0% to 9.0% as measured by the mass of the dry aggregate or as directed by the Engineer. An approved set-control agent (Ralumac or an approved equal) shall be added in such a quantity as to produce a one-hour set and shall not vary more than ±1% of the quantity specified in the mix design. The residual asphalt content shall have a tolerance of ±0.5% from design.

#### 3.10.4.1.4
The natural latex modified CSS-1h shall comply with the following requirements when sampled in accordance with ASSHTO T-40 and shall comply with the following requirements when tested in accordance with the specified test methods:

<table>
<thead>
<tr>
<th>TESTS ON EMULSION</th>
<th>TEST METHOD</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 77°F</td>
<td>AASHTO T 59</td>
<td>20-100 seconds</td>
</tr>
<tr>
<td>Storage Stability Test (24 hours)</td>
<td>AASHTO T 59</td>
<td>1.0% maximum</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>AASHTO T 59</td>
<td>Positive*</td>
</tr>
<tr>
<td>Sieve Test</td>
<td>AASHTO T 59</td>
<td>0.1% maximum</td>
</tr>
<tr>
<td>Distillation: Residue by Evaporation</td>
<td>AASHTO T 59</td>
<td>62% minimum</td>
</tr>
<tr>
<td>Oil Distillate, by volume of emulsion</td>
<td>AASHTO T 59</td>
<td>0.5% maximum</td>
</tr>
</tbody>
</table>

*If the particle charge test is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

<table>
<thead>
<tr>
<th>TESTS ON EMULSION RESIDUE</th>
<th>TEST METHOD</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration, 77°F, 100 g, 5 seconds</td>
<td>AASHTO T 49</td>
<td>40-90</td>
</tr>
<tr>
<td>Ductility, 77°F, 5 cm/min.</td>
<td>AASHTO T 51</td>
<td>70 minimum</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene</td>
<td>AASHTO T 44</td>
<td>97 minimum</td>
</tr>
<tr>
<td>Softening Point, R &amp; B</td>
<td>AASHTO T 53</td>
<td>140°F minimum</td>
</tr>
<tr>
<td>Viscosity at 140°F, 300 mm Hg</td>
<td>AASHTO T 202</td>
<td>8,000 Poises min. vacuum</td>
</tr>
</tbody>
</table>

#### 3.10.4.1.4.1
The standard distillation procedure shall be modified as follows: The temperature for this test shall be held at 180°F. The sample is oven-evaporated on a glass plate of 77°F for 24 hours (forced draft oven). Material is then removed from the plate with a razor blade tool.

#### 3.10.4.1.5
The distillation residue of the modified emulsion shall contain 3.0% to 5.0% polymer solids by mass of asphalt, as determined by an analytical method approved by the Engineer.

#### 3.10.4.1.6
The polymer modified emulsified asphalt shall be so formulated that when the paving mixture is applied with the relative humidity at not more than 50% and the ambient air temperature of at least 75°F, the paving mixture will sufficiently cure so that uniformly moving traffic can be allowed in one hour. Additional curing time may be required at locations such as driveways, intersections and where sharp turning movements may take place or where vehicles may accelerate sharply.

### 3.10.4.2 Mineral Aggregate
413.10.4.2.1 The mineral aggregate shall meet Sec 1002 or as directed by this provision and be composed of clean and durable particles of an approved blend of crushed porphyry and at least 40 percent crushed air cooled blast furnace steel slag (ACBFS) at proportions acceptable by the Engineer to achieve the desired gradation. The individual aggregates shall be reasonably uniform in gradation and other qualities; shall be uniformly blended with designated proportions using calibrated cold feeds with controlled feeders into a separate stockpile prior to use; and the proportion shall not change from that used for the mix design during the course of placement. The aggregate shall be free of cemented or conglomerated lumps and shall not have any coatings or injurious material.

413.10.4.2.2 Aggregate used for this project shall conform to the following requirements when tested in accordance with the specified test methods:

<table>
<thead>
<tr>
<th>TEST</th>
<th>METHOD</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalent</td>
<td>ASTM D 2419</td>
<td>65 minimum</td>
</tr>
<tr>
<td>Abrasion Resistance after 500 revolutions*</td>
<td>ASTM C 131</td>
<td>30% maximum</td>
</tr>
<tr>
<td>Moisture content of Aggregate</td>
<td>ASTM C 566</td>
<td>as tested</td>
</tr>
<tr>
<td>Sieve Analysis (individual and combined)</td>
<td>ASTM C 136</td>
<td>as tested</td>
</tr>
<tr>
<td>Material Passing No. 200 Sieve</td>
<td>ASTM C 117</td>
<td>as tested</td>
</tr>
<tr>
<td>Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate, 5 cycles</td>
<td>ASTM C 88</td>
<td>12% maximum</td>
</tr>
<tr>
<td>Combined Aggregate Bulk Specific Gravity</td>
<td>ASTM C 127</td>
<td>as tested</td>
</tr>
</tbody>
</table>

*On parent aggregate before crushing

413.10.4.2.3 A stockpile of aggregate shall be dedicated for this project. Rejected stockpiles of material may not be reworked or blended. Stockpile tolerances are established from the following gradation:

<table>
<thead>
<tr>
<th>ISSA Type II Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIEVE SIZE</td>
</tr>
<tr>
<td>3/8&quot;</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

* includes mineral filler

413.10.4.3 Mineral Filler

413.10.4.3.1 The Portland cement mineral filler shall be any recognized brand of non-air entrained Type 1 Portland cement that is free from lumps or foreign matter. The amount of mineral filler needed shall be determined by the laboratory mix design and will be considered as part of the mineral gradation requirement. The mineral filler shall be between 1.0% and 3.0% by the weight of dry aggregate. The laboratory mix design percentage of mineral filler can be increased or decreased up to one percent when directed by the Engineer as the micro-surfacing is being placed if it is found to be necessary for better consistency or set times.

413.10.4.4 Water
413.10.4.4.1 The water shall be potable, free of harmful soluble salts, and shall be added in an amount to provide proper consistency.

413.10.4.5 Set-control Agent

413.10.4.5.1 To improve workability a set-control agent that is approved by the Engineer, and will not adversely affect the micro-surfacing, shall be used. The set-control agent (Ralumac or an approved equal) must be included as part of the mix design and be compatible with the other components of the mix. The use of set-control additive shall not vary ±1% of the additive optimum recommended in the highest temperature mix test in the mix design.

413.10.4.6 Polymer Modifier

413.10.4.6.1 An approved polymer based modifier that consists of natural latex shall be milled into the asphalt emulsion. This additive shall allow the micro-surfacing mixture to cure sufficiently so that normal traffic can be permitted in one hour after placement of the micro-surfacing mixture, without damage to the new surface.

413.10.4.7 Composition of Micro-Surfacing Mixtures

413.10.4.7.1 Mix Design. At least 14 calendar days before micro-surfacing placement commences, the Contractor shall submit to the Engineer for approval, a dated laboratory report of tests and a proposed mix design. The date of the mix design will reflect that tests were performed no longer than 30 days prior to the start of paving construction. The recommended percentages of each individual material required shall be shown in the laboratory report. Adjustments of water and set-control agent by the Engineer may be required during construction based on field conditions. The Engineer shall approve the design mix and all micro-surfacing materials and methods prior to use and shall designate the proportions to be used within the following limits:

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual Asphalt</td>
<td>6% to 9% by dry weight of aggregate</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1% to 3% by dry weight of aggregate</td>
</tr>
<tr>
<td>Latex-based Modifier</td>
<td>3.0% to 5.0% natural latex solids based on mass of asphalt</td>
</tr>
<tr>
<td>Water</td>
<td>As required to produce proper specified properties</td>
</tr>
<tr>
<td>Set-control Agent</td>
<td>Engineer approved system to provide one hour set</td>
</tr>
</tbody>
</table>

413.10.4.7.2 The mix design shall be performed by a laboratory capable of performing all of the current applicable International Slurry Surfacing Association (ISSA) tests at one location. The Engineer may disqualify any mix design submitted by any laboratory whose capability or experience with micro-surfacing cannot be verified. The proposed latex-modified slurry seal mixture to be used for this project shall conform to the requirements specified when tested in accordance with the following tests:

<table>
<thead>
<tr>
<th>ASTM TEST</th>
<th>DESCRIPTION</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 3910</td>
<td>Consistency Test</td>
<td>2-3 cm</td>
</tr>
<tr>
<td>D 3910</td>
<td>Cure time</td>
<td>1 hour maximum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ISSA TEST</th>
<th>DESCRIPTION</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 139</td>
<td>Wet Cohesion 30 minutes (set time) 60 minutes (traffic time)</td>
<td>12 kg-cm minimum 20 kg-cm min. (Or near spin)</td>
</tr>
<tr>
<td>TB 109</td>
<td>Excess Asphalt</td>
<td>538 g/m² (50 g/ft²) maximum</td>
</tr>
<tr>
<td>TB 114</td>
<td>Wet Stripping</td>
<td>Pass (90% minimum)</td>
</tr>
<tr>
<td>TB 100</td>
<td>Wet Track Abrasion One hour soak, loss</td>
<td>538 g/m² (50 g/ft²) maximum</td>
</tr>
</tbody>
</table>
### 413.10.4.7.3

The mix design report shall be reported on the testing laboratory’s letterhead, signed by a manager of the laboratory that performed the tests and shall show the results of each of the required tests compared to the specification values. The Contractor name, Saint Charles County project name and number, date and time of collection and location of sample collection shall be noted on the report. Any test values out of specification shall be clearly noted. The report shall clearly state a recommendation of the proportions of the mineral aggregate, mineral filler, water (minimum and maximum), set-control additive (minimum and maximum), and asphalt solids content (minimum and maximum) based on the dry weight of the mineral aggregate. The laboratory shall also report the quantitative effects of moisture content on the unit weight of the mineral aggregate (bulking effect).

### 413.10.4.7.4 Bulk Specific Gravity

413.10.4.7.4.1 The Bulk Specific Gravity (BSG) of the final combined mineral aggregate shall be determined and shown as part of the mix design for an application rate of 18 pounds per square yard of the dry mass of the combined mineral aggregate. If the BSG is different from 2.65 by more than 0.5, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiply by the new BSG. For example, for a new BSG = 3.15, the new minimum application rate would be 1.15 (18 / 2.65) = 21.4 pounds per square yard. These adjusted values shall be designated on the mix design and shall then be applied in the field.

413.10.4.7.4.2 For roads requiring a micro-surfacing material application rate specified in Sec 413.10.2.2, the Bulk Specific Gravity (BSG) of the final combined mineral aggregate shall be determined and shown as part of the mix design for an application rate of 15 pounds per square yard of the dry mass of the combined mineral aggregate. If the BSG is different from 2.65 by more than 0.5, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiply by the new BSG. For example, for a new BSG = 3.15, the new minimum application rate would be 1.15 (18/2.65) = 21.4 pounds per square yard. These adjusted values shall be designated on the mix design and shall then be applied in the field.

413.10.4.7.5 The mix design will further show recommended changes in Portland cement, water and additive proportions for high temperature weather conditions by reporting proportions of materials required for 120 seconds of mix time with materials heated to 100°F. This elevated temperature mixing report will not be required for night time application nor application where either cool, foggy or overcast conditions will prevent high temperature mixing problems.

413.10.4.7.6 All of the component materials used in the mix design shall be representative of the materials to be used on the project. Once the proportions of materials to be used are approved by the Engineer, no substitutions of other materials will be permitted, unless the materials proposed for substitution are first tested and a laboratory report is submitted for design approval by the Engineer as specified above. Substituted materials shall not be used until the mix design for those materials is approved by the Engineer.

### 413.10.5. Material Sampling and Testing Responsibilities

413.10.5.1. The Contractor shall submit to the Engineer samples from all suppliers furnishing a minimum of the following materials with corresponding Material Safety Data Sheets (MSDS) sheets:

1 gallon of the base asphalt

2 pints of the polymer additive (with clear labeling of the polymer type)

1 gallon of the asphaltic emulsion
100 pounds of combined micro-surfacing mineral aggregate

50 pounds of each parent mineral aggregate

6 pounds of mineral filler (with supplier label)

413.10.5.2 Extractions of the latex-modified slurry seal shall be made by the Engineer for every 5th day of material placed, starting on the first day or as directed by the Engineer. The sampling and testing of the latex-modified slurry seal by the Engineer will result in a report submitted to the Contractor after the lab has tested the samples. Failure to comply with this requirement shall result in the immediate stoppage of work. Failure of a test report may require removal of material placed or non-payment for the area represented by the test, as directed by the Engineer. Laboratory testing report shall be in accordance with Sec 413.10.4.7.3 of this provision and will determine:

Tests on emulsion / residue as per Sec 413.10.4.1.4

Tests on mineral aggregate: Sieve Analysis as per Sec 413.10.4.2.2

413.10.5.3 Copies of all material load tickets and certified test reports shall be given to the Engineer. A certified analysis (test report) of emulsified asphalt shall accompany each shipment of emulsion to the Contractor, and the exact residual asphalt cement content of each tanker shall be plainly marked on the load tickets.

413.10.5.4 The Contractor shall furnish to the Engineer an aggregate moisture determination for the stockpile prior to placing the micro-surfacing. This shall be re-tested on delivery of new aggregate to the stockpile or if weather conditions have changed the aggregate moisture content appreciably. Aggregate moisture will be accounted for in determining the aggregate/bitumen ratio to be used during placement.

413.10.5.5 Copies of a daily control log kept in accordance with ISSA Technical Bulletin No. 107 shall be given to the Engineer before start of the next day's production, or as otherwise directed by the Engineer. The log shall contain tons of dry aggregate consumed that day, tons of asphalt emulsion consumed that day and square yardage covered that day.

413.10.6 Mixing Equipment. The machine shall be specifically designed and manufactured to lay micro-surfacing. The material shall be mixed by an automatic sequenced, self-propelled micro-surfacing mixing machine, which shall be a continuous flow mixing unit, able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive and water to a revolving multi-blade double shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive and water to maintain an adequate supply to the proportioning controls.

413.10.6.1 Belt feeder. The aggregate feed to the mixer shall be proportioned using a belt feeder that shall be equipped with a working revolution counter or similar device so that the amount of aggregate used may be determined at any time. The belt feeder shall be operated with an adjustable cutoff gate. The height of the gate opening shall be readily determinable. The belt delivering the aggregate to the pugmill shall be equipped with a device to monitor the depth of aggregate being delivered to the pugmill. Said device for monitoring depth of aggregate shall automatically shut down the power to the aggregate belt feeder whenever the depth of aggregate is less than the target depth of flow. A second device shall be located where it will monitor movement of the aggregate belt by detecting revolution of the belt feeder. The device for monitoring no flow or belt movement, as may be the case, shall automatically shut down the power to the aggregate belt when aggregate belt movement is interrupted. This second device will not be required where the aggregate delivery belt is an integral part of its drive chain. To avoid erroneous shutdown by normal fluctuation, a delay of 3 seconds between sensing and shutdown of the operation will be permitted.
413.10.6.2 **Positive Displacement pump.** The emulsion shall be proportioned by a positive displacement type pump. The pump shall be equipped with a functional revolution counter or similar device so that the amount of emulsion used may be determined at any time.

413.10.6.3 **Calibration of mixer-spreader truck.** The delivery rate of mineral aggregate and emulsion per revolution of the aggregate feeder shall be calibrated at the appropriate gate settings for each mixer-spreader truck used on the project. The calibration shall demonstrate that the delivery rates of dry aggregate and emulsion residue are within the recommended percentages stated in the laboratory mix design. The procedures for calibration of microsurfacing equipment shall be as recommended by the current edition of ISSA publication MA-1 "ISSA Inspector’s Manual".

413.10.7 **Rate Check-run**

413.10.7.1 **Aggregate belt feeder.** The aggregate belt feeder shall deliver aggregate to the pug mill with such volumetric consistency that the deviation for any individual aggregate delivery rate check-run shall not exceed 2.0 percent of the mathematical average of three runs of at least 3 tons in duration each.

413.10.7.2 **Emulsion Pump.** The emulsion pump shall deliver emulsion to the pugmill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of three runs of at least 300 gallons each in duration.

413.10.7.3 **Water Pump.** The water pump shall deliver water to the pugmill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of three runs of at least 300 gallons each in duration.

413.10.8 **Emulsion Storage**

413.10.8.1 The emulsion storage located immediately before the emulsion pump shall be equipped with a device which will automatically shut down the power to the emulsion pump and aggregate belt feeder when the emulsion level is lowered sufficiently to expose the pump suction line.

413.10.8.2 A temperature-indicating device shall be installed in the emulsion storage tank at the pump suction level. The device shall indicate temperature of the emulsion and shall be accurate to within 5°F. The maximum temperature of emulsion contained in the mixer-spreader truck emulsion storage tank shall be 120°F. In cases where cool, damp weather conditions are prevalent or night time work is performed, this maximum temperature may be increased to 140°F as directed by the Engineer.

413.10.9 **Mixing and Spreading Equipment**

413.10.9.1 **Mixer-Spreader Trucks**

413.10.9.1.1 The micro-surfacing shall be mixed in pugmill mixers of adequate size and power for the type of microsurfacing to be placed.

413.10.9.1.2 Mixer-spreader truck shall be equipped to proportion the mineral aggregate, Portland cement mineral filler, water, set-control additives and emulsified asphalt by weight, to a revolving multi-blade dual mixer, and discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for mineral aggregate, emulsified asphalt, Portland cement mineral filler, water and set-control additive to maintain an adequate supply to the proportioning controls. The machine shall be continuous-loading and be operated in that manner. All rotating and reciprocating equipment on mixer-spreader trucks shall be covered with metal guards. The paddles or augers shall be designed and operated so all fresh mix will be agitated and to create a turbulence or laminar flow.
to prevent the mixture from setting up in the box, causing side build-ups and lumps. Mobile mixers may be used on streets if approved by the Engineer.

413.10.9.1.3 The mixing machine shall be equipped with a water pressure system and a nozzle type spray bar, in good working condition, to provide a uniform water spray to dampen the surface when required immediately ahead of and outside the spreader box. No free-flowing water shall be present.

413.10.9.1.4 The mixer-spreaders truck shall not be operated unless all low-flow and no-flow devices and revolution counters are in good working condition, functioning and all metal guards are securely in place. All indicators required by these specifications shall be visible while walking alongside mixer-spreaders truck.

413.10.9.1.5 Mineral aggregate feeders shall be connected directly to the drive on the emulsion pump. The drive shaft of the aggregate feeder shall be equipped with a revolution counter that is in good working condition and reads to the nearest one-tenth of a revolution of the aggregate delivery belt.

413.10.9.1.6 The identification number of mixer-spreaders trucks shall be at least 2 inches in height and located in the front and rear of the vehicle.

413.10.9.1.7 At least 2 operational spreaders shall be available at the job during the spreading operation except when continuous placement type mixer-spreaders trucks are used.

413.10.9.1.8 When construction is being performed under traffic, all equipment, including loading vehicles and supply trucks will be required to operate in a single lane on which the micro-surfacing is being applied. The Contractor's equipment for micro-surfacing shall be operated in such a manner that will permit traffic to move safely and expeditiously through and around the work area.

413.10.10 Spreader Boxes

413.10.10.1 The micro-surfacing mixture shall be spread by means of one of the following controlled spreader box configurations conforming to the following requirements:

413.10.10.1.1 Full Width Spreader Box. The full width spreader box shall be capable of spreading a traffic lane width and shall have strips of flexible rubber belting or similar material on each side of the spreader box. The box shall be in contact with the pavement to positively prevent the loss of micro-surfacing from the ends of the box and shall be equipped with devices to adjust thickness or grade of the surface. All spreader boxes over 7.5 feet in application width shall have baffles, reversible motor driven augers, or other suitable means, to insure uniform application on super-elevated sections and shoulder slopes. Spreader box skids shall be maintained in such a manner as to prevent transverse chatter (wash boarding), tearing or shoving in the finished mat or the mat adjacent to the box. Rear flexible strike-off blades shall make close contact with the pavement, shall be designed and operated to achieve a uniform consistency that provides a free flow of material to the rear strike-off without causing skips, lumps, or tears in the finished surface. A secondary rubber strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same leveling adjustments as the spreader box.

413.10.10.1.2 Wheel Path Depression (Rut) Box. The wheel path depression box shall be designed as a double chambered box with adjustable screeds to regulate depth and shall be either 5 feet or 6 feet in width. Hydraulic augers set at a 45 ("V") degree angle shall move the mixed material from the rear to the front of the filling chamber. The augers shall push the larger aggregate into the center, deeper section of the wheel path depression and send the fine material toward the edges of the pass to act as a mastic and for feathering down the longitudinal joint along the wheel path.

413.10.10.1.3 Spreader Box Maintenance. The micro-surfacing spreader box in use shall be clean at the start of each work shift. The box shall be cleaned as needed or as directed by the Engineer to prevent excessive broken
micro-surfacing from accumulating on the spreader box and adversely affect surface texture during application. A rubber squeegee shall be attached to the adjustable metal plate at the rear of the spreader box, behind the second strike-off, to texture the surface. All strike-off blades (rubber and steel) shall be cleaned or replaced at any time problems with cleanliness and longitudinal scouring occur.

413.10.11 Material Stockpiling and Storage

413.10.11.1 Aggregate Storage. If the mineral aggregates are stored or stockpiled, they shall be handled in such a manner as to prevent segregation, mixing of the various material, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. Suitable equipment of acceptable size shall be furnished by the Contractor to work the stockpiles and prevent segregation and excessive breakdown of mineral aggregates. The aggregate shall be passed over a scalping screen, provided by the Contractor, prior to transfer to the micro-surfacing mixing machine to remove oversize material.

413.10.11.1.1 The Contractor’s material and equipment may be stored at designated area within a County’s maintenance facility, as directed by the Engineer. Equipment and materials shall not be stored on the public road right-of-way.

413.10.11.2 Asphaltic Material Storage. The asphaltic material storage shall be ample to meet the requirements of the plant. All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter. The storage stability test may be waived provided the asphalt emulsion storage tank at the project site has adequate provisions for circulating the entire contents of the tank, and provided satisfactory field results are obtained.

413.10.12 Construction Methods.

413.10.12.1 Weather Limitations.

The micro-surfacing mixture shall be spread only when:

1. the ambient air temperature is between 60°F and 100°F at the job site.

No mixture shall be placed when:

1. the pavement temperature is 50°F or below,

2. when the ambient air temperature forecast high (as per the National Weather Service) is 65°F or below,

3. when there is a forecast of temperatures (as per the National Weather Service) below 40°F within 24 hours after mix placement,

4. when the relative humidity is above 80 percent,

5. when it is foggy,

6. when it is raining, or as

7. directed by the Engineer.

413.10.12.2 Seasonal Limitations. The micro-surfacing mixture shall not be constructed before April 15th or after September 15th without written approval of the Engineer.
413.10.12.3 Test Strip. Prior to the application of the micro-surfacing mixture, the Contractor shall place a test strip, at a location established by the Engineer, to demonstrate the compatibility of the modified emulsion and the mineral aggregate under field conditions. This test strip shall also be used to demonstrate mix uniformity and compliance of the mix to the requirements of proportioning of the asphalt, mineral aggregate, mineral filler, polymer modifier, set-control agent and water. The test strip shall be at least 500 feet in length, and the width of one lane and shall consist of the application courses specified in the contract. The test strip shall be conducted at the same time of day or night the full production will be applied, in the presence of the Engineer, at least 48 hours prior to the Contractor's intended start-up date. The Engineer shall evaluate the test strip 24 hours after its placement to determine that the mix design and materials are acceptable. A new test strip shall be performed when the test strip is deemed unacceptable, a change in the mix design become necessary or as directed by the Engineer. The establishment of a test strip will be considered incidental, however the approved test strip will be measured and paid for in accordance with the contract provisions for the actual square yards of micro-surfacing placed. Failure of the test strip shall require the Contractor to completely remove the test strip with no compensation for the labor, equipment or material to place, remove or properly dispose of the failed test strip. Method or equipment substitutions used and approved by the Engineer in the test strip, shall be used in field production.

413.10.12.4 Resident Notification. The Contractor shall be responsible for prior notification of residents for no parking on streets during micro-surfacing operations. Temporary "No Parking" signs noting the time and date of construction activity shall be provided and installed by the Contractor at maximum intervals of 100 feet, 24 hours in advance of work. Should the work not occur on the specified day, a new notification will be distributed by the Contractor. The Contractor shall distribute letters of notification (to residents) with the phone number of their representative who has authority for correction of concerns that residents may have. Signs shall be removed and disposed of by the Contractor at the end of the operation on that street. No additional compensation will be allowed for delays or inconveniences when parked vehicles are encountered.

413.10.12.5 Surface Preparation. Immediately prior to placement of the micro-surfacing mixture, the Contractor shall furnish the proper labor, equipment, materials and small tools to clean the pavement thoroughly and remove all vegetation, loose materials, dirt, mud and other objectionable material that may prevent adhesion of the micro-surfacing to the existing pavement surface and then prewet as required. An Engineer approved power broom shall be used in advance of the micro-surfacing operation. The broom shall have plastic bristles, an approved suction area and enough air velocity in the nozzles to pick up and remove the above debris. A power blower shall immediately precede the slurry laydown unit.

413.10.12.5.1 Potable water used in pre-wetting the surface ahead of the spreader box and shall be applied at such a rate that the entire surface shall be damp and free of ponding or free-flowing water.

413.10.12.5.2 Utility covers, manholes, grated inlets, curb inlets and traffic device covers located in the roadway to be paved shall be protected from coverage by the micro-surfacing and referenced for prompt location and cleaning following application. The Contractor shall be responsible for covering, locating, removing and cleaning of these items following the micro-surfacing application operation. The methods used to protect, reference, locate and clean shall be submitted by the Contractor and shall be subject to approval by the Engineer. All such materials shall be removed and properly disposed of by the Contractor after the surfacing material has cured. The above items shall be cleaned to their pre-surfacing condition or as directed by the Engineer.

413.10.12.3 All existing thermoplastic pavement striping, stop bars and turn arrows in conflict with the micro-surfacing paving operation shall be completely removed and paid for in accordance with items contained in this contract. The areas where striping and markings have been removed shall be lightly coated with 0.05 Gal/s.y. SS-1h Tack before placement of the micro-surfacing on those areas. The tack shall be allowed to cure sufficiently before the application of micro-surfacing. The cost for this is incidental to the removal of the thermoplastic striping and markings. Thermoplastic removal shall be scheduled by the Contractor, 48 hours in advance of paving to allow traffic division personnel time to mark the pavement for removal.
413.10.12.5.4 The Engineer shall approve all surface preparation prior to application of the micro-surfacing.

413.10.12.6 Spreading of Mixture. The micro-surfacing shall be homogeneous during and following mixing and spreading. It shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate. A sufficient amount of materials shall be carried to all parts of the spreader at all times so that complete coverage is obtained. Over loading the spreader box shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. Under no circumstances shall water be sprayed directly into the lay-down box during application of micro-surfacing.

413.10.12.6.1 The mixture shall be uniform and homogeneous after spreading on the surfacing and shall not show separation of the emulsion and aggregate after setting. Streaks, such as those caused by oversized aggregate, shall be avoided. If excess streaking develops, the job will be stopped by the Engineer until the Contractor can demonstrate that the occurrence has been eliminated. Excessive streaking is defined as: more than 4 drag marks greater than one-half inch wide and/or 4 inches long; or 1 inch to 3 inches long in any 27.3 yd.² area. No transverse ripples or longitudinal streaks in excess of one-quarter inch will be permitted when measured by placing a 10 foot straight edge over the surface.

413.10.12.6.2 Micro-surfacing to be spread in areas inaccessible to the spreader box shall be surfaced using approved hand squeegees to provide complete and uniform coverage. If necessary, the area to be hand worked shall be lightly dampened with potable water prior to mix placement. Care shall be exercised to leave no unsightly appearance from hand work. The same type of finish as applied by the spreader box shall be required.

413.10.12.6.3 Micro-surfacing shall not be applied over steel expansion plates or bridge decks, unless directed by the Engineer.

413.10.12.6.4 All excess material that overruns in gutters, on curbs, inlet tops, or on sidewalks shall be removed immediately or squeegeed back onto the surface. All excess material removed from any non-paved area and from the ends of each job site shall be removed immediately. Discolored curbs, inlets and sidewalks shall be immediately cleaned and flushed before the material sets. Any set material left in place will be removed by sand blasting, by the Contractor, as directed by the Engineer.

413.10.12.6.5 Work at intersections shall be done in stages, or blotter materials shall be used, to allow crossing and turning movements. The blotting material shall be the same aggregate used in the micro-surfacing and shall be removed by the Contractor when designated by the Engineer. Regardless of the method chosen by the Contractor and approved by the Engineer, no marred or streaked sections in excess of that defined in Sec 413.10.12.6.1 will be allowed.

413.10.12.6.6 Pneumatic Rolling. If a section of pavement is not going to be exposed to traffic within 48 hours, it shall be compacted with a pneumatic tire roller after curing. This pneumatic tire roller shall have a tire pressure of 40 to 60 psi.

413.10.13 Wheel Path Depressions (Ruts)

413.10.13.1 When wheel path depressions have a cross section that is deformed one inch or more, the individual wheel paths shall be first filled utilizing a wheel path depression (rut) box before the final surface course is placed.

413.10.13.1.1 When required on the plans or as directed by the Engineer, but before the final surface course is placed, preliminary micro-surfacing material shall be required to fill ruts, utility cuts, depressions in the existing surface, etc. Wheel path depression spread rates will vary with depression depth. Maximum single application for wheel path depressions shall be three-quarters inch in depth, or 30 pounds per square yard as directed by the Engineer. Greater depths may require multiple applications in each depression.
413.10.13.1.2 Wheel path depression repair shall be constructed with a slight crown to permit initial traffic compaction of the micro-surfacing. Generally, the depression should be crowned by one-eighth to one-quarter of an inch per inch of wheel path depression to allow for compaction under traffic. Excessive crowning (over-filling) shall be avoided.

413.10.13.1.3 At least 24 hours of traffic compaction shall be allowed on freshly filled wheel path depressions before additional lifts are applied.

413.10.13.2 If rutting peaks extend more than one-half inch above the existing pavement, they should be milled down at or just below existing pavement surface prior to rut filling and shall be in accordance with Sec 413.10.12.5.4 of this provision.

413.10.14 Paving Courses

413.10.14.1 Irregular surfaces or pavements with wheel path deformations of less than one-half inch shall require two full width box applications of micro-surfacing. On the County Road System, the application of 1 lift of 18 pounds of dry aggregate per square yard of the dry mass of the combined aggregate will be required. For applications requiring 2 lifts per Sec 413.10.2.2, 2 lifts of 15 pounds per square yard of the dry mass of the combined aggregate will be required. The completed spread rate shall be ±10% of these rates.

413.10.14.2 Adequate means shall be provided by the Contractor to protect the micro-surfacing from damage by traffic until such time that the mixture has cured sufficiently so that the micro-surfacing mixture will not adhere to and be picked up by the tires of vehicles.

413.10.15 Seams and joints.

413.10.15.1 No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The Contractor shall provide suitable spreading equipment to produce a minimum number of longitudinal joints throughout the project. Half passes and odd width passes will be used only in minimum amounts. If half passes are used, they shall not be the last pass of any paved area.

413.10.15.1.1 Any necessary longitudinal or transverse joints in underlying layers shall be constructed in accordance with Sec 401.7.6.

413.10.15.2 Whenever possible the longitudinal joints shall be placed on the lane lines, staggering the underlaying joints by 6 inches. The Engineer may permit the Contractor to use other patterns of longitudinal joints, if such patterns will not adversely affect the quality of the finished product.

413.10.15.3 Longitudinal joints common to two driving lanes, shall not overlap more than three inches. The resultant joint shall present an elevation difference between driving lanes that is less than one-quarter inch when measured by placing a 10 foot straight edge over the joint and measuring the elevation drop off. If the Engineer determines that this is exceeded or that the seam is rough enough to cause a noticeable effect on steering of an automobile, the seam shall be removed, and new micro-surfacing patch shall be applied by the Contractor. No additional payment shall be granted for this repair.

413.10.16 Workmanship

413.10.16.1 Edge lines and joints shall be uniform and parallel, radial or perpendicular with the centerline of the roadway. Lines at and through intersections and tapers shall be kept straight and uniform in appearance. The Engineer may require the Contractor use a string line or other methods to achieve this. Edge lines should not vary by more than +/-2 inches horizontal variance in any 100 feet of length.
413.10.16.2 Micro-surfacing material required to repair deficiencies due to unsatisfactory workmanship, as determined by the Engineer, shall not be paid for but shall be entirely at the Contractor's expense.

413.10.17 Patching

413.10.17.1 Patching of damaged micro-surfacing surface shall be made with any of the above described methods. The patch repair shall be made in the same direction as the paver was traveling.

413.10.18 Method of Measurement

413.10.18.1 Although all materials are required to be measured for quality control purposes, the method of measurement for the bid item "Micro-surfacing", complete and acceptably in place, including any multiple passes or courses will be made to the nearest square yard. Linear measurements to determine the square yardage of surface area shall be made to the nearest one foot. Measurement of individual passes or courses will not be made. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Appreciable error shall be defined as 2 percent of the total contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

413.10.19 Basis of Payment

413.10.19.1 The accepted quantity of latex-modified asphalt emulsion slurry seal as provided above in the Method of Measurement, shall be paid for at the contract unit price per square yard for Micro-surfacing. This contract price shall include full compensation for furnishing all labor, materials, tools and equipment for: quality control sampling, testing and mix design; for preparation of the road surface; for supplying, installing and removing temporary “No Parking” signs; for transporting, mixing, applying, blotting (furnishing, placing and removal of material), general clean-up; and other incidentals necessary to complete and warrant the job as specified herein.

413.10.19.2 Traffic Control Devices in accordance with Sec 616 of the County’s Specifications will consist of furnishing, constructing and maintaining traffic control and safety devices as directed by the Engineer, shown on the plans or included in the construction contract, addendums or specifications. The accepted quantities for furnishing, installing, maintaining and removing the contract traffic control devices specified, will be paid for at the unit prices bid for each item in the contract.

References:

International Slurry Surfacing Association
1200 19th Street, N.W., Suite 300
Washington, D.C. 20036-2422
Phone: 1-202-857-1160
Fax: 1-202-223-4579
MICRO-SURFACING (QUALITY CONTROL)
INSPECTOR’S MANUAL

Reed and Graham Laboratory Services
550 Sunol Street
San Jose, California 95126
Phone: 1-408-287-7722
POLYMER MODIFIED SLURRY SEAL
SPECIFICATION GUIDELINE WITH
MATERIALS QUALITY CONTROL PROVISION
SECTION 413.20 ASPHALT SURFACE TREATMENT

413.20.1 Description. This work shall consist of furnishing and applying a surface sealing treatment to the existing roadway as shown on the plans. The surface treatment shall contain a mixture of cationic asphalt emulsion, latex polymer, fine aggregate, water, and other additives as needed.

413.20.2 Mix Design

413.20.2.1 At least 30 days prior to placing the surface sealing treatment on the project, the contractor shall submit a mix design for approval to the Engineer. One gallon of the asphalt emulsion and 2500 grams of each aggregate material comprising the combined gradation shall be submitted with the mix design.

413.20.2.2 Required Information. At a minimum the Surface Sealing mix design shall contain the following information on the job mix formula:

(a) Emulsified asphalt source and properties required.

(b) Fine aggregate source, Acid Insoluble Residue (AIR) results, absorption, and deleterious requirements required.

(c) Blended aggregate gradation required.

(d) Mixture performance test results required.

(e) Additives and their sources required.

413.20.2.3 Mix Design Gradation Requirement. The fine aggregate, mastic materials such as mineral filler, and/or other additives that comprise the combined gradation shall have 100% of the material passing the No. 8 (2.36 mm) sieve. For spraying applications, the following mix gradation shall be required:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 30 (600 μm)</td>
<td>85-100</td>
</tr>
<tr>
<td>No. 50 (300 μm)</td>
<td>40-70</td>
</tr>
<tr>
<td>No. 100 (150 μm)</td>
<td>30-65</td>
</tr>
<tr>
<td>No. 200 (75 μm)</td>
<td>25-60</td>
</tr>
</tbody>
</table>

413.20.2.4 Mixture Performance Requirements. The mixture shall meet the following requirements.

<table>
<thead>
<tr>
<th>Testing Requirement</th>
<th>Min.</th>
<th>Max.</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Wet-Track Abrasion Loss, grams per square meter.</td>
<td>--</td>
<td>80 g/m²</td>
<td>TB 100 (ISSA) Modified&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Asphalt Content by Ignition Method, percent</td>
<td>30%</td>
<td>--</td>
<td>AASHTO T-308-08&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Percent Solids, Asphalt Residue by Evaporation, percent</td>
<td>48%</td>
<td>--</td>
<td>AASHTO T59, Section 6</td>
</tr>
</tbody>
</table>

<sup>a</sup>This method is modified to a three day soak and samples prepared per MoDOT TM 86.

<sup>b</sup>To account for high percentage of binder, sample size should be adjusted based on laboratory oven capability.
413.20.2.5 **Required Additives.** A minimum of 3% latex polymer by weight of wet mixture is required in the surface sealant treatment and shall be listed in the job mix formula.

413.20.2.6 **Other Additives.** Any other material added to the mixture or to any of the component materials shall be listed in the job mix formula.

413.20.3 **Material Certification.**

413.20.3.1 The materials used in the mix design shall be certified to meet the following specifications.

413.20.3.2 **Bituminous Material.** The bituminous material shall be an asphalt emulsion in accordance with the following table. The bituminous material shall show no separation after mixing. The emulsion shall be sampled in accordance with AASHTO T 40.

<table>
<thead>
<tr>
<th>Asphalt Emulsion (CSS)</th>
<th>Min.</th>
<th>Max.</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 25°C, s</td>
<td>15</td>
<td>100</td>
<td>AASHTO T 72</td>
</tr>
<tr>
<td>Particle charge test</td>
<td>Positive&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Residue, %</td>
<td>60</td>
<td>--</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Test on Residue from Distillation</td>
<td>Min.</td>
<td>Max.</td>
<td>Test Method</td>
</tr>
<tr>
<td>Penetration, 25°C, 100 g, 5 s,</td>
<td>30</td>
<td>100</td>
<td>AASHTO T 49</td>
</tr>
</tbody>
</table>

<sup>b</sup> If the particle charge test is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

413.20.3.3 **Noncarbonated Fine Aggregate Requirement.** The fine aggregate material (not including mastic material or additives) shall contain 100 percent non-carbonate aggregate. The fine aggregate material shall have an acid insoluble residue (AIR), MoDOT Test Method TM 76, of at least 75 percent insoluble residue.

413.20.3.4 **Absorption and Deleterious Requirement.** The absorption of the fine aggregate (not including mastic material or additives) shall have a maximum absorption limit of 2.0 percent tested in accordance with AASHTO T84. The percentage of deleterious substances shall not exceed the following values in accordance with AASHTO T113:

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps</td>
<td>1.0</td>
</tr>
<tr>
<td>Total lightweight particles, including coal and lignite</td>
<td>0.5</td>
</tr>
<tr>
<td>Other deleterious substances</td>
<td>0.1</td>
</tr>
</tbody>
</table>

413.20.3.5 Lightweight fine aggregate sources not meeting the absorption limits or deleterious requirements of Section 3.4 above shall be in accordance with the following requirements tested on the parent material:

<table>
<thead>
<tr>
<th>Property</th>
<th>Percent Maximum Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro-Deval, ASTM D7428, percent, max</td>
<td>20</td>
</tr>
<tr>
<td>Los Angeles Abrasion for Lightweight Aggregate, MoDOT Test Method TM 78, percent, max</td>
<td>50</td>
</tr>
</tbody>
</table>

413.20.3.6 **Water.** Water shall be potable and free of harmful soluble salts.

413.20.4 **Construction Requirements.**
413.20.4.1 The surface sealing mixture may be mixed and applied through mobile distribution equipment as described herein.

413.20.4.2 **Mixing Equipment.** All materials shall be thoroughly mixed as to produce a homogenous surface treatment. Individual volume or weight controls for proportioning each material in the mix shall be provided. Materials shall be added by a calibrated controlled device capable of monitoring the amount of material used at the time.

413.20.4.3 **Distribution Equipment.** The Distributor shall be equipped with a full sweep agitation system, a pumping system designed to handle fine aggregate mixes, and sufficient power to operate the full spray system and the agitation system at the same time. The Distribution equipment shall be equipped with a monitoring system that ensures the even distribution of material and measures the application rate of the mix.

413.20.4.4 **Storage Tanks.** If the mix is being delivered from a central mixing plant, then a job site storage tank shall have the minimum capacity of the entire transport load. The storage tank shall have an internal full sweep mixing system having a mixing capability of providing a homogenous mix representing the mix design at any given location within the tank.

413.20.4.5 **Environmental Protection.** The Contractor shall comply with all federal, state, and local laws and regulations controlling pollution of the environment.

413.20.4.6 **Weather Limitations.** Bituminous material shall not be placed on any wet surface or when the ambient temperature or the temperature of the pavement on which it is to be placed is below 60°F. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.20.4.7 **Surface Preparation.** The surface shall be thoroughly cleaned immediately prior to placing the surface treatment.

413.20.4.8 **Protection of Other Surfaces.** All curbs, manhole covers, and ADA facilities shall be protected from the spray or laydown of the bituminous mixture during placement.

413.20.4.9 **Dilution.** The bituminous material shall not be diluted in the field with water or other additives except as approved by the manufacturer.

413.20.4.10 **Placement.** Placement of the mix shall be performed in two passes with a minimum coverage of 0.125 gal/yd² per pass and the minimum total coverage of 0.25 gal/yd². Contractor shall provide a mat ensuring total coverage free of voids and pit holes.

413.20.4.11 **Opening to Traffic.** After the sealant application, the roadway shall remain closed until the surface is tack-free and capable of being open to traffic without tracking.

413.20.5 **Basis of Acceptance.**

413.20.5.1 **Field Performance.** The finished surface sealant treatment shall be evaluated by the engineer based on the following criteria. Any of the following shall be considered unacceptable material.

(a) The presence of loose aggregate or synthetic materials that may cause damage to traveling vehicles.

(b) A final surface with insufficient coverage or delamination.
413.20.6 Method of Measurement. Final measurement of the surface treatment will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of the surface treatment, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

413.20.7 Basis of Payment. The accepted quantity of surface treatment, in place, will be paid for at the contract unit (square yard) price. No separate payment will be made for any additional construction methods or processes. The Contractor shall report the unit weight (lbs/gallon) of the surface sealing material on the bill of lading.

SECTION 413.30 ULTRATHIN BONDED ASPHALT WEARING SURFACE.

413.30.1 Description. This work shall consist of producing and placing an ultrathin bonded asphalt wearing surface.

413.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows, except as modified herein:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate</td>
<td>1002.2</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1002.3</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1002.4</td>
</tr>
</tbody>
</table>

413.30.2.1 Coarse Aggregate. Coarse aggregate may consist of crushed gravel, limestone, dolomite, porphyry, steel slag, flint chat, or blends of two or more of these aggregates will be acceptable. When coarse aggregate for these mixes are from more than one source or of more than one type of material, the coarse aggregate shall be proportioned and blended to provide a uniform mixture. Coarse aggregate shall be material predominantly retained above the No. 4 sieve and shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Coarse Aggregate Modified Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
</tr>
<tr>
<td>Los Angeles Abrasion Value, % Loss</td>
</tr>
<tr>
<td>Soundness, % Loss, Sodium Sulfate a</td>
</tr>
<tr>
<td>Flat &amp; Elongated Ratio, % @ 3:1 b</td>
</tr>
<tr>
<td>% Crushed, single face b</td>
</tr>
<tr>
<td>% Crushed, two faces b</td>
</tr>
<tr>
<td>Micro-Deval, % loss a</td>
</tr>
</tbody>
</table>

a Tests shall be determined on each individual ledge basis.
b Tested on the coarse portion of the blended aggregate

413.30.2.2 Fine Aggregate. Fine aggregate shall be material predominantly passing the No. 4 sieve and shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Fine Aggregate Modified Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests</td>
</tr>
<tr>
<td>Sand Equivalent a</td>
</tr>
<tr>
<td>Methylene Blue a</td>
</tr>
<tr>
<td>Uncompacted Void Content a</td>
</tr>
</tbody>
</table>

a Tested on the fine portion of the blended aggregate
413.30.2.3 Reclaimed Asphalt Pavement. The RAP shall be in accordance with Sec 401.2.2 and shall have 100 percent passing the 3/8 inch and no less than 70 percent passing the No. 4 sieve. The mixture shall contain no less than 80 percent effective virgin binder.

413.30.2.4 Asphalt Binder. The asphalt binder shall be in accordance with Sec 1015, including all subsections pertaining to PG76-22 or PG70-28.

413.30.2.5 Polymer Modified Emulsion Membrane. The emulsion shall be polymer modified and shall be in accordance with Sec 1015.

413.30.3 Job Mix Formula. At least 30 days prior to placing any mixture on the project, the Contractor shall submit a mix design to Engineer for approval. Representative samples from each ingredient for the mix shall be submitted with the mix design.

413.30.3.1 Proficiency Sample Program. Laboratories that participate in and achieve a score of three or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304 (ASTM C 1252), T 308 and T 312 will have the mixture verification process waived. The mix design shall be submitted to Engineer for approval at least seven days prior to mixture production.

413.30.3.2 Required Information. The mix design shall include raw data from the design process and contain the following information:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregate.

(c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate including all raw data.

(d) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(e) Percentage of each aggregate component.

(f) Combined gradation of the job mix.

(g) Percent asphalt binder, by weight, based on the total mixture.

(h) Theoretical maximum specific gravity (Gmm) as determined by AASHTO T 209, after the sample has been short term aged in accordance with AASHTO R 30.

(i) The tensile strength ratio as determined by AASHTO T 283 including all raw data.

(j) Mixing temperature and gyratory molding temperature.

(k) Bulk specific gravity (Gsb) of the combined aggregate.

(l) Percent chert contained in each aggregate fraction.

(m) Percent deleterious contained in each aggregate fraction.

(n) Blended aggregate properties for clay content, angularity, and thin and elongated particles.
(o) Draindown for mixture.

(p) Film thickness for mixture

### 413.30.4 Composition of Mixture.

#### 413.30.4.1 Asphalt Amount.
The amount of asphalt binder in the mixture shall meet the following limits for the type of mixture specified in the contract.

<table>
<thead>
<tr>
<th>Mix Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Asphalt Content, %</td>
</tr>
</tbody>
</table>

#### 413.30.4.2 Gradation.
Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

<table>
<thead>
<tr>
<th>Mix Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition by Weight Percentages</td>
</tr>
<tr>
<td>Sieves</td>
</tr>
<tr>
<td>3/4 in.</td>
</tr>
<tr>
<td>1/2 in.</td>
</tr>
<tr>
<td>3/8 in.</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

#### 413.30.4.3 Film Thickness.
The film thickness shall be a minimum 10.0 microns when calculated using the effective asphalt content in conjunction with the surface area for the aggregate in the Job Mix Formula. The surface area factors can be found in Table 6.1 of the Asphalt Institute MS-2, Mix Design Methods for Asphalt Concrete and Other Hot Mix Types, Sixth Edition.

#### 413.30.4.4 Non-Carbonate Aggregate Requirement.
Mixtures containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the plus No. 4 sieve criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

<table>
<thead>
<tr>
<th>Coarse Aggregate (+ No. 4)</th>
<th>Minimum Non-Carbonate by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
<td>30% Plus No. 4</td>
</tr>
<tr>
<td>Dolomite</td>
<td>No Requirement</td>
</tr>
</tbody>
</table>

#### 413.30.4.5 Drain Down.
Drain down from the loose mixture shall not exceed 0.10 percent when tested in accordance with AASHTO T 305.
### 413.30.4.6 Moisture Susceptibility

The mixture shall have a tensile strength ratio (TSR) of 80 percent or greater when compacted to 3.7 inches with $7 \pm 0.5$ percent air voids and tested in accordance with AASHTO T 283.

### 413.30.5 Construction Requirements

#### 413.30.5.1 Weather Limitations

Mix shall not be placed if the air temperature or the temperature of the surface on which the mixture is to be placed is below 50°F, the surface is wet or frozen, or weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

#### 413.30.5.2 Paver

The paver shall be capable of spraying the polymer modified asphalt emulsion membrane, applying the hot mix asphalt overlay and leveling the surface of the mat in one pass. Wheels or other parts of the paving machine shall not come in contact with the polymer modified emulsion membrane before the hot mix asphalt concrete wearing course is applied. The screed shall have the ability to crown the pavement at the center and shall have vertically adjusted extensions to accommodate the desired pavement profile.

#### 413.30.5.3 Surface Preparation

Immediately prior to placing the ultrathin bonded asphalt wearing surface, the roadway surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material. All non-working surface cracks with an opening size exceeding 1/4 inch and any size working crack shall be sealed prior to placement of the ultrathin bonded asphalt wearing surface. Immediately prior to spraying the polymer modified emulsion membrane, the surface shall be free of fresh bituminous mix. The ultrathin bonded asphalt wearing surface shall not be placed until the sealant has cured. Curing time of sealant shall be in accordance with the manufacturer’s recommendations.

#### 413.30.5.4 Application of Membrane

The polymer modified emulsion membrane application shall be applied in accordance with the manufacturer’s recommendations. The sprayer shall accurately and continuously monitor the rate of spray and shall provide a uniform application across the entire width to be overlaid.

#### 413.30.5.4.1 Adjusting Membrane Rate

The Engineer may make adjustments to the spray rate based on the existing pavement surface conditions and the recommendations of the polymer modified emulsion membrane manufacturer.

#### 413.30.5.4.2 Application Rate of Membrane

Unless otherwise shown on the plans, the target field application rate of the asphalt emulsion shall be as follows for the type of mixture specified in the contract:

<table>
<thead>
<tr>
<th>Membrane Application Rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixture Type</td>
<td>Field Application Rate (gal/sy)</td>
</tr>
<tr>
<td>Type A</td>
<td>0.15</td>
</tr>
<tr>
<td>Type B and C</td>
<td>0.19</td>
</tr>
</tbody>
</table>

#### 413.30.5.4.2.1 Tolerance for Membrane Application Rate

At any given time during placement, the application rate of the asphalt emulsion shall be within 0.02 gal/sy of the target field application rate in the table or as indicated in the plans. The yield of the application rate over the entire project area shall be within 0.01 gal/sy of the target field application rate given in the table or as indicated in the plans.

#### 413.30.5.5 Application of Mixture

The hot mix asphalt concrete shall be applied at a temperature of 290 to 330°F and shall be spread over the polymer modified emulsion membrane immediately after application of the polymer modified emulsion. The hot asphalt concrete wearing course shall be placed over the full width of the polymer modified emulsion membrane with a heated vibratory-tamping bar screed.
413.30.5.5.1 Handwork. For handwork, the hot mix asphalt shall be applied within five minutes after the application of the polymer modified emulsion.

413.30.5.5.2 Application Rate of Mixture. The target application rate of the ultrathin bonded asphalt wearing course shall be as shown on the plans. The application rate shall be adjusted to minimize fracturing of the top size aggregate by the screed. The Engineer will determine the acceptable extent of fracturing at the edges for tapering purposes.

413.30.5.6 Rolling. Rolling of the wearing course shall consist of no more than three passes immediately following placement of the ultrathin bonded asphalt wearing course with a steel, double-drum, asphalt roller with a minimum weight of 10 tons. All rolling shall be completed before the material temperature has fallen below 195°F. Rollers shall be equipped with a functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. An acceptable release agent approved by the Engineer may be added to the water system to prevent adhesion of the fresh mix to the roller drum and wheels. Rolling shall be done in the static mode. Excessive rolling to the extent of aggregate degradation will not be permitted. The Engineer will determine the acceptable extent of fracturing at the edge of the pavement from the rolling operation. New pavement shall not be opened to traffic nor shall any roller sit idle on the pavement until the rolling operation is complete and the material has been cooled below 140°F.

413.30.5.7 Bituminous Mixing Plants. Bituminous mixing plants and preparation of materials and mixtures shall be in accordance with Sec 404.

413.30.5.8 Hauling Equipment. Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.

413.30.5.9 Wearing Course. The finished wearing course shall have a minimum thickness of 1/2 inch for Type A, 3/4 inch for Type B, and 3/4 inch for Type C.

413.30.5.10 Pavement Marking. Pavement marking shall be replaced in accordance with Sec 620.

413.30.5.11 Acceptance. Acceptance will be based on test results indicating that the ultrathin bonded asphalt wearing surface meets the specification requirements.

413.30.6 Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of ultrathin bonded asphalt wearing surface, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

413.30.7 Basis of Payment. The accepted quantity of ultrathin bonded asphalt wearing surface will be paid for at the contract unit price.

SECTION 413.31 BONDED HOT MIX ASPHALT USING POLYMER MODIFIED EMULSION MEMBRANE.

413.31.1 Description. This work shall consist of the placement of a Polymer Modified Emulsion Membrane prior to a bituminous overlay of hot asphaltic concrete pavement. The Polymer Modified Emulsion Membrane shall be spray applied immediately prior to the application of the hot asphaltic concrete pavement so as to produce a homogeneous surface in accordance with Sec 401.

413.31.2 Materials. The Polymer Modified Emulsion Membrane shall be in accordance with Sec 1015.20.6.2.

413.31.3 Construction Requirements. The asphaltic concrete pavement shall be placed in accordance with Sec 401 except as modified herein.
413.31.4 Equipment. No wheel, track or other part of the paving machine or any hauling equipment shall come in contact with the Polymer Modified Emulsion Membrane before the asphaltic concrete pavement mixture is applied.

413.31.5 Application of Polymer Modified Emulsion Membrane.

413.31.5.1 The Polymer Modified Emulsion Membrane shall be sprayed at a temperature of 120 - 180°F. The sprayer shall accurately and continuously monitor the application rate and provide a uniform coverage across the entire width to be overlaid. The target application rate of the asphalt emulsion membrane shall be 0.20 gallons per square yard. The Engineer may make adjustments to the application rate based upon the existing pavement surface conditions and the recommendations of the Polymer Modified Emulsion Membrane supplier; however, the application rate shall be within +/- 0.05 gallon per square yard of the target application rate.

413.31.5.2 The application rate of the Polymer Modified Emulsion Membrane shall be verified by dividing the volume (of Polymer Modified Emulsion Membrane used) by the area of paving for that day.

413.31.5.3 No water shall be added to the Polymer Modified Emulsion Membrane.

413.31.6 Method of Measurement. Measurement of the Polymer Modified Emulsion Membrane shall be based on the volume in gallons in accordance with Sec 1015.

413.31.7 Basis of Payment. The accepted quantity of the Polymer Modified Emulsion Membrane will be paid for at the contract unit price.

413.40 Not Used

413.50 BITUMINOUS PAVEMENT CRACK SEALING

413.50.1 Description. This work shall consist of preparing and sealing all working transverse and longitudinal cracks in bituminous pavement as shown on the plans or as directed by the Engineer.

413.50.2 Material. The sealant shall be a single-component material in accordance with AASHTO M 301, except as herein modified.

413.50.2.1 The sealant shall be capable of being reheated to pouring temperatures at least once after the initial heating, while retaining the sealant’s physical characteristics.

413.50.2.2 Penetration at 77°F, 150 grams, 5 seconds, shall be no less than 50 or greater than 90.

413.50.2.3 When tested at 77°F, the resilience recovery shall be a minimum of 50 percent.

413.50.2.4 The sealant shall meet all physical requirements after prolonged heating for six hours with constant mixing in a laboratory melter at the recommended field pouring temperature, complete cool down, and reheating to the recommended pouring temperature.

413.50.3 Construction Requirements.

413.50.3.1 The Engineer will mark the cracks to be sealed. Sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40°F. The Contractor shall furnish to the Engineer the manufacturer’s recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer’s recommendations.
413.50.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 1/2-inch wide x 1/2-inch deep. The crack shall be clean, free from all loose and foreign material, and dry, prior to application of the sealant. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.50.3.3 The sealant shall be applied to the reservoir from the bottom up. The reservoir shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.50.3.4 The Contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed sealant if traffic results in tracking of the crack sealing material.

413.50.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot along the centerline of the roadway from the start of the first crack sealed to the end of the last crack sealed.

413.50.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

413.60 PORTLAND CEMENT CONCRETE PAVEMENT JOINT/CRACK SEALING

413.60.1 Description. This work shall consist of preparing and resealing all existing transverse and longitudinal joints, and working transverse and longitudinal cracks in Portland cement concrete pavement (PCCP) as shown on the plans or as directed by the Engineer.

413.60.2 Material. Sealant material shall be in accordance with Sec 1057.

413.60.3 Construction Requirements.

413.60.3.1 The Engineer will mark the existing joints and cracks to be sealed. The sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40°F. The Contractor shall furnish to the Engineer the manufacturer’s recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer’s recommendations.

413.60.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 3/8-inch wide x d/4 deep, where d is the thickness of the pavement. The joint/crack shall be clean, free from all loose and foreign material, including existing sealant, and dry prior to application of the sealant.

413.60.3.3 Sealant shall be applied to the joint or reservoir uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.60.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot along the centerline of the roadway from the start of the first crack sealed to the end of the last crack sealed.

413.60.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

413.70 BITUMINOUS PAVEMENT CRACK FILLING

413.70.1 Description. This work shall consist of preparing and filling all cracks in bituminous pavement as shown on the plans or as directed by the Engineer.
413.70.2 Material. Filler material shall be in accordance with one of the following:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Binder</td>
<td>1015.10</td>
</tr>
<tr>
<td>Polymer Modified Asphalt Emulsion</td>
<td>1015.20.5</td>
</tr>
<tr>
<td>Crack Sealing Material</td>
<td>413.50.2</td>
</tr>
</tbody>
</table>

413.70.3 Construction Requirements.

413.70.3.1 The Engineer will mark the cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40°F. The Contractor shall furnish to the Engineer the manufacturer’s recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer’s recommendations.

413.70.3.2 The crack shall be clean, free from all loose and foreign material, and dry prior to application of the filler material. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.70.3.3 Filler material shall be applied to the crack from the bottom up. The crack shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.70.3.4 The Contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed filler if traffic results in tracking of the crack sealing material.

413.70.4 Method of Measurement. Measurement of crack filling will be made to the nearest linear foot along the centerline of the roadway from the start of the first crack sealed to the end of the last crack sealed.

413.70.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.

413.80 PORTLAND CEMENT CONCRETE PAVEMENT CRACK FILLING

413.80.1 Description. This work shall consist of preparing and filling all cracks in PCCP, as shown on the plans or as directed by the Engineer.

413.80.2 Material. Filler material shall be in accordance with Sec 413.50.2 or Sec 1057.

413.80.3 Construction Requirements.

413.80.3.1 The Engineer will mark the existing cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40°F. The Contractor shall furnish to the Engineer the manufacturer’s recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer’s recommendations.

413.80.3.2 The crack shall be clean, free from any loose and foreign material, and dry prior to application of the filler material.

413.80.3.3 Filler material shall be applied to the crack uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.
413.80.4 Method of Measurement. Measurement of crack filling material will be made to the nearest linear foot along the centerline of the roadway from the start of the first crack sealed to the end of the last crack sealed.

413.80.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price
Division 500

RIGID PAVEMENTS
SECTION 501
PORTLAND CEMENT CONCRETE

501.1 Description. Concrete shall consist of a mixture of cement, fine aggregate, coarse aggregate and water, combined in the proportions specified for the various classes. Admixtures may be added as specifically required or permitted.

501.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregatea</td>
<td>1005.2</td>
</tr>
<tr>
<td>Fine Aggregatea</td>
<td>1005.3</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>1018</td>
</tr>
<tr>
<td>Cement</td>
<td>1019</td>
</tr>
<tr>
<td>Concrete Admixture</td>
<td>1054</td>
</tr>
<tr>
<td>Concrete Tinting Material</td>
<td>1056</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

a Regardless of the gradation of the coarse and fine aggregate used in concrete for pavement or base, the aggregate shall meet the quality requirements of coarse and fine aggregate for concrete pavement.

501.2.1 Mix Design. The proportions of cement, fine aggregate, and coarse aggregate for Portland cement concrete shall be as specified by the Engineer within the applicable limits of the specifications for the class of concrete designated in the contract. All fine aggregate used for concrete driveways, concrete sidewalk, curb ramps, and paved approaches shall contain only Finish Sand or Meramec Sand. The Engineer assumes no responsibility for the volume of concrete produced or furnished for the work.

501.2.1.1 The Contractor shall submit to the Engineer for approval, a mix design for all types of concrete to be used on the project. The mix design shall be submitted far enough in advance to allow for review and comment by the Engineer.

501.2.1.2 Alterations in the pavement mix design may be allowed at the discretion of the Engineer to accommodate the early opening of the roadway. Proposals for pavement mix modifications to accomplish accelerated strength gain of the concrete shall be submitted to the Engineer two weeks prior to the intended pavement date for review and approval.

501.2.1.3 For simplicity of design, the various fine aggregates are grouped into four classes and a minimum and maximum cement factor has been established for each class. The cement factor for the individual job may vary within the maximum and minimum limits, depending upon the gradation of the coarse aggregate, the quantity of mixing water used, the quantity of entrained air when air-entrained concrete is specified, and upon changes in proportions which may be necessary to produce satisfactory workability, strength, or entrained air content. The Engineer will make such changes in proportions, within the limits of these specifications, as necessary to produce concrete of satisfactory workability and strength.

501.2.1.4 Eastern Missouri Pavement Consortium (EMPC) Portland Cement Concrete. The Contractor may substitute a PCCP mix design for an approved EMPC PCCP mix design per Sec 511.

501.2.1.5 Required Information. The concrete mix design shall contain the following information:

(a) Source, type and specific gravity of Portland cement

(b) Source, type (class, grade, etc.) and specific gravity of supplementary materials, if used
(c) Source, name, type and amount of admixtures

(d) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregate

(e) Specific gravity and absorption of each fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including raw data

(f) Unit Weight of each fraction in accordance with AASHTO T 19

(g) The percent of each aggregate component used for optimized concrete mixes

(h) The design air content and slump

(i) Batch weights of Portland cement and supplemental cementitious materials

(j) Batch weights of coarse, intermediate and fine aggregates

(k) Batch weight of water

501.2.2 Paving Concrete. For PCCP mixes, the gradation requirements of Sec 1005 will not apply. For all fractions, 100 percent of each fraction shall pass the 2 inch sieve. When Grade F is required, 100 percent of each fraction shall pass the 3/4 inch sieve.

501.2.3 Optimized Masonry Concrete. For optimized PCCM mixes, the gradation requirements of Sec 1005.2 and Sec 1005.3 will not apply. For coarse aggregate, 100 percent of each fraction shall pass the one inch sieve and no more that 2.5 percent shall pass the No. 200 sieve. This value may be increased to 3.0 percent passing, provided there is no more than 1.0 percent of the material passing the No. 200 sieve in the fine aggregate. For fine aggregate, no more than 2.0 percent shall pass the No. 200 sieve for natural sand, and no more than 4.0 percent shall pass the No. 200 sieve for manufactured sand.

501.2.4 Non-Optimized Masonry Concrete. When optimized aggregate gradations are not selected by the Contractor, all provisions, including gradations requirements of Sec 1005 shall apply

501.2.5 Fine Aggregate Classes. Fine aggregates are grouped into four classes and a minimum cement factor has been established for each class.

501.2.6 Cement Factors. The minimum cement requirements in pounds per cubic yard of concrete for the various classes of sand shall be as follows:

<table>
<thead>
<tr>
<th>Class of Sand</th>
<th>Class A-1 Concrete</th>
<th>Class B Concrete</th>
<th>Class B -1 Concrete</th>
<th>Class B -2 Concrete</th>
<th>Class MB -2 Concrete, h</th>
<th>Pavement Concrete</th>
<th>Seal Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>600</td>
<td>525</td>
<td>610</td>
<td>705</td>
<td>600</td>
<td>588</td>
<td>660</td>
</tr>
<tr>
<td>B</td>
<td>640</td>
<td>565</td>
<td>640</td>
<td>735</td>
<td>620</td>
<td>602</td>
<td>695</td>
</tr>
<tr>
<td>C</td>
<td>--</td>
<td>585</td>
<td>660</td>
<td>750</td>
<td>640</td>
<td>602</td>
<td>715</td>
</tr>
<tr>
<td>D</td>
<td>--</td>
<td>620</td>
<td>695</td>
<td>790</td>
<td>660</td>
<td>602</td>
<td>735</td>
</tr>
</tbody>
</table>

a When used, Type IP, I(PM), IS or I(SM) cement shall be substituted on a pound for pound basis for Type I or Type II cement and adjustments in design mix proportions will be required to correct the volume yield of the mixture.
The Contractor may submit an optimized mix design which has a maximum 50 pounds per cubic yard reduction in cement from that shown in the tables. If the Contractor chooses this option, the mixture will be subject to review, laboratory testing and approval by the Engineer. All other requirements for the cement factor will apply.

Class A sand will include all sand, except manufactured sand, weighing 109 pounds per cubic foot or more.

Class B sand will include all chert, river and Crowley Ridge sand weighing from 106 to 108 pounds, inclusive, per cubic foot or glacial sand weighing 108 pounds or less per cubic foot.

Class C sand will include all chert, river and Crowley Ridge sand weighing from 101 to 105 pounds, inclusive, per cubic foot.

Class D sand will include all sand weighing 100 pounds or less per cubic foot and any manufactured sand that is produced by the process of grinding and pulverizing large particles of aggregate or which contains more than 50 percent of material produced by the reduction of coarser particles. Manufactured sand produced from limestone or dolomite shall not be used in Portland cement concrete for driving surfaces such as bridge decks, pavements and full depth shoulders.

Modified B-2 (MB-2) concrete may be used in-place of Class B-2 Concrete.

Modified B-2 (MB-2) concrete shall use at least one supplementary cementitious material in accordance with this specification. In no case shall MB-2 concrete use less than 15 percent fly ash when used as the individual supplementary cementitious material. In no case shall MB-2 concrete use less than 6 percent metakaolin when used as the individual supplementary cementitious material.

### 501.2.7 Compressive Strength Requirements

Concrete classes shall meet the following compressive strength requirements in pounds per square inch:

<table>
<thead>
<tr>
<th>Minimum Design Compressive Strength¹</th>
<th>Class A-1 Concrete</th>
<th>Class B Concrete</th>
<th>Class B -1 Concrete</th>
<th>Class B -2 Concrete</th>
<th>Class MB -2 Concrete</th>
<th>Pavement Concrete</th>
<th>Seal Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,000</td>
<td>3,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>3,000</td>
</tr>
</tbody>
</table>

¹Minimum compressive strength required unless otherwise specified in the contract documents or approved by the Engineer.

### 501.3 Sampling

Sampling of fresh concrete shall be in accordance with AASHTO R 60, except that for central or truck mixed concrete, the entire sample for slump and air tests and for molding compressive strength specimens may be taken at one time after approximately one cubic yard of concrete has been discharged. Acceptability of the concrete for slump and air content and, if applicable, for strength requirements, will be determined by tests on these samples.

### 501.4 Consistency

The slump of the concrete shall be within the limits for the respective classes of concrete. The concrete shall be uniform in consistency and shall contain the minimum quantity of water required to produce the designated slump. The slump of concrete mixes will be determined in accordance with AASHTO T 119. The quantity of mixing water in the concrete shall be considered the net quantity after proper allowance has been made for absorption by the aggregate. The slump and mixing water content of the concrete, when placed in the work, shall not exceed the following limits:
<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Max. Slump, In.</th>
<th>Max. Pounds of Mixing Water Per Pound of Cementitious Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Air-Entrained</td>
</tr>
<tr>
<td>A-1</td>
<td>3 1/2</td>
<td>0.46</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>0.51</td>
</tr>
<tr>
<td>B-1</td>
<td>4</td>
<td>0.44</td>
</tr>
<tr>
<td>B-2</td>
<td>3</td>
<td>0.40</td>
</tr>
<tr>
<td>MB-2</td>
<td>6</td>
<td>0.42</td>
</tr>
<tr>
<td>Pavement</td>
<td>4</td>
<td>0.50</td>
</tr>
<tr>
<td>Seal</td>
<td>8</td>
<td>----</td>
</tr>
</tbody>
</table>

501.5 Measurement of Material. The cement and aggregate for concrete shall be measured by weight. The weights of coarse and fine aggregates to be used will be calculated from the proportions approved by the Engineer. Batches that do not contain the proper quantities of material shall be wasted at the Contractor’s expense.

501.5.1 Weighing Tolerances. The weighing and batching equipment shall be designed and maintained in such a condition that the material for each batch can be quickly and accurately weighed and shall be operated within a tolerance of plus or minus 0.5 percent for cement and plus or minus 1.0 percent for aggregate. The equipment used for delivery of material to the weigh hoppers shall not permit intermingling of material. Weighing hoppers shall discharge completely and there shall be no accumulation of tare material. Scales shall be accurate to within 0.4 percent of the net load applied. The change in load required to change the position of rest of the indicating element or elements of indicating scales an observable amount shall not be greater than 0.1 percent of the nominal scale capacity. If beam-type scales are used, a separate beam shall be provided for each type of material to be used and means shall be provided for adjustment of tare on a scale separate from those used for other material.

501.5.2 Water Meter Tolerances. Mixing water shall be measured by volume or by weight. If measured by weight, scales shall be in accordance with Sec 501.5.1. The device for the measurement shall be readily adjustable and under all operating conditions shall measure the required quantity within a tolerance of one quart or one percent, whichever is greater.

501.5.3 Calibration Frequency. Plant scales and water metering devices shall be calibrated and certified annually and after every plant move by an approved commercial scale service. Admixture metering devices shall be calibrated by a commercial scale company, the admixture company or the concrete plant company. Plant scales that have not been moved shall be verified six months after their calibration. A copy of the calibration and verification shall be provided to the Engineer.

501.6 Mixing. The mixer shall produce concrete uniform in color, appearance and distribution of the material throughout the mixture. The cement, aggregate and no less than 60 percent of the water shall be mixed a minimum of one minute. The remaining water shall be added within 15 seconds after all other material for the batch is in the mixer. If mixers having multiple compartment drums are used, the time required to transfer material between compartments will be considered mixing time. The speed at which the drum rotates shall be as designated by the manufacturer. If such mixing does not result in uniform and smooth texture concrete, a sufficient number of additional revolutions at the same speed shall be performed until a thorough mixing of each batch of concrete is secured. The mixing time shall be measured from the time all cement, aggregate and 60 percent of the water are in the drum. The volume of concrete mixed in each batch shall not exceed the manufacturer's rated capacity. The mixer shall be equipped to automatically time the mixing of each batch of concrete. If the automatic timing device becomes inoperable, a manual timing device shall be provided to complete the day's operation.
501.7 Central and Truck Mixed Concrete. The following additional requirements will apply to central and truck mixed concrete.

501.7.1 Mixer Inspection. All central mixers, truck mixers and agitators shall comply with the requirement of these specifications prior to use, and inspection of the equipment shall be made periodically during the work. Only equipment found acceptable in every respect and capable of producing uniform results will be permitted.

501.7.2 Bridge Construction. When the concrete is to be used in bridge construction, the Contractor shall furnish and conform to a schedule of delivery which provides that all batches receive essentially the same amount of mixing and agitation. Failure to deliver consistently uniform concrete will be cause for its rejection and the Contractor will be required to furnish concrete produced by a stationary mixer on the job site without any adjustments in the contract unit bid price.

501.7.3 Uniformity Testing. A uniformity test in accordance with ASTM C 94 Annex A1, shall be performed during the annual calibration at a central mix drum plant and at the beginning of production for a project at a mobile paving plant.

(a) A uniformity test shall be performed for the largest and smallest proposed batch size.

(b) The two samples shall be obtained within an elapsed time of no more than 15 minutes.

(c) The air content, slump and mix proportions of the concrete tested shall be in accordance with these specifications for that class of concrete or the uniformity tests shall be invalid.

(d) The use of a one-quarter cubic foot measure will be permitted in determination of weight per cubic foot.

(e) Cylinders may be cured in damp sand after the first 48 hours.

(f) The Contractor may designate the mixing time for which uniformity tests are to be performed. The mixing time shall be a minimum of 60 seconds. The maximum mixing time shall not exceed the mixing time established by uniformity tests by more than 60 seconds for air-entrained concrete. The mixed concrete shall meet the uniformity requirements specified above before any concrete may be used for pavement or structures. The Engineer may allow the use of the test concrete for appropriate incidental construction. Tests shall be performed by the Contractor, in the presence of the Engineer. No direct payment will be made for labor, equipment, material or testing. After operational procedures of batching and mixing are thus established, no changes in procedure will be permitted without reestablishing procedures by uniformity tests.

501.7.3.1 Measuring Mixing Time. Measurement of mixing time shall start at the time all the solid material is in the drum and shall end at the beginning of the next sequential operation.

501.7.3.2 Verification of Mixer. Mixer performance tests shall be repeated whenever the appearance of the concrete or the coarse aggregate content of samples selected in accordance with ASTM C 94, as modified above, indicates that adequate mixing is not being accomplished.

501.7.4 Truck Mixed Concrete. Truck mixed concrete shall be mixed at the proportioning plant and the mixer shall operate at agitating speed while in transit. Truck mixed concrete may be mixed at the point of delivery, provided the cement or cement and mixing water, are added at that point. Mixing of truck mixed concrete shall begin immediately after the introduction of the mixing water and cement to the aggregate or the introduction of the cement to the aggregate.

501.7.5 Truck Mixer Requirements. A truck mixer shall consist of a watertight revolving drum suitably mounted, fitted with adequate blades, and equipped with a device for determining the number of mixing revolutions. Truck
mixers shall produce a thoroughly mixed and uniform mass of concrete and shall discharge the concrete without segregation. A truck agitator shall consist of a watertight revolving drum or a watertight container suitably mounted and fitted with adequate revolving blades. Truck agitators shall transport and discharge the concrete without segregation. Mixers and agitators shall be cleaned of accumulation of hardened concrete or mortar.

501.7.6 Rating Plate. Except as hereinafter permitted, each truck mixer shall have permanently attached to the truck a metal rating plate issued by and in accordance with the capacity requirements of the Truck Mixer Manufacturers Bureau (TMMB), as approved by NRMCA, on which is stated the maximum capacity in terms of volume of mixed concrete for the various uses to which the equipment is applicable. The truck shall also have attached a manufacturer’s data plate that shall state the actual capacity as an agitator, and the maximum and minimum mixing and agitating speeds. If truck mixers are used for mixing or agitating, the volume of concrete in each batch shall not exceed the maximum capacity shown on the metal rating plate issued by the TMMB, as approved by NRMCA, except that if a lower capacity for agitating is shown on the manufacturer’s data plate, that lower capacity shall govern. The minimum batch size for truck mixers shall be one cubic yard. The Engineer may reduce the batch size or reject use of any truck mixer that does not produce concrete uniform in color, appearance and distribution of material throughout the mass. A quantity of concrete that results in axle and gross loads in excess of statutory limits will not be permitted.

501.7.7 Truck Mixing Requirements. Truck mixers and agitators shall be operated at the speed of rotation designated by the manufacturer of the equipment. Truck mixed concrete shall initially be mixed no less than 70 or more than 100 revolutions of the drum at mixing speed after all ingredients, including water, are in the mixer, except that when the batch volume does not exceed 57.5 percent of the gross volume of the drum or 91 percent of the rated maximum capacity, the number of revolutions required for mixing shall be no less than 50 or more than 100. When a truck mixer or truck agitator is used for transporting concrete that has been completely mixed, agitation of the concrete shall continue during transportation at the speed designated by the manufacturer of the equipment as agitating speed. Water may be added to the mixture no more than two times after initial mixing is completed. Each time water is added, the drum shall be turned an additional 30 revolutions, or more if necessary, at mixing speed, until uniform mixing is accomplished. All water added will be included in determining the effective water in the mixture.

501.7.8 Water Adjustments at Job Site. Each increment of water added at the job site shall be measured within a tolerance of one percent of the total effective water required for the batch. Water used to wash the drum of the mixer shall not be used as mixing water.

501.7.9 Handling and Discharge Requirements. Central or truck mixed concrete shall be delivered to the site of the work and discharge shall be completed within one hour for concrete used for bridge deck surface slabs, and within 1-1/2 hours for all other concrete, after the beginning of mixing operations. In hot weather or under conditions contributing to quick stiffening of the concrete, the time shall be reduced as directed by the Engineer. Concrete shall be discharged without delay and the time required between the start and completion of discharge shall not exceed 15 minutes for bridge deck slabs. Discharge time for other concrete pours shall not exceed 15 minutes, except that in the case of small pours the discharge time may be extended as necessary to provide for proper placing and inspection procedures provided the total mixing, delivery, and discharge time does not exceed that specified. A small concrete pour will be hereby defined as pours for curbs, curb and gutters, sidewalk, paved drainage, and paved approach for private entrances. The 15 minutes discharge time will be enforced for all pavement and structural pours.

501.7.10 Non-Agitating Equipment. Consideration will be given to permitting the use of non-agitating equipment for the transportation of central mixed concrete, but approval of this procedure, except as qualified in Sec 502.3.4.1 for use in Portland cement concrete pavement, may be granted only when the quantity of concrete is small, the length of haul short, and its use does not require high structural strength for satisfactory performance. The discharge of concrete, for other than pavement, transported in non-agitating equipment shall be completed within 45 minutes after introduction of the mixing water to the cement and aggregates. When hauling heated concrete,
or under other conditions contributing to quick stiffening of the concrete, the time shall be reduced as directed by the Engineer.

501.7.10.1 Bodies of non-agitating hauling equipment shall be smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory, controlled rate without segregation. If unloading the concrete is accomplished by tilting the body, baffles may be required to retard the discharge.

501.7.10.2 Non-agitating flatbed dump trucks shall be equipped with protective covers that encompass the entire open portion of the bed. A backup tailgate latching system shall be utilized to prevent accidental discharge of material during transport. Tailgates shall be equipped to restrict seepage of mortar between the lip of the truck bed and the closed gate. Grout, seal concrete, and other high slump materials shall not be transported by flatbed dump trucks.

501.7.11 During the time that concrete is being discharged for pours requiring more than one load of concrete, facilities shall be provided to permit immediate radio communication between the site where the concrete is being placed and the proportioning plant.

501.7.12 Delivery Tickets. The manufacturer of truck mixed concrete and of central mixed concrete for use in structures shall furnish to the Engineer with each truck load of concrete before unloading at the site, a delivery ticket on which is shown information concerning the concrete as follows:

(a) Name of concrete plant.

(b) Serial number of ticket.

(c) Date and truck number.

(d) Name of Contractor.

(e) Specific project, route, and county designation.

(f) Specific class of concrete.

(g) Quantity of concrete in cubic yards.

(h) Time when batch was loaded, or of first mixing of cement and aggregates.

(i) Arrival time on project.

(j) Time when truck has finished discharging load.

(k) Any additional water added at jobsite to attain pouring consistency, unless otherwise specified under Special Provisions.

501.7.13 Concrete Plant Documentation. The Contractor shall complete the required concrete plant documentation once per working day at the central ready mix or paving plant. The documentation shall be made available to the Engineer within 24 hours after concrete is batched.

501.8 Volumetric Batched and Continuous Mixed Concrete. Upon written request by the Contractor, the Engineer may approve the use of concrete proportioned by volume. If concrete is proportioned by volume, the other requirements of these specifications with the following modifications will apply.
501.8.1 Proportional Devices. Volume proportioning devices, such as counters, calibrated gate openings or flow meters, shall be available for controlling and determining the quantities of the ingredients discharged. In operation, the entire measuring and dispensing mechanism shall produce the specified proportions of each ingredient.

501.8.2 Controls. All indicating devices that affect the accuracy of proportioning and mixing of concrete shall be in full view of and near enough to be read by the operator while concrete is being produced. The operator shall have convenient access to all controls.

501.8.3 Calibration. The proportioning devices shall be calibrated by the Contractor in the presence of and subject to approval from the Engineer. Calibration of the cement and aggregate proportioning devices shall be accomplished by weighing each component. Calibration of the admixture and water proportioning devices shall be accomplished by weight or volume. Tolerances in proportioning the individual components will be as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, Weight percent</td>
<td>0 to +4</td>
</tr>
<tr>
<td>Fine Aggregate, Weight percent</td>
<td>± 2</td>
</tr>
<tr>
<td>Coarse Aggregate, Weight percent</td>
<td>± 2</td>
</tr>
<tr>
<td>Admixtures, Weight or Volume percent</td>
<td>± 3</td>
</tr>
<tr>
<td>Water, Weight or Volume Percent</td>
<td>± 1</td>
</tr>
</tbody>
</table>

501.8.4 Verification of Yield. Verification of the proportioning devices may be required at any time by the Engineer. Verification shall be accomplished as follows. With the cement meter set on zero and all other controls set for the designated mix, the activated mixer shall discharge mixed material into a 1/4 cubic yard container measuring 36 x 36 x 9 inches. When the container is level-struck full, making provisions for settling the material into all corners, the cement meter shall show a discharge equal to the design proportion of cement for 1/4 cubic yard. A tolerance of ± 1/8 inch from the top of the container will be permitted. If the correct yield is not obtained, the proportioning devices shall be adjusted to obtain the design mix or the proportioning devices shall be recalibrated as directed by the Engineer.

501.8.5 Water Control. The rate of water supplied shall be measured by a calibrated flow meter coordinated with the cement and aggregate feeding mechanism and with the mixer. The rate shall be adjustable in order to control slump at the desired level.

501.8.6 Liquid Admixture. Liquid admixtures shall be dispensed through a controlled flow meter. A positive means to observe the continuous flow of material shall be provided. If an admixture requires diluting, the admixture shall be diluted and thoroughly mixed prior to introducing the admixture into the dispenser. When admixtures are diluted, the ratio of dilution and the mixing shall be approved by and performed in the presence of the Engineer.

501.8.7 Concrete Mixer. The concrete mixer shall be approved by the Engineer and shall be an auger-type continuous mixer used in conjunction with volumetric proportioning. The mixer shall produce concrete, uniform in color and appearance, with homogeneous distribution of the material throughout the mixture. Mixing time necessary to produce uniform concrete shall be established by the Contractor and shall comply with other requirements of these specifications. Only equipment found acceptable in every respect and capable of producing uniform results will be permitted.

501.8.7.1 Material Storage Capacity. The continuous mixer shall be capable of carrying sufficient unmixed dry bulk cement, fine aggregate, coarse aggregate, admixtures and water, in separate compartments to produce no less than 6 cubic yards of concrete at the job site. Each batching or mixing unit or both, shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator.
501.8.7.2 **Measurement of Cement.** The continuous mixer shall be capable of positive measurement of cement being introduced into the mix. A recording meter visible to the operator and equipped with a ticket printout shall indicate the quantity.

501.8.7.3 **Measurement of Water.** The continuous mixer shall provide positive control of the flow of water and admixtures into the mixing chamber. Water flow shall be indicated by a flow meter and be readily adjustable to provide for minor variations in aggregate moisture. The mixer shall be capable of continuously circulating or mechanically agitating the admixtures.

501.8.7.4 **Scalping Screen.** The continuous mixer shall have a one inch maximum size scalping screen over the fine aggregate bin to screen out mud balls, conglomerate lumps or any other contaminant material that could interrupt the flow of fine aggregate during proportioning.

501.8.7.5 **Batching Operations.** The continuous mixer shall be capable of being calibrated to automatically proportion and blend all components on a continuous or intermittent basis as required, and shall discharge mixed material through a conventional chute.

501.8.8 **Handling Materials.** Storage facilities for all material shall be designed to permit the Engineer to make necessary inspections prior to the batching operations. The facilities shall also permit identification of approved material at all times, and shall be designed to avoid mixing with or contaminating by, unapproved material. Coarse and fine aggregate shall be furnished and handled so variations in the moisture content affecting the uniform consistency of the concrete will be avoided.

501.9 **Air-Entrained Concrete.** Air content for all classifications of concrete shall be determined in accordance with AASHTO T 152. Air-entrained concrete shall be used for the construction of the following items:

   (a) All retaining walls and bridge units, except culvert-type structures and seal courses.

   (b) Concrete median barriers.

   (c) All piles (not required for cast-in-place concrete piles).

   (d) Concrete pavements.

   (e) Approach slabs and paved approaches.

   (f) Concrete medians and median strips.

   (g) Sidewalks, curb ramps and steps.

   (h) Curbs, gutters, curb and gutter and surface drain basins and drains.

   (i) Concrete pedestals for signs, signals and lighting.

501.9.1 **Other Concrete.** All other concrete, except seal concrete, may be air-entrained but only in accordance with the requirements of these specifications.

501.9.2 **Air Content Limitations.** When air-entrained concrete is used, the mix design target range for quantity of air content by volume shall not be less than 4.5 percent or greater than 7.5 percent. When field measured air content exceeds 7.5 percent, but is less than or equal to 9.0 percent, the concrete may be placed at the Contractor’s risk that all other concrete requirements will be met, including strength. When field measured air content is less
than 4.5 percent, the concrete may be re-dosed with air entrainment admixture in accordance with Sec 501.9.4. Under no circumstances shall any concrete be incorporated into the work with an air content less than 4.5 percent or greater than 9.0 percent.

501.9.3 Incorporation Procedures. Air-entraining admixtures shall be added to the concrete during the mixing process. The admixture shall be of such volume and strength that the admixture can be accurately measured and dispensed in accordance with the manufacturer’s recommendations. The dispenser shall consistently deliver the required quantity of admixture within a tolerance of ± 3 percent.

501.9.4 Re-Dosing. When the measured air content is below the minimum specified limit, the Contractor will be allowed one attempt per mixer truckload to re-dose the concrete in the field. The Contractor shall immediately contact the concrete supplier to make adjustments to all remaining truckloads so they arrive within specifications. If no adjustments are made, re-dosing will not be allowed for subsequent truckloads. The Contractor shall obtain approval of the Re-Dosing Plan from the Engineer prior to the start of work. The Re-Dosing Plan shall address the following:

(a) Field measurement of the air entrainment admixture

(b) Brand of air entrainment admixture being used

(c) Incorporation and mixing of the air entrainment admixture

(d) The use of additional water

501.10 Concrete Admixtures for Retarding Set. If specified in the contract, an approved retarding admixture shall be provided and incorporated into the concrete. If not specified in the contract, the use of an approved retarding admixture will be permitted upon written notification from the Contractor. Any retarding admixture shall be added in accordance with Sec 501.9.3 by means of a dispenser conforming to the requirements of that section. No direct payment will be made for furnishing the retarding admixture or for incorporating the admixture into the mixture.

501.11 Water-Reducing Admixtures. Type A water-reducing admixtures may be used in any concrete. When Type A water-reducing admixture is added to pavement concrete for paving purposes, a reduction of cement up to 25 lbs per cubic yard will be permitted. The dosage rate of Type A water-reducing admixture shall be within the ranges recommended by the manufacturer and approved by the Engineer. Any cementitious material substitution permitted by specification shall be based on the reduced cement content. Water-reducing admixtures shall be added in accordance with Sec 501.9.3 by means of a dispenser conforming to the requirements of that section. High range water-reducing admixtures may be used when specified or as approved by the Engineer.

501.11.1 Modified B-2 Utilized. Modified B-2 concrete shall use a Type A or Type D water-reducer admixture.

501.11.2 Silica Fume and Metakaolin Utilized. Concrete utilizing silica fume or metakaolin shall use a water-reducer admixture that may be added by hand methods. The amount of water contained by the water-reducer admixture shall be included in the overall water content of the concrete.

501.11.3 Consistency Requirement. When a water-reducer admixture is used the maximum allowed slump may be increased to 6 inches for all concrete classes. The concrete shall be homogeneous with no aggregate segregation.

501.12 High Early Strength Concrete. The condition under which high early strength concrete may be used must either meet the written approval of, or be specified by, the Engineer. All materials, mixture and placement requirements shall be in accordance with Sec 501 and Sec 502, except as specified herein. The concrete mixture shall be in accordance with Sec 613.10.2.3, except a compressive strength of 3500 pounds per square inch shall be obtained prior to opening to traffic, and no calcium chloride will be allowed. An approved non-chloride accelerator
will be allowed. The mix design for the high early strength concrete shall be submitted to the Engineer for approval. The accepted quantities of accelerated PCCP will be paid at the same contract unit price as PCC Pavement, unless specified in the contract.

501.12.1 Incorporating Calcium Chloride. Calcium chloride shall be incorporated into the concrete mix in solution form using water. The water used for the solution shall to be accounted for in the approved mix design. The use of calcium chloride in concrete mixtures will be permitted in special cases only by approval of the Engineer.

501.12.2 Amount of Calcium Chloride. The amount of calcium chloride shall not exceed 2 percent by mass of the cementing material, unless otherwise approved by the Engineer.

501.13 Mixing Water. Maximum mixing water shall be based on total cementitious material. The quantity of mixing water in the concrete shall be considered the net quantity after proper allowance has been made for absorption by the aggregate.

501.14 Fly Ash. Approved Class C or Class F fly ash may be used to replace the Portland cement on a pound for pound basis in all Class A-1, B, B-1, B-2, and PCCP concrete mixes.

501.14.1 Approved Class C or F fly ash may be used to replace a maximum of 15 percent of Type I or II cement and a maximum of 10 percent of Type IP or I(PM) cement, only when made with a natural pozzolan, on a pound for pound basis in all concrete except concrete designed for high early strength. When the Type IP or I(PM) cement is made with a natural pozzolan and not fly ash, fly ash may be used as a replacement as limited herein.

501.14.1.2 Changes in class or source of fly ash used in concrete structures will be permitted only with the written approval of the engineer. Only fly ash resulting in concrete of the same color shall be used in any individual unit of the structure.

501.14.1.3 Fly ash, Type IS or I(SM) cement, or Type IP or I(PM) cement made with fly ash pozzolan shall not be used in pavement concrete placed between November 1 and April 1. These date restrictions do not apply to Type IP or I(PM) cement made with a natural pozzolan.

501.14.2 All proportioning, air-entraining, slump, maximum mixing water requirements, mixing, sampling, measurement of material, transporting of concrete and all material shall be in accordance with Sec 501.

501.14.3 When fly ash is used, an adjustment in design mix proportions will be required to correct the volume yield of mixture. Mix design shall be as specified by the engineer. Approval shall be obtained from the engineer prior to any change in mix design or proportions.

501.14.4 Maximum mixing water shall be based on total cementitious material. Ninety-four pounds of cementitious material will be considered a sack or bag. The quantity of mixing water in the concrete shall be considered the net quantity after proper allowance has been made for absorption by the aggregates.

501.14.5 Fly ash shall be stored in separate enclosed storage silos during batching operations.

501.14.6 Fly ash shall be measured in the same manner and with the same accuracy as cement. Fly ash may be weighed separately on the same scale as cement provided the scale increments are such that the specified weighing accuracy can be maintained. If, however, the fly ash is weighed together with the cement, the cement shall be weighed first and the accuracy shall apply to the combined weight.

501.14.7 Fly ash shall be considered as cement when measuring mixing time.
501.14.8 When a commercial mixture of concrete is allowed and fly ash is used, the contractor shall notify the engineer of the class, source and quantity of fly ash proposed, in addition to the other requirements of Sec 501. The fly ash shall be from an approved source. The quantity of fly ash shall not exceed 15 percent, by weight, replacement of the cement.

501.15 Modified B-2 Concrete. The Contractor may use propose a Ternary mix containing fly ash, silica fume or metakaolin in the production of modified B-2 concrete in accordance with these specifications. Ternary mixes are mixes that contain a combination of Portland cement and two supplementary cementitious materials. Supplementary cementitious materials may be used to replace a maximum of 40 percent of the Portland cement. The amount of each supplementary cementitious materials used in a ternary mix shall not exceed the limits specified herein.

501.15.1 Fly Ash. Approved Class C or Class F fly ash may be used to replace a maximum of 25 percent of the Portland cement on a pound for pound basis in modified B-2 concrete mixes.

501.15.2 Silica Fume. Approved silica fume may be used to replace a percent of the Portland cement on a pound for pound basis. The following limits shall apply when silica fume is used:

<table>
<thead>
<tr>
<th>Silica Fume Replacement Limits, %</th>
</tr>
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<tbody>
<tr>
<td>Class of Concrete</td>
</tr>
<tr>
<td>MB-2</td>
</tr>
</tbody>
</table>

501.15.2.1 Silica Fume Requirements. Silica fume shall be approved prior to use and be in accordance with ASTM C 1240, except as noted herein. If dry compacted form, the admixture shall be 100 percent silica fume with no admixtures. Silica fume slurries may contain other approved admixtures, such as water reducers or retarders, if the admixtures are included by the manufacturer of the silica fume admixture.

501.15.2.2 Manufacturer Certification. The Contractor shall furnish to the Engineer a manufacturer’s certification along with the brand name, batch identification, quantity represented, percent solids and the type, name and quantity of any admixtures, that are provided in the silica fume admixture.

501.15.2.3 Silica Fume Test Results. The manufacturer’s certification shall contain results of recent tests conducted on samples of the silica fume material taken during production or transfer and indicating conformance with Tables 1 and 3 of ASTM C 1240 and this specification. The supplier shall further certify that the material being furnished is in accordance with this specification.

501.15.2.4 Silica Fume Slurry. Liquid silica fume admixture shall be protected from freezing at all times.

501.15.2.5 Admixture Compatibility. All admixtures used shall be compatible with the silica fume admixture and shall be recommended or approved in writing by the manufacturer of the silica fume admixture.

501.15.3 Metakaolin. Approved metakaolin may be used to replace a maximum of 15 percent of the Portland cement on a pound for pound basis in all concrete.

501.15.3.1 Metakaolin Requirement. Metakaolin shall be approved prior to use and be in accordance with AASHTO M321.

501.15.3.2 Manufacturer Certification. The Contractor shall furnish to the Engineer a manufacturer’s certification along with the brand name, batch identification and quantity represented.
501.15.3.3 Metakaolin Test Results. The manufacturer’s certification shall contain results of recent tests conducted on samples of the metakaolin taken during production or transfer and indicating conformance with AASHTO M321 and this specification. The supplier shall further certify that the material being furnished is in accordance with this specification.

501.15.4 Source Changes. Changes in class or source of fly ash, brand and source of silica fume or brand and source of metakaolin used in concrete structures will be permitted only with written approval from the Engineer. Only fly ash, silica fume or metakaolin resulting in concrete of the same color shall be used in any individual unit of the structure.

501.15.5 Mix Proportions. When fly ash, silica fume or metakaolin is used, an adjustment in design mix proportions will be required to correct the volume yield of mixture. Approval shall be obtained from the Engineer prior to any change in mix design or proportions.

501.15.6 Measuring Fly Ash. Fly ash shall be measured in the same manner and with the same accuracy as cement. Fly ash may be weighed separately on the same scale as cement, provided the scale increments are such that the specified weighing accuracy can be maintained. If the fly ash is weighed together with the cement, the cement shall be weighed first and the accuracy shall apply to the combined weight.

501.15.7 Measuring Silica Fume and Metakaolin. Silica fume or metakaolin shall be measured by weight or volume within a tolerance of plus or minus 2 percent.

501.15.8 Silica Fume and Metakaolin Batching Sequence. Silica fume or metakaolin shall be added at the plant at the same point in the batch sequence as recommended by the manufacturer of the material. The silica fume or metakaolin may be added by hand methods.

501.15.9 Calculating Silica Fume Solids. For silica fume solutions, the quantity of liquid silica fume admixture needed to furnish the required silica fume solids shall be calculated based on the weight per gallon and percent solids of the silica fume admixture being used.

501.15.10 Measuring Cementitious Materials. Fly ash, silica fume or metakaolin will be considered as cement when measuring mixing time.

501.16 Tinted Concrete. Where the contract requires concrete to be tinted, the tinting materials used shall meet the requirements of Sec 1056.

501.16.1 Concrete shall be tinted by mixing tinting material into the fresh concrete to create a fully tinted mixture. Tinting material may be mixed at the plant or at the site when concrete is delivered in truck mixers. The tinted concrete shall be uniform in color throughout the quantity of concrete delivered. Tinted concrete shall be cured in accordance with the curing requirements for the contract item for which tinting is specified, except that white pigmented membrane curing material shall not be used. When the Contractor elects to use membrane curing for those items where its usage is permitted, it shall be of the clear or transparent type.

501.17 Commercial Mixture. If specified in the contract that an approved commercial mixture of concrete may be used, the Contractor shall notify the Engineer in writing, setting out for approval the source and proportions of the mixture proposed to be furnished. The statement shall include the following:

(a) The types and sources of aggregate.

(b) Type and source of cement and other cementitious material.

(c) Scale weights of each aggregate proposed as pounds per cubic yard of concrete.
(d) Quantity of water proposed, as pounds or gallons per cubic yard of concrete.

(e) Quantity of cement proposed as pounds per cubic yard of concrete.

501.17.1 Minimum Cement Content. The concrete shall contain no less than 517 pounds of cement per cubic yard. The use of fly ash shall be in accordance with Sec 501.13. The plant shall comply with other requirements of these specifications or be as approved by the Engineer. The concrete will be subject to acceptance or rejection by visual inspection at the job site.

501.17.2 Certification. The supplier shall furnish certification with the first truck load of each day’s production of concrete that the material and mix proportions used are in accordance with the approved mixture. Upon completion of the work, plant certification shall be furnished by the supplier for the total quantity delivered.
SECTION 502
PORTLAND CEMENT CONCRETE PAVEMENT

502.1 Description. This work shall consist of constructing a Portland cement concrete base or pavement, with or without reinforcement as specified, shown on the plans or directed by the Engineer.

502.2 Material. All material, proportioning, air-entrainment, mixing, slump and transporting for Portland cement concrete shall be in accordance with Sec 501. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
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<tbody>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Materials for Joints</td>
<td>1057</td>
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</table>

502.3 Equipment. Equipment and tools including portable mixers necessary for handling materials and performing all parts of work shall be approved by the Engineer as to design capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly for approval and shall comply with the following requirements.

502.3.1 Batching Plant and Mixer. The batching plant, mixer, water measuring equipment, weighing and hauling equipment shall be in accordance with Sec 501.

502.3.1.1 Central or truck mixed concrete shall be produced and delivered from not more than three (3) plants per day for any individual project or subdivision. This restriction will not apply to material suppliers who qualify as “Disadvantaged Business Enterprises”, when D.B.E. participation is stipulated in the construction contract.

502.3.2 Hauling. Batch trucks used for transporting unmixed batches from the plant to the paver shall have compartments of size and construction adequate to prevent loss of material and spillage or contamination from one compartment to the other. Cement shall be handled in such manner as to prevent loss during the loading, hauling, and unloading process. To prevent loss of cement, the material shall be transported by:

(a) batch trucks equipped with separate metal or metal-lined bulk cement containers kept closed while the material is in transit, or

(b) batch truck compartments equipped with rigid, tight-fitting covers to be kept closed while the material is in transit and opened when the batches are being discharged, and in which at least a portion of the aggregate is placed prior to placing the cement, or

(c) placing the cement on the coarse aggregate and adequately covering with sand when rigid compartment covers or separate cement containers are not used, or

(d) other methods specifically approved by the Engineer.

502.3.2.1 Trucks for transporting mixed concrete shall meet the requirements of Sec 501. Consideration will be given for the use of an approved type of non-agitating equipment for transporting central mixed concrete provided the discharge of the concrete is completed within 30 minutes after the introduction of the mixing water to the cement and aggregates. Bodies of non-agitating hauling equipment shall be smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory, controlled rate without segregation. Covers shall be provided when needed for protection or to comply with Statutes.
502.3.3 Forms. Side forms, except as otherwise permitted, shall be of metal, of an approved section, with a base width not less than the height, except a 9 inch base width will be permitted for 10 inch pavement. The height shall be equal to the edge thickness of the pavement. Each form section shall be straight and free from bends and warps. No section shall show a variation greater than 1/8 inch/10 feet from the true plane surface on the top, and 1/4 inch/10 feet along the face of the form. The method of connecting form sections shall insure a tight, neat joint. Built-up metal forms when allowed may be used by rigidly attaching a wood or metal section of suitable width and thickness to the bottom of the form providing an increase in depth of not more than 20 percent. Each 10 feet form will be securely held in position by a minimum of three approved form pins.

502.3.3.1 Forms for curved form lines shall comply with the grade and alignment requirements of Sec 502.4.3.2, except that straight steel form sections 10 feet or less in length may be used for form lines having a radius greater than 200 feet. Special forms of wood or steel will be permitted for curved form lines having a radius of 200 feet or less, and may be permitted if approved by the Engineer in other special cases where it is not practicable to use standard pavement forms. Straight steel form sections 5 feet in length will be acceptable for curved form lines having a radius of not less than 100 feet. Forms shall be of sufficient rigidity to prevent distortion in edge alignment due to pressure of the concrete. Wood forms may be used with a minimum thickness of 1 inch. Radius of 32 feet or less will be formed with segmented steel or wood forms with a minimum thickness of 1 inch and will be held securely with approved form pins as required by the Engineer. Wood forms shall not be used as a track for operating paving and finishing equipment. All forms will be set on compacted subgrade without support devices.

502.3.4 Slip-Form Construction. Concrete base or pavement may be constructed by the use of sliding form methods. Slip-form construction shall be in accordance with these specifications.

502.3.4.1 Consolidating and Finishing Equipment. The concrete shall be consolidated and finished by a slipform paver designed to spread, consolidate and shape the concrete in one complete pass of the machine in such a manner to provide a smooth, dense and homogeneous pavement in conformance with the plans and specifications.

502.3.5 Vibrators. Vibrators used for full width vibration of the concrete shall be of the internal type. They shall not come in contact with the reinforcement, load transfer devices, subgrade or side forms. Vibrating equipment shall be operated in accordance with the manufacturer's recommendation at a frequency to provide satisfactory results, but shall not be less than 4500 impulses per minute. Hand vibrators shall have a frequency of not less than 4500 impulses per minute. The Contractor shall have a satisfactory tachometer available at all times for checking the vibration frequency.

502.3.6 Wire Comb. A wire comb shall be not less than 10 feet long with a single line of wires exposed to a length of approximately 4 inches. The wire shall be blue tempered and polished spring steel with nominal dimensions of 0.028 inch thick and 0.100 to 0.125 inch wide. The wires shall be spaced to provide 1/2 inch clear space between wires and securely mounted in a rigid head with the width of each wire parallel to the longitudinal center line of the head. The wire comb shall be mechanically operated with the length of the comb parallel to the pavement centerline and capable of transversing the full width of pavement in a single pass at a uniform speed and at a uniform depth. Final approval of the wire comb will be based on satisfactory performance during actual use. Texturing equipment, other than a wire comb, may be approved provided it produces a texture equivalent to that produced by a wire comb and upon satisfactory performance during actual use. Hand use of a wire comb of standard dimension will be permitted with prior approval of the Engineer. An unsatisfactorily combed area will be refloated and textured.

502.3.7 Concrete Saw. If sawed joints are required, equipment shall be capable of providing a groove of the specified dimensions in the concrete. Equipment shall be a wet-cut saw, referred to as a “conventional concrete saw” or a lighter weight dry-cut saw, referred to as an “early-entry concrete saw,” used to establish joints sooner than the conventional saw.
502.3.8 Equipment for Sealing Joints. An approved double boiler-type heating kettle equipped with a mechanical agitator and a satisfactory temperature indicating device will be required. The equipment shall be capable of heating the joint sealing material uniformly without damage.

502.3.9 Auxiliary Equipment. Auxiliary equipment shall be available at all times as follows:

(a) A minimum of one footbridge designed to be readily transportable and having no contact with the concrete base or pavement.

(b) Two or more 10 foot straightedges of an approved type. The blades will be composed of aluminum or magnesium, reinforced on the upper edge and rigidly jointed to the handle. The blades shall be capable of producing the proper section and slope. Blades shall be replaced when edges become wavy or warped.

(c) Long-handled floats, each having a blade of 3 feet in length and 6 inches in width.

(d) Sufficient burlap, waterproof paper, or plastic film for the protection of the pavement in case of rain or breakdown of the curing equipment.

(e) A manually operated long-handled wire comb approximately 2 feet wide with wire size and spacing in accordance with the requirements of Sec 502.3.6.

502.3.10 Check Template. An approved heavy metal check template rolling on the side forms shall be provided. The template shall have a square edge for checking the subgrade surface. Scratch templates with spikes or teeth will not be permitted. In instances of small concrete pavement pours, the use of a string line or an approved portable template to check the subgrade may be used with the approval of the Engineer.

502.4 Construction Requirements.

502.4.1 Weather Limitations. Unless otherwise authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending ambient temperature away from artificial heat reaches 40°F and not resumed until an ascending ambient temperature away from artificial heat reaches 35°F If approval has been granted for the Contractor to place the concrete while the ambient temperature is at or lower than 40°F, the Contractor shall take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates or applying heat directly to the contents of the mixer. Aggregates shall not be heated higher than 150°F, and the temperature of the aggregates and mixing water combined shall not be higher than 100°F, when the cement is added. Unless otherwise authorized, the temperature of the mixed concrete when heating is employed shall not be less than 50°F and not more than 80°F at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen subgrade except with written approval of the Engineer.

502.4.2 Protection of Pavement.

502.4.2.1 Protection from Freezing. All concrete shall be effectively protected from freezing for a period of at least five (5) days after it has been placed and until a minimum compressive strength of 3000 psi has been attained. Protection will be required for not more than ten (10) days. Regardless of precautions taken, the Contractor shall assume all risks, and all frozen concrete shall be removed and replaced at its expense.

502.4.2.2 Protection Against Rain. To protect against rain, the Contractor shall have on location at all times material for the protection of the edges and surface of the unhardened concrete. The Contractor shall protect the concrete from damage due to rain. Failure to properly protect unhardened concrete may constitute cause for the removal and replacement of defective concrete at the Contractor's expense.
502.4.3 Setting Forms. Forms shall be set so that they rest firmly throughout their length upon the thoroughly compacted subgrade. Any subgrade which is more than 1/2 inch below the established grade at the form line shall be brought to grade for a sufficient width, outside the area required by the pavement, to support the forms adequately, and shall be compacted to specified density. Any variations, whether below or above grade, shall be brought to true grade.

502.4.3.1 Forms shall be staked into place with not less than three pins for each 10 feet section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. If the subgrade becomes soft and yielding after the forms have been set and before the concrete is placed, the forms shall be reset on a stable foundation.

502.4.3.2 Both straight and curved forms shall be supported in such position that the face of the form shall be vertical on tangents and perpendicular to the superelevated section on curves. The top of the form shall not vary more than 1/8 inch from the true grade line during placing, compacting, and finishing operations. The form alignment shall not vary more than 1/4 inch from the true alignment.

502.4.3.3 Unless otherwise permitted, sufficient forms shall be provided so that at least 500 feet of forms on each side of the roadbed are accurately set at all times in their required final position in advance of the point where concrete is being placed. Each time forms are used, they shall be cleaned thoroughly and oiled before reuse.

502.4.4 Conditioning of Subgrade. When forms have been securely set to grade, the subgrade shall be brought to proper cross section in accordance with Sec 209, Subgrade Preparation. The final checking for proper crown and elevation of the subgrade by means of the check template required in Sec 502.3.10 shall be performed in the presence of the Engineer after all equipment traffic on the subgrade has ceased and as close as is practicable to the area of current concrete placement. If calibrated rod measurements taken when the surface of the pavement has been finished indicate that pavement thickness is less than specified on the plans, the subgrade planer and template shall be immediately adjusted.

502.4.4.1 Low areas of treated bases shall be filled only with concrete integral with the pavement. No direct payment will be made for the concrete used to fill these low areas.

502.4.5 Proportioning and Mixing Concrete. Concrete shall be proportioned and mixed by truck or central mixers in accordance with Sec 501. This shall consist of batching all aggregate, cement and water by means of automatic weighing or metering, with all additives dispensed automatically and interlocked with the automatic weighing or metering controls. For central mixed concrete, the mixing cycle shall be timed and interlocked with the weight batch cycle. The weight setting controls shall be equipped so that they may be locked when directed by the Engineer. The automatic batching equipment shall be capable of conversion to manual operation if necessary. In the event of an automatic equipment breakdown, manual operation of the plant will be permitted until the end of the workday.

502.4.6 Placing Concrete. The concrete shall be deposited full depth over the entire width of the subgrade between forms in such manner as to require as little rehandling as practicable. Where concrete is being placed for mainline pavement, mechanical spreading equipment shall be required. Concrete shall be thoroughly vibrated along the forms or sides and along expansion and key type longitudinal joints. Attachments on finishing machines to vibrate the concrete adjacent to forms and longitudinal joints will be permitted provided satisfactory results are attained. Care shall be taken that the vibrator does not penetrate the subgrade or dislodge or move the joints. The vibrating shall be sufficient to produce a smooth pavement edge. Honeycombed edges may be cause for rejection of the pavement.

502.4.7 Strike-off of Concrete and Placement of Reinforcement. Following the placing of the concrete, it shall be struck off so that when the concrete is properly consolidated and finished, the surface of the pavement will be at the proper elevation and cross section. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of wire fabric may be laid full length.
on the concrete in its final position without further manipulation. The reinforcement shall be placed directly upon the concrete and the top layer of the concrete placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor’s expense. When reinforced concrete is placed in one layer, the reinforcement shall be positioned on the plastic concrete and vibrated into correct position by means of a reinforcement installer.

502.4.8 Tie Bar Placement. Tie bars shall be supported in the proper position by chairs driven into the subgrade, or may be placed by approved mechanical methods prior to the consolidation of the concrete after it has been struck-off. Tie bars required at longitudinal construction joints shall be positioned before concrete base or pavement consolidation.

502.4.9 Paving Accessories. Paving accessories including but not limited to dowel baskets and tie bars shall be free from dirt, oil, paint, grease, loose mill scale, and thick rust that could impair bond of the steel with the concrete. Thin, powdery rust need not be removed. Tie bars and dowel bars shall be epoxy coated.

502.4.10 Final Strike-off, Consolidation, and Finishing. Machine finishing by vibrating and screeding processes will be required for all pavement except as permitted by Sec 502.4.11.5. After the final course of the concrete has been placed it shall be struck off and thoroughly vibrated until concrete of a uniform and satisfactory density is obtained. The surface of the pavement shall be screeded as many times and at such intervals as necessary to leave a surface of uniform texture to the proper grade and typical section. Excessive screeding over a given area shall be avoided. Finishing machines shall be kept in satisfactory repair and adjustment and shall be operated without lift, wobbling, or other variation tending to affect a precision finish. While operating, a roll of concrete shall be maintained in front of the full length of all screeds so that the vibrating and screeding work will be fully effective.

502.4.10.1 Consolidation. Vibrating tubes shall extend into the concrete the distance necessary to provide adequate consolidation. Vibrators shall be operated only when the machine to which the vibrators are attached is moving. Care shall be taken that the vibrator does not penetrate the subgrade or dislodge or move the joints. Vibrators shall not come in contact with the reinforcement, load transfer devices, subgrade or side forms.

502.4.10.2 Machine Floating. After the finishing machine operations have been completed, the concrete surface on arterial roadway pavement shall be smoothed and consolidated by mechanical floating, either longitudinal or transverse, leaving the pavement finished to the required cross section, elevation and surface smoothness. Mechanical floats shall be adjusted and so operated that the float or screed will have a small quantity of concrete in front of its full length at all times for filling depressions. The screed or float shall not be raised or lowered for the purpose of maintaining the proper quantity of concrete in front of the float. The longitudinal float shall pass over each area of pavement. Manually operated floating will be required following machine floating and in advance of straightedge testing.

502.4.10.3 Added Finishing Water. Moisture in any form shall not be applied to the surface of the concrete except for emergency conditions. When emergency conditions exist and it becomes necessary to apply additional moisture to the surface of the concrete in order to complete the final finishing operation, water may only be applied in the form of a fine pressure spray. Under such conditions, placement of additional concrete on the subgrade shall be discontinued until the emergency conditions cease.

502.4.10.4 Straight-Edge Testing and Surface Correction. Immediately following the machine floating and while the concrete is still plastic, the Contractor shall test the slab surface for trueness by means of a 10 foot straightedge as specified in Sec 502.3.9 (b). Straightedging shall be done by holding the straightedge in contact with the concrete surface, parallel to the road centerline, and drawing the straightedge lightly across the surface. Advance along the road shall be in successive stages of not more than one-half the length of the straightedge. All variations shall be eliminated by filling depressions with freshly mixed concrete or striking off projections, and the areas so corrected.
shall be consolidated and refinshed by means of a long-handled float. The surface shall again be checked by the Contractor by means of the 10 foot straightedge and any irregularities eliminated.

502.4.11 Surface Finish.

502.4.11.1 Pavement. After surface irregularities have been removed, the concrete shall be given a uniformly roughened surface finish by use of a wire comb or other approved texturing device which produces a texture similar to that produced by a wire comb. The texturing operation shall be executed so that the transverse corrugations will be uniform in appearance. Successive passes of the comb or other approved device shall be overlapped the minimum necessary to obtain a continuously textured surface. The surface texture produced shall have the characteristics of a texture produced using a wire comb as specified in Sec 502.3.6, and which has an average texture depth of approximately 1/8 inch. Texturing shall be completed while the concrete is in such condition that it will not be torn or unduly roughened, and before it has attained its initial set. The texturing device shall be cleaned or replaced as often as necessary to obtain the required surface texture. Upon completion of texturing, the pavement surface shall be uniform in appearance and free from surplus water, rough or porous spots, irregularities, depressions, and other objectionable features. Small or irregular areas, or areas not suitable for machine texturing when adjacent surrounding concrete is ready for texturing, shall be textured with a hand operated device producing a textured surface equivalent to that required for machine combing.

502.4.11.2 Sidewalks, Driveways and Drive Approaches. Sidewalks, driveways and driveway approaches shall be given a uniformly roughened surface finish by the use of a broom. Brooms shall be drawn across the surface from the centerline toward each edge with the broom held perpendicular to the surface, each stroke slightly overlapping the preceding stroke, unless it meets the criteria in Sec 502.4.11.2.1. The brooming operation shall be executed so that the corrugations will be uniform in appearance and not more than 1/16 inch deep. A machine capable of producing a finished surface similar to that required for hand brooming may be used. Brooming shall be completed before the concrete is in a condition that it will be torn or unduly roughened and before the concrete has attained its initial set. The brooms shall be cleaned or replaced as often as necessary to attain the required surface texture. Upon completion of brooming, the surface of the pavement shall be uniform in appearance and shall be free from surplus water, rough or porous spots, irregularities, depressions, and other objectionable features.

502.4.11.2.1 Matching Special Surface Finishes. Existing sidewalks, driveways, and driveway approaches on private property with a special finish, other than described in Sec 502.4.11.2, shall be replaced with a similar finish, pattern, and texture. The Contractor shall match the special surface finishes at no additional cost to the County, unless specified in the contract.

502.4.11.3 Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each form line, and of each side of transverse expansion joints and construction joints shall be worked with an edging tool having a radius of approximately 3/8 inch. A well-defined and continuous radius having a smooth, dense finish shall be produced. The surface of the slab shall not be unduly disturbed by tilting of the tool during use. Tool marks on the slab shall be eliminated by floating. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other.

502.4.11.4 Modified Machine Finishing. For isolated pavement lanes less than 300 feet, all machine finishing equipment will be required except that a manually operated longitudinal float may be used in lieu of the machine float.

502.4.11.5 Hand Finishing. Compacting and finishing pavement by hand methods will be permitted:

(a) For all curves having a form line radius of less than 200 feet or where wood forms are used.
(b) For all tapered and irregular shaped areas.

(c) For isolated pavement lanes when approved by the Engineer.

(d) For pavement lanes of less than 8 feet in width and 200 feet in length.

(e) When a breakdown of the mechanical compacting and finishing equipment occurs or in the event of some other emergency. After a breakdown, only material that has already been proportioned which is within time limits as determined by time stamped on material ticket, and which may become unsatisfactory for use may be finished by hand.

(f) For bridge approaches and pavement to first expansion joint.

502.4.11.5.1 Hand finishing shall consist of all operations required under Sec 502.4.10 except mechanical finishing equipment will not be required. If the mechanical finishing machine is not used, a vibrating screed or a tamping template, the face of which is at least 4 inches wide, having a length slightly in excess of the width of the pavement, and having sufficient rigidity to maintain the true cross section of the pavement shall be used. If a mechanical float is used, a manually operated longitudinal float worked from each side of the pavement shall be used.

502.4.11.5.2 A vibratory screed is required for all taper lanes adjacent to mainline pavement. The screed shall also be used on any mainline pavement not poured with a slip form paver other than in the irregular shaped areas mentioned above.

502.5 Joints. Joints shall be of designated type and dimensions, and constructed at the locations shown on the plans or as approved by the Engineer. Where joints are preformed, the form or joint shall be set and securely fastened to insure the joint being in the required position when the concrete is finished. Dowels and tie bars in their final position shall be parallel to the subgrade and perpendicular to the line of the joint. Dowel supporting assemblies shall conform to one of the types shown on the plans. The concrete shall be placed so that it will not displace or disarrange the joint installations. Joint spacing shall not exceed 15 feet.

502.5.1 Expansion Joints. Expansion joints shall extend for the full cross section and full depth of the concrete pavement. The filler shall be premolded. Filler placed prior to the placement of the concrete shall be installed with a removable cap or edging bar to serve as a guide for edging the joint and protection for the filler during the placing and finishing of the concrete. Joints constructed after the placement of concrete shall be sawed full depth and the exposed edges shall be ground to a chamfer of 3/8 inch. The filler shall rest snugly on the subgrade from form to form. The joints shall be sealed as required in Sec 502.5.4. Upon removal of the forms, any struts or fins of concrete extending across the joint shall be removed to the full width of the joint and the full thickness of the pavement.

502.5.2 Construction Joints. Construction joints shall be made at the close of each day’s work or when the work is stopped or interrupted for more than 30 minutes. No transverse construction joint shall be constructed within 10 feet of an expansion or contraction joint. For transverse contraction joint spacing of 15 feet or less, the transverse construction joint shall be located within the normal sequence of contraction joint spacing as shown on the plans. Construction joints shall be constructed perpendicular to the top surface and the centerline of the pavement. Construction joints may be formed with a timber header or may be sawed full depth. The final joint shall conform to the cross section of the pavement. Before paving operations are resumed, all surplus concrete and other refuse shall be removed from the subgrade.

502.5.3 Sawing Joints. Unless otherwise provided, all transverse contraction joints and all longitudinal joints in the pavement shall be sawed with the joint groove cut to the dimensions shown on the plans. If the groove for poured type transverse joints is cut prior to removal of the forms, the groove shall be cut as close as is practicable to the pavement edge, and the resulting crescent shaped plug in the groove, immediately adjacent to the form, will be acceptable. For intersections and irregular pavement, joints shall be sawed at locations as approved by the
Engineer. Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. All joints shall be sawed before uncontrolled shrinkage cracking takes place. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. The County reserves the right to have the Contractor install preformed type joints on multiple width construction when the use of sawed joints fails to prevent random cracking. Any non-reinforced concrete pavement with random cracking not controlled by dowels or tie bars shall be removed and replaced using dowels or tie bars as appropriate to the nearest controlled joint at the Contractor’s expense.

502.5.4 Sealing Joints. All sawed contraction joints and sawed or formed expansion joints shall be sealed with joint sealing material before the pavement is opened to traffic, including construction traffic, and as soon after completion of a minimum curing period of 72 hours providing vehicles are not placed on the pavement when performing the sealing operation. Immediately prior to sealing, the joints shall be thoroughly cleaned and dried. The sealing material shall be heated to the pouring temperature recommended by the manufacturer. Any material that has been heated above the maximum safe heating temperature will be rejected. The sealing mixture material shall be installed in such a way as to fill the joint opening completely and uniformly from the bottom to approximately 1/8 inch from the top, and any excess material shall be removed from the pavement surface. Sawed joints in vertical curb shall be sealed with caulking approved by the Engineer.

502.5.5 Adding New Pavement. New pavement constructed parallel to existing pavement shall be tied to the existing pavement with the existing longitudinal tie bars. The tie bars shall be straightened and incorporated into the new abutting slabs. Where tie bars do not exist, new 5/8 inch diameter bars, 30 inches long shall be installed on 30 inch centers into the existing pavement. The drilled holes for the tie bars 3/4 inch diameter and 18 inches deep. An approved epoxy bonding material shall be used to bond the tie bars to the existing slab. Existing pavement joints shall be duplicated in the abutting slabs. No direct payment will be made for the work.

502.6 Curing. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface and exposed edges of the newly placed concrete shall be covered and cured in accordance with one of the following methods. The concrete shall not be left exposed for more than 30 minutes between stages of curing or during the curing period.

502.6.1 White Pigmented Membrane. After the free water has left the pavement surface, the entire surface shall be sealed by spraying with a uniform application of white pigmented membrane curing material. The Contractor shall provide satisfactory equipment to ensure uniform mixture and coverage of curing material, without loss, on the pavement at the rate of not less than one gallon for each 150 square feet. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor shall apply additional curing material to the affected portions. All areas cut by finishing tools subsequent to the application of the curing material shall immediately be given new applications at the rate specified above. If hairline cracking develops before the membrane can be applied, the concrete shall be initially cured with wet burlap in accordance with Sec 502.6.3 before the membrane is placed. Membrane curing shall not be used on Portland cement concrete base. Emulsified asphalt may be used to cure the concrete base if the surface course is to be a bituminous type.

502.6.2 Waterproofed Paper, Polyethylene Sheeting, and Polyethylene--Burlap Sheeting. As soon as the concrete has set sufficiently to prevent marring, the top surface of the pavement shall be covered with units of waterproofed paper, white polyethylene sheeting, or white polyethylene-burlap sheeting, which shall be lapped not less than 18 inches. If polyethylene-burlap sheeting is used, the burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All coverings shall be so placed and weighted that they remain in contact with the pavement surface and edges for not less than 72 hours after the concrete has been placed. If hair-checking develops before the covering can be applied, the concrete shall be initially cured with wet burlap as specified in Sec 502.6.3 before the covering is placed.
502.6.3 Burlap. The top surface of the concrete shall be temporarily covered with thoroughly damp burlap after the concrete has set sufficiently to prevent marring of the surface. Burlap shall be handled in such a manner that contact with earth or other deleterious substances is avoided. All burlap, except burlap previously used for curing concrete, shall be thoroughly washed. The burlap shall be kept thoroughly wet until removed for application of the final curing material. Neither the top nor the edge of the concrete shall be left unprotected for more than 30 minutes. When the burlap is removed, white pigmented membrane curing material shall be continued by one of the approved methods.

502.7 Removing Forms. Forms shall be removed carefully so as to avoid damage to the pavement. Removed forms will not be placed on pavement during the 72 hour curing period. Honeycombed areas will be considered as defective work and shall be immediately repaired. If the forms are removed prior to 72 hours after placing concrete, the sides of the slab shall be cured by one of the methods specified above. Any trench excavated for the forms shall be entirely backfilled so no water will stand next to the pavement.

502.8 Surface Smoothness. The pavement surface shall be thoroughly tested for smoothness by profiling or straightedging as indicated in Sec 610.

502.9 Opening to Traffic. The concrete pavement shall not be opened for light traffic or construction traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3000 psi. The pavement shall not be opened to all types of traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3500 psi. If high early strength concrete is used, the pavement may be opened to all types of traffic when the concrete has attained a minimum compressive strength of 3500 psi. In either case an ultimate strength of 4000 psi must be obtained for all concrete pavement. Compressive strength will be determined by tests made in accordance with St. Charles County Highway Department methods. Pavement shall be cleaned and joints sealed prior to opening to traffic.

502.10 Slip-Form Construction. At the option of the Contractor, pavement may be constructed by the use of sliding form methods. All applicable provisions of Sec 502, Portland Cement Concrete Pavement, shall be followed. In addition, the following provisions shall apply.

502.10.1 Subgrade and Base. Where an aggregate base course is required for the pavement, it shall be constructed in accordance with the requirements of Sec 304, Aggregate Base Course. After the grade or base has been placed and compacted to the required density, the areas that will support the paving machine shall be cut to the proper elevation by means of an approved machine. The subgrade on which the pavement is to be constructed shall be brought to the proper profile by means of an approved subgrade machine or subgrade planer. An approved check template shall be used to determine if the finished subgrade conforms to the required cross section. The use of a check template may be waived by the Engineer when the subgrade is prepared by full-width equipment using automatic controls operating from an established grade reference line on both sides of the machine.

502.10.2 Placing Concrete. A self-propelled concrete spreader equipped with a power-driven device for spreading the concrete uniformly across the subgrade transversely shall be used to place the concrete. The spreader shall also be equipped with an adjustable strike-off blade capable of striking off the surface of the concrete in the longitudinal direction of the pavement at any required elevation. For isolated pavement lanes over 200 feet long but less than 2000 feet long, a mechanical spreader will not be required. The final surface texture may be applied manually with a wire comb meeting the requirements of Sec 502.3. Concrete can be placed directly on subgrade only with 24 hour prior approval of the Engineer.

502.10.3 Consolidating and Finishing Equipment. The concrete shall be consolidated and finished by a slip-form paver designed to spread, consolidate and shape the concrete in one complete pass of the machine in such a manner to provide a smooth, dense and homogeneous pavement in conformance with the plans and specifications. Hand finishing is discouraged. The slip-form paver shall be fully energized, self-propelled and crawler mounted. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown
on the plans at an adequate forward speed, and without transverse, longitudinal or vertical instability or displacement. The slip-form paver shall produce a surface reasonably free of surface voids and tears. The machine shall satisfactorily vibrate the concrete for the full width and depth of the pavement being placed. No apparent slumping of the concrete shall occur 6 inches or more in from the pavement edge. All operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

502.10.4 Forms. Forms shall be used where necessary to produce a pavement of plan section and shall incorporate a keyway where required.

502.10.4.1 Longitudinal tongue and groove joints of the specified type and size shall be constructed at locations shown on the plans or approved by the Engineer. The groove side of the joint shall be slip-formed or formed with approved metal forms that will produce a keyway conforming to plan location and dimensions. The form shall remain in place for sufficient time to prevent slump. Metal forms may be left in place if approved by the Engineer. The tongue side of the joint may be constructed without forms provided the plan section of the pavement and joint is maintained.

502.10.4.2 Where tie bars are required at longitudinal joints the bars shall be machine positioned before pavement consolidation. Hand placing of tie bars after consolidation of concrete will not be allowed. At Contractor’s option, drilling and epoxying of the tie bars will be permitted after 72-hour curing period in accordance with Sec 502.5. If a tongue and groove type joint is constructed the tie bars shall be installed in the groove side of the joint.

502.11 Material Testing

502.11.1 Fine and Coarse Aggregate.

502.11.1.1 Aggregate Gradation. A sieve analysis shall be performed by the Engineer in accordance with AASHTO T 27 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt. The Engineer will determine the testing frequencies.

502.11.1.2 Deleterious Materials. Deleterious content testing will be performed by the Engineer. Testing shall be performed in accordance with MoDOT Test Method TM 71 from randomly sampled material taken from the discharge gate of the storage bin or from the conveyor belt. Test shall be performed on coarse aggregate fractions.

502.11.2 Slump. Slump tests shall be performed on a random basis by the Engineer. The slump shall be in accordance with Sec 501.4. Slump tests shall be in accordance with AASHTO T 119 from randomly sampled material discharged from trucks at the paving site. Material samples shall be in accordance with AASHTO R 60.

502.11.3 Entrained Air Content. Tests for entrained air content shall be performed on a random basis for each 400 cubic yards of material produced. The air content shall be in accordance with Sec 501.9.2, except that the minimum air content in front of the paver shall be 4.5 percent plus the air loss through the paver. The air loss through the paver is determined a minimum of once per day production by sampling the concrete ahead of the paver and behind the paver and subtracting the value obtained ahead of the paver from the value obtained behind the paver. On the first day of paving, the target air content shall be determined immediately after placing 200 cubic yards of concrete. The entrained air content of the first 200 cubic yards of concrete placed on the first day of paving, sampled in front of the paver, shall be greater than 6.0 percent. Tests shall be in accordance with AASHTO T 152.

502.11.4 Compressive Strength Testing. Cylinder Specimens for strength testing shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of at least three 4 by 8 inch or at least two 6 by 12 inch cylinders made from the same sample of concrete.
and tested at 28 days or at the age designated for determination of the concrete compressive strength. Unless otherwise directed, the cylinders shall be tested at the following intervals:

<table>
<thead>
<tr>
<th>Compressive Strength</th>
<th>Deductions, Percent of Bid Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000 psi or more</td>
<td>None</td>
</tr>
<tr>
<td>3836 psi to 3999 psi</td>
<td>20</td>
</tr>
<tr>
<td>3500 psi to 3835 psi</td>
<td>40</td>
</tr>
<tr>
<td>Less than 3500 psi</td>
<td>100 or remove and replace</td>
</tr>
</tbody>
</table>

502.11.4.1 Deficiencies in Compressive Strength. The compressive strength of concrete pavement will be determined through testing of cylinders and/or cores at frequencies determined by the Engineer. If any compressive strength measurement is deficient from the design compressive strength, the County will have the option of having the Contractor remove and replace the pavement at its expense or allow the Contractor to leave the pavement in place and receive the below deductions in payment.

<table>
<thead>
<tr>
<th>Compressive Strength</th>
<th>Deductions, Percent of Bid Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000 psi or more</td>
<td>None</td>
</tr>
<tr>
<td>3836 psi to 3999 psi</td>
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<tr>
<td>3500 psi to 3835 psi</td>
<td>40</td>
</tr>
<tr>
<td>Less than 3500 psi</td>
<td>100 or remove and replace</td>
</tr>
</tbody>
</table>

502.11.4.1.1 Any pavement, for which the sum of deductions for thickness and compressive strength exceeds 100 percent of the bid price, may be removed and replaced at the sole discretion of the County.

502.11.4.2 Representative Area. The core or set of cylinders will represent the compressive strength for a distance extending one-half the distance to the next core (or set of cylinders), measured along centerline, or in the case of a beginning or ending core (or set of cylinders), the distance will extend to the end of the pavement section.

502.11.5 Pavement Thickness. For the purpose of determining the constructed thickness of the pavement, cores will be taken at random intervals in each traffic lane at the rate of four (4) cores per 1000 feet. Cores taken for determining density may also be used for determining thickness. Additional cores will be taken at 30 foot interval parallel to the centerline ahead and back of all locations where core measurements indicate a deficiency of 0.25 inches or greater from the plan thickness until such time a deficiency in excess of or equal to 0.25 inches are no longer found. Deductions for thickness deficiencies will be in accordance with Sec 502.11.6.4.

502.11.5.1 The Engineer can require additional cores be drilled at all locations where thickness measurements taken during construction indicate a thickness deficiency.

502.11.5.2 Cores. Cores shall be taken in accordance with AASHTO T 24. Cores shall not be taken until a minimum compressive strength of 3,000 psi has been attained. Cores shall be neatly cut with a core drill. The Contractor shall furnish all tools, labor and material for cutting samples and filling the cored hole. The Contractor shall fill the core holes with an approved non-shrink grout within one day after sampling.

502.11.5.3 Pavement Thickness after Diamond Grinding. If the Contractor elects to diamond grind to improve smoothness or surface texture, in accordance with Sec 610.4.5.3, then pavement thickness determination will be made after all smoothness correction has been completed. Cores shall be 4 inch in diameter. Location of coring will be determined by the Engineer using random sampling procedures in accordance with ASTM D 3665.
502.11.5.4 Compensation for Thickness Deficiencies. If any core measurement is less than the thickness indicated on the plans, the Contractor will have the option of either removing and replacing the pavement at his sole expense or accepting the monetary deduction for the deficiency in accordance with the schedule below. The choice of penalty for the greater than 0.75 inches deficiency shall be at the sole discretion of the County.

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Percent Deduction in Unit Price per SY</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.25 in.</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 0.25 in. to ≤ 0.50 in.</td>
<td>25%</td>
</tr>
<tr>
<td>&gt; 0.50 in. to ≤ 0.75 in.</td>
<td>50%</td>
</tr>
<tr>
<td>&gt; 0.75 in.</td>
<td>100%, or remove and replace</td>
</tr>
</tbody>
</table>

502.11.5.5 Representative Area. It will be assumed that each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section. The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of concrete pavement, may be waived by the Engineer. In this case the designed thickness will be considered as the measured thickness.

502.11.6 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement shall be thoroughly tested for smoothness by profiling or straightedging in accordance with Sec 610.

502.12 Marred Surface. A marred surface is any surface that has not been properly finished as required by these specifications. Pavement that has been rained on; pavement that has not reached its initial set and has had water flow on its surface washing away cement; pavement that has had plastic placed on it wherein the plastic has actually caused indentations and random patterns; pavement that has been walked on by humans or animals or driven on by any type of vehicle; or pavement that has had curing compound sprayed on it before the initial set, resulting in pitting marks. Areas corrected for smoothness will not be considered marred surfaces.

501.12.1 Marred Surface Deduction. For marred surface areas or slightly damaged concrete that remains in the completed pavement, a minimum deduction of 20 percent of the contract unit bid price will be made for the areas affected. The deduction will be applied to a section of pavement extending from edge of the pavement to a longitudinal joint or between longitudinal joints in that section of pavement affected. If the length of the section affected is less than 15 feet, the deduction will be computed for 15 feet.

502.13 Method of Measurement. Pavement areas will be computed to the nearest 1/10 square yard. Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

502.14 Basis of Payment.

502.14.1 The contract unit price for Portland cement concrete pavement will be considered as full compensation for all labor, equipment, and materials; including reinforcement, dowels, dowel supports, tie bars and any other items entering into the construction of the traveled way pavement or Portland cement concrete shoulders, and for the cost of smoothness testing. The unit price will be modified by smoothness per Sec 610, by compressive strength per Sec 502.11.5, by thickness per Sec 502.11.5, and by marred surface per Sec 502.12. Payment for obtaining and delivering samples from the pavement and replacing the surface will not be made, as all such sampling requirements shall be considered incidental. No additional compensation will be allowed for any excess thickness.
502.14.2 When paving widths are greater than the travel lane widths, profiling and payment for profiling will apply to the traffic lane design driving width only, normally 12 feet. Random lane coring for thickness will include the full paved lane width to the longitudinal joints or edge of shoulder, whichever is first.
SECTION 503
BRIDGE APPROACH SLAB

503.1 Description. This work shall consist of constructing a reinforced concrete or asphaltic concrete bridge approach slab on a prepared subgrade in accordance with these specifications and as shown on the plans or as directed by the Engineer.

503.2 Material. All material, proportioning, air-entraining, mixing, slump and transporting of Portland cement concrete shall be in accordance with Sec 501. Approach slabs shall be constructed of pavement concrete, Class B-1 concrete mixture, or an approved EMPC pavement concrete per Sec 511. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate for Base</td>
<td>1007.3</td>
</tr>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
<td>1036</td>
</tr>
<tr>
<td>Concrete Sealer</td>
<td>1053</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Materials for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Polyethylene Sheeting</td>
<td>1058</td>
</tr>
</tbody>
</table>

503.3 Construction Requirements. Concrete bridge approach slabs shall be constructed in accordance with Sec 703 and Sec 706, and shall attain a compressive strength of 4,000 psi prior to opening to traffic. Concrete bridge approach slabs shall be textured in accordance with Sec 703. Curing shall be in accordance with Sec 502, except the liquid membrane-curing compounds shall be in accordance with Sec 1055 for bridge curing compounds. Bridge approach slabs shall require sealing with a concrete sealer. Asphalt bridge approach slabs shall be constructed in accordance with the specifications for the mix type specified.

503.3.1 Voids Under Completed Concrete Approach Slabs. Prior to acceptance of the work, underseal access holes may be required to be drilled by the Contractor to permit investigation by the Engineer of any suspected voids or cavities, which if found shall be filled by the Contractor using an approved method. Care shall be taken during pumping operations to avoid raising the approach slab.

503.3.1.1 Filling Holes. At the completion of the investigation or underseal pumping, the holes shall be filled with sand to within one inch of the top and the remainder filled with joint sealing material.

503.4 Method of Measurement. Approach slab areas will be computed to the nearest 1/10 square yard. The section of contiguous pavement placed continuous with the approach slab will not be measured as approach slab. Final measurement of the completed bridge approach slab will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

503.5 Basis of Payment. The accepted quantity of bridge approach slabs will be paid for at the contract unit bid price.

503.5.1 No direct payment will be made for the reinforcing steel for bridge approach slabs. Also, no direct payment will be made for investigating void conditions under the completed slab, for filling any voids found, nor for correcting settlement.
504.1 Description. This work shall consist of placement and preparation of base material and the construction of concrete approach pavement in accordance with these specifications, as shown on the plans or as directed by the Engineer.

504.2 Material. All material, proportioning, air-entraining, mixing, slump and transporting of Portland cement concrete shall be in accordance with Sec 501. Approach pavement shall be constructed of pavement concrete, an approved Class B-1 concrete mixture, or an approved EMPC pavement concrete per Sec 511. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate for Base</td>
<td>1007.3</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
</tbody>
</table>

504.3 Construction Requirements.

504.3.1 Base placement shall be in accordance with Sec 304. Concrete approach pavement and shoulders shall be constructed in accordance with Sec 503. Concrete approach pavement will not require sealing with a concrete sealer. Type A Curb, where required, shall be constructed in accordance with Sec 609.

504.3.2 Aggregate Base Testing of aggregate base will be completed by the Engineer.

504.4 Method of Measurement. Final measurement of the completed concrete approach pavement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, concrete approach pavement areas, including shoulders, will be measured to the nearest 1/10 square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

504.5 Basis of Payment. The accepted quantity of concrete approach pavement will be paid for at the contract unit price and will be considered full compensation for Type A Curb, all labor, equipment and material to complete the described work.
SECTION 510
ROLLER COMPACTED CONCRETE

510.1 Description. Roller Compacted Concrete (RCC) is proportioned, mixed, placed, compacted, and cured in accordance with these specifications. RCC shall conform to the lines, grades, thickness, and typical cross section shown in the plans or otherwise established by the Engineer.

510.2 Materials. All materials shall be in accordance with Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate(^a)</td>
<td>1005.2</td>
</tr>
<tr>
<td>Fine Aggregate(^a)</td>
<td>1005.3</td>
</tr>
<tr>
<td>Ground Granulated Blast Furnace Slag</td>
<td>1017</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>1018</td>
</tr>
<tr>
<td>Cement</td>
<td>1019</td>
</tr>
<tr>
<td>Concrete Admixture</td>
<td>1054</td>
</tr>
<tr>
<td>Curing Compound</td>
<td>407, 1055</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

510.2.1 Aggregate. The plasticity index of the aggregates used shall not exceed 5. The aggregate gradation shall be well-graded without gradation gaps and shall meet the following combined gradation for the application type for RCC specified in the contract:

<table>
<thead>
<tr>
<th>Application</th>
<th>RCC as a Base or Intermediate Lift (Overlaid with 2-inch HMA or greater)</th>
<th>RCC as the Final Surface or with a thin Lift Overlay (RCC as the final surface or capped with a thin HMA overlay less than 2-inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
<td>Percent Passing by Weight</td>
<td>Percent Passing by Weight</td>
</tr>
<tr>
<td>1 Inch</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>3/4 Inch</td>
<td>---</td>
<td>100</td>
</tr>
<tr>
<td>1/2 Inch</td>
<td>70 - 95</td>
<td>85 - 100</td>
</tr>
<tr>
<td>3/8 Inch</td>
<td>60 - 85</td>
<td>---</td>
</tr>
<tr>
<td>No. 4</td>
<td>40 - 60</td>
<td>60 - 85</td>
</tr>
<tr>
<td>No. 8</td>
<td>---</td>
<td>40 - 60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 8</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

510.3 Mix Design. At least 30 days prior to the beginning of placing RCC on the project, the Contractor shall submit a proposed mix design to the Engineer. The target and allowable gradation range of each fraction shall be included. The Contractor may be required to submit representative samples of each ingredient to Engineer for laboratory testing.

510.3.1 Required Information. The mix design shall contain the following information:

(a) Source, type and specific gravity of Portland cement

(b) Source, type (class, grade, etc.) and specific gravity of supplementary materials, if used

(c) Source, name, type and amount of admixture, if used
(d) Source, type (formation, etc.), ledge number if applicable, of the aggregate

(e) Specific gravity and absorption of each fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including raw data

(f) Unit weight of each fraction in accordance with AASHTO T 19

(g) Batch weights of Portland cement and supplemental cementitious materials

(h) Batch weights of coarse, intermediate and fine aggregates

(i) Batch weight of water in pounds per cubic yard (optimum moisture content)

(j) Maximum laboratory density

(k) The laboratory proctor curves illustrating moisture contents vs. density for each cementitious material content. The RCC mix design shall be done in a similar fashion as is done to determine the relationship between the moisture content and the unit weight as soils and soil aggregate mixtures. The apparatus and compacted effort used to fabricate the moisture density specimens correspond to that described in AASHTO T 180, Method D. Strength specimens shall be made in accordance with ASTM C 1176 or ASTM C 1435 at the optimum moisture content for each cementitious material content to verify minimum compressive strength requirements.

510.3.2 Trial Batch. The Contractor shall prepare and test a trial batch mixture at the mixing facility to verify that the RCC mix complies with the design criteria. The trial batch shall be prepared and tested in the presence of the Engineer.

510.3.3 Production. Production shall not begin until an approved mix design has been obtained and verified by the trial batch.

510.3.4 Design Strength. The mix design shall have a minimum compressive strength of 3,500 psi within 28 days when specimens prepared according to ASTM C 1176 or ASTM C 1435. Compressive strength test shall be performed in accordance with AASHTO T 22.

510.3.5 Minimum Water Content. The water-cement ratio shall not be lower than 0.25.

510.3.6 Minimum Cementitious Content. The total amount of cementitious materials shall not be below 450 pounds per cubic yard.

510.3.7 Supplementary Cementitious Material. RCC may use fly ash, slag cement (GGBFS), or silica fume. Ternary mixes will be allowed for RCC. Ternary mixes are mixes that contain a combination of Portland cement and two supplementary cementitious materials. The amount of supplementary cementitious material content shall be limited to the following requirements:

<table>
<thead>
<tr>
<th>Supplementary Cementitious Material (SCM)</th>
<th>Maximum Percent of Total Cementitious Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash (Class C or Class F)</td>
<td>25%</td>
</tr>
<tr>
<td>Slag Cement (GGBFS)</td>
<td>30%</td>
</tr>
<tr>
<td>Silica Fume</td>
<td>8%</td>
</tr>
<tr>
<td>Ternary Combinations</td>
<td>40%</td>
</tr>
</tbody>
</table>
510.4 **Equipment.** RCC shall be constructed with any combination of equipment that will produce a pavement meeting the requirements for mixing, transporting, placing, compacting, finishing, and curing as provided in this specification.

510.4.1 **Mixing Plant.** The mixing plant shall be capable of producing RCC to the proportions defined by the final approved mix design and within the specified tolerances. The capacity of the plant shall be sufficient to produce a uniform mixture at a rate compatible with the placement equipment.

510.4.2 **Paver.** RCC shall be placed with a high-density or conventional asphalt type paver subject to approval by the Engineer. The paver shall be of suitable weight and stability to spread and finish the RCC material, without segregation, to the required thickness, smoothness, surface texture, cross-section, and grade.

510.4.3 **Compactors.** When a conventional asphalt type paver is used, self-propelled steel drum vibratory rollers shall be used for primary compaction. For final compaction, a steel drum roller, operated in a static mode, or a rubber-tired roller may be utilized to meet density requirements.

510.4.4 **Haul Equipment.** The hauling equipment shall be smooth, mortar-tight, metal containers capable of discharging the concrete at a controlled rate without segregation. Hauling equipment shall have a retractable cover to protect mix from weather and excessive evaporation. The time elapsing from when water is added to the mix until it is deposited in place at the work shall not exceed 45 minutes.

510.4.5 **Access for Inspection and Calibration.** The Engineer shall have access at all times for any plant, equipment, or machinery to be used in order to check calibration, scales, controls, or operating adjustments.

510.5 **Construction Requirements.**

510.5.1 **Preparation of Subgrade.** Before the RCC processing begins, the subgrade and base course must be prepared in accordance with Sec 304.

510.5.2 **Subbase Condition.** The surface of the subbase shall be clean and free of foreign material and standing water prior to placement of the RCC. The aggregate base shall be uniformly moist at the time of RCC placement. RCC shall not be placed upon frozen subbase.

510.5.3 **Mixing Time.** Mixing time shall be adequate to ensure a thorough and complete mixing of all materials. Concrete shall be homogeneous with no aggregate segregation. In no case shall the mixing time, after all materials including water are in the mixer, be less than 90 seconds.

510.5.4 **Operating Tolerances.** The mixing plant shall receive the quantities of individual ingredients to within the following tolerances:

<table>
<thead>
<tr>
<th>Material</th>
<th>Variation by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cementitious Materials</td>
<td>± 2.0%</td>
</tr>
<tr>
<td>Water</td>
<td>± 3.0%</td>
</tr>
<tr>
<td>Aggregates</td>
<td>± 4.0%</td>
</tr>
</tbody>
</table>

510.5.5 **Plant Calibration.** Prior to RCC production, the Contractor shall calibrate the plant in accordance with the manufacturer’s recommended practice. A copy of the calibration shall be provided to the Engineer when requested.

510.5.6 **Curing.** Immediately after final rolling, the RCC surface shall be kept continuously moist until an approved curing compound is applied. The application of the curing compound shall progress such that no more than 10 linear feet of the final RCC surface is exposed without curing at any time.
510.5.6.1. Water Cure. Water cure shall be applied such that a uniform moist condition on the surface of the RCC is attained. Application of this moisture shall be done in a manner that will not erode or damage the finished RCC surface.

510.5.6.2 Curing Compound. When RCC is used as the final surface, either white pigmented curing compound applied at the rate of one gallon for each 100 square feet or a tack coat product applied at 0.14 gal/yd² shall be used for curing. When RCC is to be overlaid with asphalt, the curing compound shall be a tack coat product applied at 0.14 gal/yd² in accordance with Sec 407.

510.5.7 Lift Thickness. The minimum and maximum compacted lift thickness for constructing RCC shall be 4 inches and 8 inches respectively. Additional lifts shall be placed within 60 minutes of completing the previous lift. If a subsequent lift cannot be placed within 60 minutes due to factors outside the Contractor’s control, such as inclement weather or equipment breakdown, the previous lift shall be made clean, free of laitance, and moist, but not wet, at the time of placement of the subsequent lift.

510.5.8 Weather Conditions.

510.5.8.1 Hot Weather Precautions. The Contractor shall schedule placing and finishing of the RCC during hours in which the ambient air temperature is forecast to be lower than 85°F.

510.5.8.2 Cold Weather. For cold weather placement, RCC may be placed when the air temperature is above 40°F and rising, and placement shall stop when the falling temperature reaches 45°F or below, unless otherwise approved by the Engineer. The Contractor shall provide a method, meeting the approval of the Engineer, of monitoring the concrete that demonstrates that the concrete has been protected from freezing.

510.5.8.3 Protection Against Rain. To protect against rain, the Contractor shall have on location at all times material for the protection of the unhardened concrete. The Contractor shall protect the concrete from damage due to rain.

510.5.8.4 Windy Conditions. During periods of windy conditions, special precautions shall be taken to minimize moisture loss due to evaporation.

510.5.9 Finished Surface. The finished RCC surface shall be smooth, uniform, and continuous without tears, ridges, or aggregate segregation once it leaves the paver. RCC mainline pavement shall meet the smoothness criteria of Sec 502.8. When RCC is the final surface, the finished surface texture shall be broom finished, diamond ground, or other finishes approved by the Engineer. All finished surface textures shall be in accordance with Sec 502.4.

510.5.9.1 Inaccessible Areas. All areas inaccessible to either roller or paver shall be paved with cast-in-place concrete in accordance with Sec 502.

510.5.9.2 Handwork. Broadcasting or fanning the RCC material across areas being compacted is not permissible. Such additions of materials may only be done immediately behind the paver and before any compaction has taken place.

510.5.9.3 Segregation. If segregation occurs in the RCC during paving operations, placement shall cease until corrective measures are taken.

510.5.10 Cold Joints. Prior to placing fresh RCC mixture against a cold vertical joint, the joint shall be thoroughly cleaned of loose or foreign material. The vertical joint face shall be wetted and in a moist condition immediately prior to placement of the adjacent lane.

510.5.11 Control Joints. Concrete control joints shall be constructed at 15-foot intervals in RCC mainline pavement. Control joint spacing for RCC shoulders adjacent to HMA or composite pavement shall be a minimum of 30-foot
intervals. RCC shoulders adjacent to existing PCC pavement shall have control joints located to match the joints of the adjacent pavement. For all other PCC joint spacing; the RCC control joints shall match the adjacent PCC pavement’s joints or cracks not to exceed a 30-foot interval. All control joints shall be tooled or cut to 1/3 the depth of the RCC thickness. Sealing the control joints is not required.

510.5.12 Opening to Traffic. The Contractor shall protect the RCC from traffic during the curing period. The RCC shoulder pavement may be opened to light traffic after one day and opened to unrestricted traffic after 5 days. The RCC mainline pavement may be opened to light traffic at 2,500 psi and opened to unrestricted traffic at 3,000 psi.

510.6 Material Testing.

510.6.1 Density. The Engineer will determine the density in accordance with AASHTO T 310, direct transmission. Tests shall be performed no later than 30 minutes after the completion of the rolling. Only wet density will be used for evaluation. The Engineer will determine the density of the RCC shoulder and mainline pavement at a frequency of no less than one per 7500 square yards. Sampling locations will be determined by the Engineer using random sampling procedures in accordance with ASTM D 3665.

510.6.2 Pavement Thickness. For the purpose of determining the constructed thickness of the pavement, cores will be taken at random intervals in each traffic lane at the rate of four (4) cores per 1000 feet. Cores taken for determining density may also be used for determining thickness. Additional cores will be taken at 30 foot interval parallel to the centerline ahead and back of all locations where core measurements indicate a deficiency of 0.25 inches or greater from the plan thickness until such time a deficiency in excess of or equal to 0.25 inches are no longer found. Deductions for thickness deficiencies will be in accordance with Sec 510.6.5.2.

510.6.2.1 The Engineer can require additional cores be drilled at all locations where thickness measurements taken during construction indicate a thickness deficiency.

510.6.2.2 Cores. Cores shall be taken in accordance with AASHTO T 24. Cores shall not be taken until a minimum compressive strength of 3,000 psi has been attained. Cores shall be neatly cut with a core drill. The Contractor shall furnish all tools, labor and material for cutting samples and filling the cored hole. The Contractor shall fill the core holes with an approved non-shrink grout within one day after sampling.

510.6.3 Aggregate Gradation. The Engineer will perform the sieve analysis and determine the testing frequencies. Testing will be performed in accordance with AASHTO T 27 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

510.6.4 Deleterious Materials. The Engineer will determine the deleterious content and testing frequencies. The test will be performed in accordance with MoDOT TM 71 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt. Tests shall be performed on coarse aggregate fractions.

510.6.5 Acceptance.

510.6.5.1 Density. The density shall not be less than 98 percent of the maximum laboratory density.

510.6.5.1.1 Compressive Strength. Roller compacted concrete properly placed and compacted, but not meeting the density requirements shall be cored and tested for compressive strength at no additional cost to the County. Cores shall be taken in accordance with AASHTO T 24. The compressive strength shall be determined by approved methods. Cores shall be tested for compressive strength within 7 days of density testing. If the tested area achieves the design strength, the material will be paid for at full price. Areas that fail to comply with the design strength will be deemed unacceptable and shall be addressed in accordance with Sec 105.11.
510.6.5.2 Pavement Thickness. If any core measurement is less than the thickness indicated on the plans, the Contractor will have the option of removing and replacing the pavement at its sole expense, or will be allowed to reimburse the County for the deficiencies in thickness noted on the schedule below. The choice of alternate penalty for the greater than 0.75 in. deficiency shall be at the sole discretion of the County.

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Percent Deduction in Unit Price per SY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 in. to 0.25 in.</td>
<td>0%</td>
</tr>
<tr>
<td>0.25 in. to 0.50 in.</td>
<td>25%</td>
</tr>
<tr>
<td>0.5 in. to 0.75 in.</td>
<td>50%</td>
</tr>
<tr>
<td>Greater than 0.75 in.</td>
<td>100%, or remove and replace</td>
</tr>
</tbody>
</table>

510.6.5.2.1 Representative Area. It will be assumed that each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section. The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of RCC pavement, may be waived by the Engineer. In this case the designed thickness will be considered as the measured thickness.

510.6.5.3 Aggregate Gradation. When one test is outside the allowable gradation range, immediate steps shall be taken to correct the gradation.

510.6.5.4 Deleterious Materials. When one test is outside the specification limits, immediate steps shall be taken to correct the deleterious content.

510.7 Marred Surface. A marred surface is any surface which meets the following:

(a) Pavement that has been rained on.

(b) Pavement that has not reached its initial set and has had water flow on its surface washing away cement.

(c) Pavement that has had plastic placed on it wherein the plastic has actually caused indentations and random patterns.

(d) Pavement that has been walked on by humans or animals or driven on by any type of vehicle.

(e) Pavement that has had curing compound sprayed on it before the initial set, resulting in pitting marks.

510.7.1 Areas corrected for smoothness will not be considered marred surfaces.

510.7.2 Marred Surface Deduction. For marred surface areas or slightly damaged RCC which is the final surface, a minimum deduction of 20 percent of the contract unit bid price will be made for the areas affected. The deduction will be applied to a section of pavement extending from edge of the pavement to a longitudinal joint or between longitudinal joints in that section of pavement affected. If the length of the section affected is less than 15 feet, the deduction will be computed for 15 feet.

510.8 Method of Measurement. Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of the RCC mainline pavement and shoulders, complete in place, will be made to the nearest 1/10 square yard. The revision or correction will be computed and added to or deducted from the contract quantity.
510.9 Basis of Payment. The accepted quantities of RCC will be paid for at the contract unit price. The unit price will be modified by smoothness per Sec 610, by thickness per Sec 510.6.5.2, and by marred surface per Sec 510.7. The contract unit price will be considered as full compensation for all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work. No additional compensation will be allowed for any excess thickness.
SECTION 511
EASTERN MISSOURI PAVEMENT CONSORTIUM
PORTLAND CEMENT CONCRETE

511.1 **Description.** Concrete shall consist of a mixture of cement, fine aggregate, coarse aggregate and water, combined in the proportions specified for the various classes. Admixtures may be added as specifically required or permitted.

511.2 **Material.** Material requirements shall be in accordance with Sec 501, except as follows.

511.2.1 If Eastern Missouri Pavement Consortium (EMPC) Portland cement concrete is designated in the project contract, then the Sec 511 specifications shall be used for all pavements, curb and gutters, curbs, gutters, approach pavements, driveways, and sidewalks. If EMPC concrete is not designated in the contract the Contractor may use EMPC concrete mix designs, with approval of the Engineer, and at no additional cost to the County.

511.2.2 **Mix Designs.** All EMPC mix designs shall meet the current EMPC specifications and shall be currently approved by the EMPC. The current EMPC specifications will govern, over the requirements in Sec 511. The current specifications, approved suppliers, and approved mix designs can be found at www.empcpavement.org. Procedures on submitting materials and mix designs can also be found on the EMPC’s website. The Contractor shall submit the approved EMPC concrete mix designs to the Engineer.

511.2.2.1 The 28-day compressive strength for concrete shall be 4,000 psi and designated “EMPC 4K”. Compressive strength shall be determined in accordance with ACI 318. All mix designs submitted to the Eastern Missouri Pavement Consortium shall have a unique name designated by the concrete supplier. This unique name must match the name on the concrete delivery ticket or the concrete shall be rejected.

511.2.2.2 28-day compressive strength for sidewalk concrete shall be 3,000 psi. Refer to Sec 511.2.10 for additional requirements for sidewalk concrete.

511.2.3 **Coarse Aggregate.** The EMPC shall approve each coarse aggregate source. Coarse aggregate shall consist of sound, durable rock, free from objectionable coatings or frozen or cemented lumps. Aggregate sampling and grading shall be performed in accordance with ASTM C33 and gradation sizes shall comply with 57 or 67. Coarse aggregate shall meet the chemical and physical requirements of ASTM C33 unless amended or modified by this specification. Mix designs shall specify the gradation designation.

511.2.3.1 **Testing.** Coarse aggregates consisting of limestone, calcitic dolomite or other materials referred to as “limestone” shall undergo additional testing by an independent 3rd party testing agency approved by the EMPC. The testing performed shall include ASTM C295, ASTM C586 and ASTM C1105. The agency performing these tests must be informed prior to testing to look specifically for the potential of ACR and the reports generated from the testing shall specifically address the potential of ACR in the text. This testing shall be performed for each ledge within a quarry seeking approval for use in EMPC concrete. The following requirements pertain to the testing:

   (a) ASTM C295 evaluation shall be performed by a petrographer experienced in identifying ACR-prone dolomitic limestone or calcitic dolomite and show no ACR potential. The reports of the testing noted herein shall be submitted to the EMPC.

   (b) The analysis and interpretation of results for ACR potential per CSA A23.2-26A shall be performed, with interpretation from the testing agency indicating ACR potential per ASTM C1778 and show no ACR potential.

   (c) Either results of the ASTM C1105 or ASTM C1293 as modified in ASTM C1778 shall be performed. Results shall be interpreted as follows:
(1) Results of the ASTM C1105 tests at 90 days, 180 days, and 365 days shall be submitted to the EMPC. ASTM C1105 results shall demonstrate less than 0.015% elongation at 90 days, 0.025% at 180 days, and 0.03% at 365 days to remain conditionally approved for the EMPC year. Test results shall be submitted within 7 days of the test date.

(2) Results of the ASTM C1293 test modified according to ASTM C1778 at 90, 180, and 365 days shall be submitted to the EMPC. Results shall demonstrate less than 0.01% elongation at 90 days, 0.02% elongation at 180 days for conditional approval. In order to maintain approval, passing results of 0.04% at 12 months shall be submitted. All test results listed above shall be submitted within 7 days of their test date. Test results at other time periods listed in the test method shall also be supplied.

511.2.3.1 All testing in Sec 511.2.3.1 regarding ACR shall have occurred within 12 months of the concrete mix design submittal.

511.2.3.2 Deleterious Substances. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances, exclusive of items 5 and 6, shall not exceed 6.0 percent:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Deleterious Material</th>
<th>Test Method</th>
<th>Maximum Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deleterious Rock</td>
<td>MoDOT TM 71</td>
<td>6.0</td>
</tr>
<tr>
<td>2</td>
<td>Shale</td>
<td>MoDOT TM 71</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>Chert in Limestone</td>
<td>MoDOT TM 71</td>
<td>4.0</td>
</tr>
<tr>
<td>4</td>
<td>Other foreign material (Clay lumps, mud balls, lignite, coal, roots, sticks)</td>
<td>MoDOT TM 71</td>
<td>0.5</td>
</tr>
<tr>
<td>5</td>
<td>Material passing No. 200 sieve</td>
<td>ASTM C117</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>Flat and Elongated pieces (5:1)</td>
<td>ASTM D 4791</td>
<td>5.0</td>
</tr>
</tbody>
</table>

511.2.3.3 Crushed Stone. Crushed stone shall be obtained from rock of uniform quality. Rock tested for approval shall be in accordance with the criteria below. Source approval and production samples shall also meet the following criteria:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>Allowable Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Specific Gravity (Oven-Dry)</td>
<td>ASTM C127</td>
<td>2.59 --</td>
</tr>
<tr>
<td>Los Angeles Abrasion, percent</td>
<td>ASTM C131</td>
<td>-- 45</td>
</tr>
<tr>
<td>Micro Deval Abrasion Test, percent</td>
<td>ASTM D6928</td>
<td>-- 20</td>
</tr>
<tr>
<td>Absorption, percent</td>
<td>ASTM C127</td>
<td>-- 2</td>
</tr>
<tr>
<td>Sodium Sulfate Soundness (5 cycles), percent</td>
<td>ASTM C88</td>
<td>-- 10</td>
</tr>
<tr>
<td>Durability Factor, percent</td>
<td>ASTM C666</td>
<td>75 --</td>
</tr>
</tbody>
</table>

511.2.3.4 Coarse aggregate currently approved for use by Kansas City Metro Materials Board will be accepted for use in EMPC mixes. Testing data meeting the Kansas City Metro Materials Board specification shall be provided.

511.2.4 Fine Aggregate. Fine aggregate for concrete shall be a fine granular material naturally produced by the disintegration of rock of a siliceous nature or manufactured from an approved limestone or dolomite source. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating of injurious material. Fine aggregate shall meet the chemical and physical requirements of ASTM C33 unless amended or modified by this specification. The percentage of deleterious substances shall not exceed the following values:
### Deleterious Material Test Method Allowable Maximum Limits (Percent by weight)

<table>
<thead>
<tr>
<th>Deleterious Material</th>
<th>Test Method</th>
<th>Allowable Maximum Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps and Friable Particles</td>
<td>ASTM C142</td>
<td>0.25</td>
</tr>
<tr>
<td>Coal and lignite</td>
<td>ASTM C123</td>
<td>0.25</td>
</tr>
<tr>
<td>Total lightweight (low mass density) Particles, including coal and lignite</td>
<td>ASTM C123</td>
<td>0.50</td>
</tr>
<tr>
<td>Material Passing Number 200 Sieve</td>
<td>ASTM C117</td>
<td>2.0</td>
</tr>
<tr>
<td>Other deleterious Substances (such as shale, alkali, mica, coated grains, and soft and flaky particles)</td>
<td>MoDOT TM 71</td>
<td>0.10</td>
</tr>
<tr>
<td>Sodium Sulfate Soundness (5 cycles)</td>
<td>ASTM C88</td>
<td>10</td>
</tr>
</tbody>
</table>

511.2.4.1 **Gradation for fine aggregate** shall be in accordance with ASTM C33. In lieu of the organic impurities test; a seven-day compressive mortar strength test from AASHTO T 106 provided by and meeting MoDOT compressive mortar strength tests requirements may be provided.

511.2.4.2 **Aggregates in mixes** shall be proportioned to have a minimum of 55% coarse aggregate by weight.

511.2.5 **Cementitious materials.**

The total weight of cementitious materials shall be a minimum of 600 pounds per cubic yard of concrete.

511.2.5.1 **Fly Ash.** When using fly ash, the total weight of cementitious materials shall consist of a minimum of 450 pounds of ASTM C150 Type I, II, I/II, or III Portland cement combined with a minimum of 150 pounds of ASTM C618 Class F fly ash at 25% of the combined total cementitious weight. Loss on ignition is limited to a maximum of 1.5% for Class F fly ash.

511.2.5.2 **Ground Granulated Blast Furnace Slag.** When using slag cement, the total weight of cementitious materials shall consist of a minimum of 420 pounds of ASTM C150 Type I, II, I/II, or III Portland cement combined with a minimum of 180 pounds of ASTM C989 Grade 100 or 120 Ground Granulated Blast Furnace Slag (GGBFS) at 30% of the combined total cementitious weight.

511.2.5.3 **Alkali Content.** The total alkali content of the concrete shall be limited to the sum of the acid soluble alkali content of Portland cement plus either one-sixth the alkali content of fly ash or one-half of the alkali content of slag, to a maximum of 5 lb/yd3.

511.2.5.4 **Mortar Bar Expansion.** Mortar Bar Expansion (ASTM C1567) tests are required. The mortar bar expansion shall be a maximum of 0.1% at 16 days when tested per ASTM C1567. A modified ASTM C1567 may be used provided the proposed combination of materials, cement, secondary cementitious, coarse aggregate, fine aggregate, and water is tested. This modified mortar bar expansion test must be a maximum of 0.10% at 16 days. One test may be applied to any mix design where the ratio and source of cement to SCM and coarse to fine aggregates are the same.

511.2.6 **Water Cement Ratio.** Water cement ratio shall not exceed 0.43. Only potable water shall be used. The minimum water cement ratio shall be 0.28.

511.2.7 **Air Entrainment.** Air entrainment shall meet the requirements set forth in the current ASTM C260. The percentage of air content by volume shall be 6.5% plus/minus 1.5%. Mixes shall be designed for 6.5% air content.

511.2.8 **Admixtures.** All admixtures proposed for use in the EMPC concrete shall be listed on the MoDOT PAL. Concrete mixes approved for use on projects shall include required admixtures in accordance with the currently approved EMPC mix design. Requests for use of admixtures listed as optional on specific mix designs shall be submitted to the County and approved by the County prior to use on the project.
511.2.9 High Early Mix Designs. For High Early mix designs, test results for the ASTM C1074 (Maturity Method) shall be submitted to the EMPC. Compression tests may be performed at times other than those in ASTM C1074 provided the tests occur within the time limits of ASTM C1074 and give the majority of data points early in the time frame. Control of slump, time of set, and workability shall be controlled by use of admixtures only. No water shall be withheld from a high early mix.

511.2.10 Sidewalk Mix Designs. Sidewalk concrete shall meet the requirements of EMPC concrete with the following exceptions:

(a) Maximum coal and lignite content shall not be greater than 0.05% per ASTM C123.

(b) Minimum concrete strength shall be 3,000 psi and the mix designation shall include “-S” at the end.

(c) Cementitious minimums in section 5 shall be waived provided the ratio of Portland Cement to SCM follows section 5 and concrete meets minimum strengths per ACI.

(d) Coarse aggregate for sidewalk applications containing more than 2% chert will not be permitted.

511.3 Construction Requirements.

511.3.1 Pavement and Base. Construction requirements shall be in accordance with Sec 502, with the exceptions in Sec 511.

511.3.2 Concrete Median, Median Strip, Sidewalk, Curb Ramps, Steps and Paved Approaches. Construction requirements shall be in accordance with Sec 608, with the exceptions in Sec 511.

511.3.3 Delivery Tickets. All deliveries shall be accompanied by documentation which includes the plant name, design w/c ratio, actual w/c batched, batch weights per cubic yard, total batched weight of all materials for quantity delivered, time batched, design slump, water withheld (2 gal/yd maximum), allowable slump range, moisture correction for aggregates, and dosages of all approved admixtures.

511.4 Method of Measurement.

511.4.1 Pavement. Pavement areas will be computed to the nearest 1/10 square yard. Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

511.4.2 Median. Measurement of concrete median and median strip will be made to the nearest 1/10 square yard or to the nearest linear foot as indicated in the contract. Final measurement of the completed concrete median and median strip will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

511.4.3 Sidewalk. Concrete sidewalk will be measured to the nearest 1/10 square yard. No additional payments will be made for constructing curb ramps.

511.4.4 Paved Approach. Paved approach will be measured from the beginning of the return on one side of the approach to the end of the return on the other side of the approach to the nearest 1/10 square yard. Integral curb constructed on paved approaches will not be measured and paid for separately, but will be included in the contract unit price for paved approaches. Final measurement of the completed paved approach will not be made except for
authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

511.4.5 All excavation and all work necessary in preparing the subgrade and backfilling will be paid for as one or more of the classifications of roadway excavation. Final measurement of excavation will not be made except as set out in Sec 203.

511.5 Basis of Payment.

511.5.1 Pavement. Pavement areas will be paid according to Sec 502.14.

511.5.2 Concrete Median, Median Strip, Sidewalk, Curb Ramps, Steps and Paved Approaches. Concrete Median, Median Strip, Sidewalk, Curb Ramps, Steps and Paved Approaches will be paid according to Sec 608.5.
Division 600

INCIDENTAL CONSTRUCTION
SECTION 603
WATER SERVICE CONNECTIONS

603.1 Description. This work shall consist of furnishing materials for and installing water lines and appurtenances in conformity with the lines and grades shown on the plans or established by the Engineer.

603.2 Materials.

603.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Water Tube</td>
<td>ASTM B 88M (B88), Type K</td>
</tr>
</tbody>
</table>

603.2.2 Service connections 2 inch inside diameter or less, shall be seamless copper water tube.

603.2.3 The Contractor shall furnish manufacturers' certifications in triplicate certifying that all of the specified tests have been made and that the materials and fittings comply with the requirements of the specifications.

603.3 Construction Requirements.

603.3.1 All work shall conform to the requirements of the County Plumbing Code and/or requirements of the appropriate water company. Separate pay items are included in the bid for "Expose Water Service House Lead" and "Relocation of Water Service House Lead." Separate payment for excavation and backfill will not be made.

603.3.2 Service shall not be interrupted without the approval of the Engineer and of the proper utility official. The Contractor shall arrange its work to interrupt services the shortest possible time. Prior notice of at least 24 hours shall be given the proper utility official and the Engineer before any main is shut off. In no case shall a valve or hydrant be opened or shut without proper authorization.

603.3.3 Expose Water Service House Lead. Will consist of the excavation necessary to expose the individual water service lead from the corporation valve to the limit of construction. The overall depth of the water service lead will be determined from this exposure. Regardless of the number of times or locations along a single service lead an exposure is required by the Engineer, only one payment per service lead will be made. When it is determined that the service lead is usable at its existing location, the excavation will be backfilled in accordance with Sec 726.5.4. Construction or detour phasing will provide no basis for claim for any exposures on a single service lead which must be made at different time intervals during construction.

603.3.4 Relocation of Water Service House Lead. Will include both new construction and the relocation in grade or alignment or both of the existing water service lead or portions thereof on the private side of the water meter. Regardless of the condition of the existing water service lead, new copper lead and fittings will be required from the corporation valve or meter to the limit of construction. The use of a minimum number of fittings in each lead run will be required. When the house service lead or any portion thereof will not be covered by 42 inches of material below finish grade, the water service lead must be relocated.

603.3.4.1 If necessary to join pipe of dissimilar metals, a method of insulation against the passage of electric current shall be provided as approved by the Engineer.

603.3.4.2 Trenches shall be excavated so that the pipe can be laid to the alignment and minimum depth designated on the plans, except that approved changes may be made to avoid obstructions or to connect to an existing line. The width of the trench shall be sufficient to permit the pipe to be laid and joined properly, and the backfill to be placed and compacted as specified. The Contractor shall locate and carefully expose existing
water, gas, and sewer services, and other underground structures for a sufficient distance ahead of pipe laying to determine the grade and alignment of the pipe to be laid.

603.3.4.3 The trench shall be prepared to provide a uniform and continuous support for the pipe. Ledge rock, boulders, and large stones shall be removed to provide a clearance below and on each side of all pipe and pipe appurtenances of at least 6 inches.

603.3.4.4 Material placed around and 12 inches above the top of the pipe shall be free from cinders, ashes, refuse, boulders, rocks, or other unsuitable material. The remainder of the trench shall be backfilled in accordance with the applicable provisions of Sec 726.

603.3.4.5 Where the water main is less than 42 inches below grade, that portion of the water service connection not meeting the cover requirement of Sec 603.3 shall be insulated from the main to a point where the cover requirement can be met. Insulation shall be a commercially available product such as Arma-flex rubber insulation material or an approved equal with a factor of R-1.4. Installation methods shall be in accordance with the manufacturer's instructions and shall meet the approval of the Engineer.

603.4 Final Inspection of Water Valves and Water Meters. Following the sodding or seeding operations, but before final payment is made, a final inspection of all adjusted and relocated water service valves and meters will be made by the Engineer accompanied by the Contractor's superintendent and a representative from the appropriate water company. This inspection is to ensure that these facilities have not been covered over or otherwise disturbed by other construction in the vicinity.

603.5 Method of Measurement.

603.5.1 Measurement of Expose Water Service House Lead will be made on a per each basis at the contract unit bid price.

603.5.2 Measurement for Relocating House Water Service Lead will be to the nearest foot along the geometrical centerline of the lead from corporation valve or water meter to construction limit for leads 2 inches in diameter and less, and will include all fittings in the measurement.

603.5.3 When a contract bid item, rock excavation in trench will be measured to the nearest cubic yard. Rock excavation will be measured at a width of 18 inches and to a depth of 6 inches below the bottom of the lead. The lead will be bedded in sand or clean dirt, the cost of which will be incidental. The term "Rock Excavation" is defined as that excavation which would be classified as Class C in Sec 203. It shall be the Contractor's responsibility to notify the Engineer before removing any such material. Any rock excavation removed before the Engineer has been notified and has established lines of demarcation will not be measured or paid for. When not a bid item, rock removal from the trench will be paid in accordance with Sec 203. No payment will be made for backfilling, rock overbreak, or for bedding through the rock excavation area.

603.6 Basis of Payment.

603.6.1 No direct payment will be made for the Contractor's cooperation in the final inspection or for replacing or repairing defective valves or meters or their appurtenances. No direct payment will be made for further adjusting or relocating facilities as directed. All costs involved therewith are considered to be completely covered by the unit prices bid for the water service appurtenance adjustment and relocation items included in the itemized bid.

603.6.2 Accepted water service connection items will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the
work unless specifically provided as a pay item in the contract. No direct payment will be made for excavation or backfill, except for rock excavation in trench in accordance with Sec 603.5.3.
SECTION 604.10 CONCRETE HEADWALLS, DROP INLETS AND MANHOLES

604.10.1 Description. This work shall consist of the construction of headwalls, drop inlets, and manholes in accordance with these specifications, and in conformity with the lines and grades shown on the plans or established by the Engineer. Drop inlets and manholes may be constructed of brick masonry, poured concrete, or precast concrete.

604.10.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
<tr>
<td>Mortars and Grouts</td>
<td>1066</td>
</tr>
<tr>
<td>Sewer Brick</td>
<td>Grades SM conforming to ASTM C32</td>
</tr>
</tbody>
</table>

604.10.2.1 Unless otherwise specified, concrete for precast items will be class A1 concrete producing 4000 psi in 28 days. All other concrete for this work is to be Class B or concrete of a commercial mixture (air entrained) with 3500 psi minimum compressive strength at 28 days. Materials, proportioning, mixing slump and transporting shall be in accordance with Sec 501. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 703. Sewer brick shall be grade SM.

604.10.2.2 All brick shall be new and whole, of uniform standard size and with substantially straight and parallel edges and square corners. Bricks shall be of compact textures, burned hard entirely through, tough and strong, free from injurious cracks and flaws, and shall have a clear ring when struck together. No soft or salmon brick shall be used in any part of the work. Brick shall be culled after delivery, if required, and no culls shall be used except at such places, to such extent, and under such conditions as may be approved by the Engineer. The Contractor may be required to furnish the County with at least five (5) bricks of the character and make it proposes to use at least one week before any bricks are delivered for use. All brick shall be of the same quality as the accepted samples.

604.10.2.3 Steps for concrete manholes and drop inlets shall be copolymer polypropylene plastic. The portion of the step to be embedded in the concrete shall have a configuration such that it will prevent any pullout. The steps shall have properties such that they will withstand a single concentrated load of 300 pounds without distortion on that portion protruding from the wall. The minimum width of rungs or cleats shall be 10 inches and shaped to prevent the foot from slipping off the side. The step shall project a minimum distance of 4 1/2 inches from the wall of the riser or cone section measured from the point of embedment. The steps shall be embedded a minimum distance of 5 1/2 inches and shall be spaced vertically at a maximum distance of 16 inches.

604.10.3 Construction Requirements.

604.10.3.1 Concrete Structures. Where concrete structures are permitted or required by the project plans, they shall be built of Class B or B-1 concrete as shown on the project plans. The structure shall be built on prepared foundations, conforming to the dimensions and shapes shown on the plans. The construction shall conform to the methods, forms, mixture, placement, and curing for concrete as detailed in the specifications, the Standard Drawing, and the project plans and specifications. Any required reinforcement shall be of the kind, type, and size, and shall be located, spaced, bent and fastened as shown in the project plans. Concrete reinforcing in place shall be approved by the Engineer before any concrete is placed. All invert channels shall be accurately constructed and shaped so as to be smooth, uniform, give minimum resistance to flow, and shall slope downward toward the outlet. Inlet and outlet pipes shall extend through the walls of structures only a sufficient distance beyond the outside surface to allow for connections and shall cut off flush with inside the surface of the walls as shown in the project.
plans, or otherwise directed. Concrete or brick masonry or mortar shall be so placed around the pipes as to provide full continuous contact between masonry and outside of pipe, to prevent leakage, and to form a neat connection. Adequate water stops, approved by the Engineer shall be used with all plastic inlet and outlet pipes. In brick manholes and inlets, a rowlock arch shall be placed over all incoming and outgoing pipes. The pipes for a precast manhole base shall be placed as an integral part of the base or the connections may be of any approved patented compression type joint. Steps shall clear all pipes and shall be built on an unobstructed wall as designated by the Engineer. Steps shall be installed as shown in the Standard Drawing. When the steps are set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry unit is being built. The steps shall not be disturbed or used until the concrete or mortar has set and cured for at least seven days. Forms on cast in place construction will not be removed for 24 hours or backfilled for 72 hours.

604.10.3.2 Manholes, Inlets, Junction Chambers and Headwalls. The Contractor shall build manholes, inlets, junction chambers, headwalls, culverts, and other such miscellaneous structures as are required at the locations shown on the project plans, or as otherwise directed. The structures will be either of concrete, plain or reinforced as required, or of brick masonry. Where the top elevation is not shown on the plans, the structure or appurtenance shall be built to conform to the elevation ordered by the Engineer. Manholes shall not be out of plumb more than 1 foot in 30 feet. Detailed shop drawings must be submitted and accepted prior to approval for inclusion in the contract. The various structures shall be built as the pipe laying or sewer construction progresses. The Engineer, at their discretion, may stop the laying of pipe or building of other structures until the structure just passed has been completed. Completion of the structure shall include the installation of fittings and connections to pipes and other construction as shown on the plans.

604.10.3.2.1 Brick Masonry Construction. All materials used in brick masonry construction shall conform to the requirements of Sec 1000. Mortar for sewer construction shall consist of a uniform mixture of Portland cement and masonry sand with the minimum amount of water necessary to produce the desired consistency. No admixtures shall be used without the approval of the Engineer. Mortar for brick masonry and plastering shall consist of one volume of cement and three volumes of sand. Mortar shall be prepared in suitable mixing equipment, or for small amounts, on a hard-impervious surface. It shall be kept free at all times of earth, debris, contamination, or other deleterious substances. Retempered or partially set mortar shall not be used. Mortar required for patching or jointing areas in the vicinity of sanitary sewage shall be of an approved rapid setting variety. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed. This shall be of the materials and dimensions shown in the standard drawing or on the project plans and specifications. All brick shall be thoroughly clean. The bed which is to receive the brick shall be thoroughly cleaned and damp, but should be free of water before placing mortar thereon. All bricks shall be laid in courses in freshly prepared mortar. The bricks shall be laid in a workmanlike manner and true to the lines and grades indicated on the plans. The arrangement of headers and stretchers shall be such as will thoroughly bond the masonry. Unless otherwise indicated, brick masonry shall be of alternate headers and stretchers with consecutive courses breaking joints. In manholes, all bricks in each course shall be headers. The course shall be laid continuously with joints broken or alternating evenly with the joints in the preceding course. Horizontal joints shall average 3/8 inch, but shall be not less than 1/4 inch or more than 1/2 inch in thickness. Face joints shall be flush and neatly struck, and all joints on unexposed faces shall be solidly filled. No spalls or bats shall be used except in shaping around irregular openings or connections, or when unavoidable to finish out a course. In this case, a full brick shall be used at the corner with the bat in the interior of the course. If any brick is moved or a joint broken during laying, the brick shall be removed, the mortar thoroughly cleaned from the brick, bed, and joints and the brick relaid in fresh mortar. Where required by the Standard Drawings or by the project plans and specifications, the inside and outside surfaces of brick masonry shall be neatly plastered with mortar to a thickness not less than 1/2 inch, and be finished to a true, uniform, continuous, smooth surface. All plastering shall be applied as the manhole or brick structure is constructed, as opposed to plastering upon completion. On completion of each brick structure, all waste mortar and debris shall be immediately removed from the structure and any necessary repairs or required pointing shall be completed.
604.10.3.2.2 Brick masonry, plastering, and mortar shall be protected from freezing or lack of moisture. Brick masonry shall not be constructed when the temperature is 40°F or lower without the permission of the Engineer, nor without adequate approved means for protection against freezing. Brick masonry shall have sufficient moisture for proper curing and be protected from drying. Requirements for protection of brick masonry and masonry materials are the same as required for concrete structures.

604.10.3.3 New Manhole on Existing Sewer. If a new manhole must be constructed for the connection, the new manhole and invert shall be constructed over and around the existing sewer pipe to the elevation shown on the project plans. The work shall be done carefully to avoid breaks in the existing sewer until the manhole is completed. Any joints in the existing sewer shall be pointed upon with a 1-3 cement-sand mortar, if necessary to stop leakage before building the manhole. After construction of the manhole, the top half of the existing pipe shall be carefully cut and removed to be flush at each end with the inside wall and pointed up to present a neat smooth surface at the junction of the cut pipe with the invert and wall. The newly placed concrete mortar or plastering at the connection shall be protected from sanitary sewage or foul water by completely covering with a thick coat of emulsified asphalt applied after the initial set of the mortar or concrete. No sewage or water shall be permitted to touch the protected surfaces until the emulsion has set and properly hardened. Any portion of an existing sewer that is damaged in constructing the new manhole shall be repaired with new material of a type matching the old, at the Contractor's expense.

604.10.3.4 Pipe Connection to Existing Manhole or Stub. The Contractor will verify the exact location and elevation of existing sewers immediately prior to actual construction. Any differences should then be brought to the attention of the County. If a bulkhead opening of adequate size or a stub of proper size, elevation, location, and direction exists at the manhole, the pipe connection will be made as required for pipe laying. The cost of removing the bulkheads and making the pipe connection is included in the cost of laying the new pipe sewer. If the existing stub is not suitable for use, or if no stub exists, a new connection must be made to the manhole. The stub shall be removed or a hole shall be cut in the manhole wall to permit inserting the pipe at the required flowline elevation, horizontal angle, and slope, and to allow 2 inches of space around the pipe for bedding and filling solidly with 1-3 cement-sand mortar. Care shall be used to avoid unnecessary damage to the masonry. All loose material shall be removed from the cut surfaces, which shall be completely coated with mortar before setting the pipe. Before inserting the pipe, a sufficient thickness of mortar shall be placed at the bottom and sides of the opening for proper bedding of the pipe. After setting, all spaces around the pipe shall be solidly filled with mortar, and neatly pointed up on the inside to present a smooth joint, flush with the inner wall surface. Any necessary revisions in the existing invert shall be made to provide a smooth plastered surface for properly channeled drainage from the new connection. Particular care shall be given to ensure that the earth sub-base and bedding adjacent to the manhole will provide firm solid support to the pipe.

604.10.4 Basis of Payment. All manholes will be paid for at the contract unit bid price, per each.

604.10.4.1 No direct payment will be made for:

(a) Maintaining service, or for cutting the existing sewer.

(b) Weep holes, including excavation, permeable granular backfill, 4 inch drain tile, screen for inlet or any other work incidental thereto.

(c) Manhole steps.

604.10.4.2 Payment will be made for constructing a new manhole over an existing sewer at the bid price as described for manhole construction. The cost of cutting and removing the pipe, and pointing up are included in the payment made for manhole construction.
604.10.4.3 New connections at levels above the manhole flowline for invert lines will be made similarly except for the requirements of invert adjustment, unless otherwise required in the project plans and specifications.

604.10.4.4 Inlets. Payment will be made for each type of inlet per each at the bid price for the type of inlet required by the project plans and specifications, and shown in the Standard Drawings. Such payment shall include all costs of the base, walls, tops, sill, blocks, angle seats, cement mortar, plaster, pipe specials for the trap when a trapped inlet is required, steps, grates and covers, and all costs for the construction of the required gutter sump, including the removal and replacement of the pavement and curbing required for construction of the inlets.

604.10.4.5 Junction Chambers. Payment will be made for each junction chamber completed as required by the project plans and specifications at the lump sum bid price for constructing the junction chamber. Such payment shall include all cost of masonry, forms, concrete, reinforcing steel, steps, manhole construction above the top of the chamber, and making pipe connections.

604.10.4.6 No separate payments will be made for backfill around manholes, catch basins, inlets, junction chambers, or other structures.

604.10.4.7 No direct payment will be made for excavation, in accordance with Sec 726.7. Excavation will be considered a portion of the various items.

SECTION 604.20 Adjusting Drainage Facilities

604.20.1 Description. This work shall consist of adjusting manholes, catch basins, inlets, and similar items in accordance with the details shown on the plans or as approved by the Engineer. Existing frames and covers shall be salvaged and reused if required by the contract. New manhole steps shall be provided as necessary. New manhole adjusting rings (adapters) shall be provided when required in the contract. Frame and covers shall be positioned so as to be flush with the finished roadway grade.

604.20.2 Basis of Payment. The accepted adjustments of manholes, and catch basins and inlets, will be paid for at the unit bid price per each structure to be adjusted. No direct payment will be made for steps or adjusting rings, unless specified in the contract.

SECTION 604.30 Adjusting House Sewer Connections

604.30.1 Description. This work shall consist of laying or relaying sanitary sewer house connections which may be any part of the sanitary waste disposal system between the trunk line or lateral sewer to the construction limits which are to be relocated to clear new construction or which are to be reconnected to new sewers or temporarily removed to permit installation of other items in the contract. Septic tanks and absorption fields when encountered in construction shall be reconstructed in accordance with local codes.

604.30.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>ASTM D 3034</td>
</tr>
<tr>
<td>PVC Joints Type “D”</td>
<td>ASTM D 3212</td>
</tr>
</tbody>
</table>

The size and class of pipe to be used shall meet the requirements of the local authority having jurisdiction over the installation of sewer connections. The Contractor will be responsible for acquisition of all permits required.

604.30.3 Construction Requirements. The excavation for the laying of the pipe, and backfilling of the trench shall be in accordance with the applicable portions of Sec 726. The adjustment shall be made to the line and grade shown...
on the plans or as directed by the Engineer. When a house sewer connection is relocated or relaid within a minimum of 2 linear feet above a water main, Class B concrete meeting the requirements of Sec 501, shall be used to encase the sewer line to a minimum thickness of 6 inches. The encasement shall extend to a point where the normal distance from the sewer to the water main is a minimum of 10 feet.

604.30.4 Method of Measurement. Measurements of adjusting house sewer connections will be made to the nearest foot along the geometrical center of the adjusted pipe.

604.30.5 Basis of Payment

604.30.5.1 Payment for adjusting house sewer connections, complete in place, including all necessary pipe, tees, bends, wyes, the cutting of and joining of new pipe to old pipe or structure, excavation, backfill, traps, fittings, and items incidental thereto including permits, will be considered as completely covered by the contract unit bid price per linear foot for each house sewer connection.

604.30.5.2 Payment for encasement, complete in place, will be made at the contract unit bid price. Payment for encasement when not in contract will be incidental to the unit price for the sewer pipe.

SECTION 604.40 PIPE COLLARS

604.40.1 Description. This work will consist of metal or concrete collars constructed around a pipe joint in accordance with the plans.

604.40.2 Materials.

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated Metallic-Coated Steel Culvert Pipe, Pipe-Arches, and End Sections</td>
<td>1020</td>
</tr>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
</tbody>
</table>

604.40.2.1 Metal pipe for pipe collars shall be of the same gage and have the same corrugation dimensions as the corrugated metal pipe to be connected. Concrete used for collars shall be Class B or B-1, pavement concrete or commercial mix concrete, meeting the requirements of Sec 501.

604.40.3 Construction Requirements. Pipe collars will be required for the purpose of

1. extending existing pipes where the pipe required for the extension will not form a normal joint with the pipe in place;

2. connecting two different sizes of pipe;

3. connecting corrugated metal pipe to concrete pipe;

4. connection of concrete pipe to box culvert.

604.40.3.1 If the pipe collar design is not applicable to the type of pipe being extended, the pipe collar shall be modified to insure a joint connection that will fit the pipe.

604.40.4 Basis of Payment. No payment will be made for pipe collars unless specifically listed as a bid item.

SECTION 604.50 CONNECTING PIPE TO EXISTING STRUCTURES.
604.50.1 Description. Connections to existing sewers shall be made as shown in the Standard Drawings or as modified in the project plans. Care shall be used to avoid damage to the adjacent sewer walls or masonry. The opening shall be of sufficient size to permit inserting the pipe at the required flowline elevation, horizontal angle and slope, and to allow at least 2 inches of space around the pipe for bedding and filling solidly with 1-3 cement-sand mortar. If there are reinforcing bars in the sewer walls, only those preventing insertion of the pipe may be cut. All others shall be bent into the concrete collar at the junction of the connecting pipe and existing sewer. Unless a detail is provided, the collar shall have vertical walls not less than 6 inches thick above, below, and at the sides of the connecting pipe, at least 12 inches from the outside of the existing sewer at the spring line of the connecting pipe. The bottom of the collar shall extend to solid support at its base. All loose material shall be removed from the cut surfaces, and any surfaces to be in contact with newly placed concrete shall be cleaned to the base concrete or masonry, and thoroughly coated with cement grout before placing the concrete for the collar. Before inserting the pipe, a sufficient thickness of mortar shall be placed at the bottom and sides of the opening for proper bedding of the pipe. All spaces around the pipe shall be filled with mortar or concrete, and be neatly pointed up on the inside to form a smooth joint that is flush with the inner sewer surface. Any portion of an existing structure that is damaged in joining the new pipe shall be repaired or replaced with new materials of a type matching the old, at the Contractor's expense. These requirements shall also be applicable in joining one new pipe to another when the use of a manufactured connection joint is waived by the Engineer. Any saw cutting or removal of existing reinforcement will be included in bid price.

604.50.2 Basis of Payment. No direct payment will be made for connecting pipe to existing structures for pipe sizes up to 36 inch diameter.

604.50.2.1 Connecting 36 inch diameter pipe and larger sizes to existing structures will be paid for at the contract unit bid price. Payment will be made for cutting the opening in the sewer, constructing the concrete collar, and making the completed pipe connection at the bid price for making the completed pipe connection to the existing sewer.

SECTION 604.60 TRENCH DRAINS

604.60.1 Description. This work shall consist of constructing trench drains across driveways, parking lots or other locations as shown on the plans. The trench drains shall be made of High Density Polyethylene 235 p.s.i. Industrial Strength or other approved materials and be rated for an H-20 wheel load rating. The grates shall be cast iron and securely fastened to the trench drain. The trench drain shall have a built-in sloped invert. The width of the trench drain shall be as shown on the plans. The trench drain shall be installed in accordance with the manufacturer’s recommendations.

604.60.2 Method of Measurement. Measurements of trench drains will be made to the nearest foot along the center of the trench drain.

604.60.3 Basis of Payment. Payment for trench drains, complete in place, will be at the contract unit price.
SECTION 605
UNDERDRAINAGE

605.1 Description. This work shall consist of furnishing and installing underdrains and edge drains as shown on the plans or as directed by the Engineer, and shall include excavating the trench, installing all required drainage media, and backfilling with material as specified or as directed by the Engineer.

605.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate for Drainage</td>
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<tr>
<td>Geotextile</td>
<td>1011</td>
</tr>
<tr>
<td>Geocomposite Edge Drainage</td>
<td>1012</td>
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<tr>
<td>Outlet Pipes</td>
<td>1013</td>
</tr>
<tr>
<td>Pipe Aggregate Pavement Edge Drain</td>
<td>1013</td>
</tr>
<tr>
<td>Corrugated Metallic-Coated Steel Cross Drain and Structural Drain Pipe</td>
<td>1022</td>
</tr>
<tr>
<td>Corrugated Aluminum Alloy Cross Drain and Structural Drain Pipe</td>
<td>1025</td>
</tr>
</tbody>
</table>

605.2.1 All underdrain and edge drain pipes shall be perforated, except as specified otherwise.

605.2.2 All special fittings, such as caps, wyes, tees and couplings, shall be of standard design and manufacture, and shall be compatible with the type of pipe or geocomposite drain to be used.

605.2.3 All steel fittings shall be zinc or aluminum coated.

605.2.4 All welds and cuts of steel pipe or fittings shall be repaired after welding, in accordance with Sec 1020.

605.3 Construction Requirements.

605.3.1 Although probable locations of underdrains are shown on the plans, modifications may be necessary due to conditions found on the project. The Contractor shall perform work only as shown on the plans or as specified or approved in writing by the Engineer.

605.3.2 Any underdrain trenching that results in an uneven trench bottom or exposes soft, yielding or unstable ground in the trench bottom shall be undergraded and backfilled with drainage aggregate material of sufficient thickness to ensure maintenance of proper alignment and gradient for all subsequent operations.

605.3.3 Any required drain pipe shall be firmly bedded and carefully aligned. The pipe shall be laid with perforations down if the perforations are not uniformly distributed around the circumference of the pipe, unless otherwise shown on the plans. All longitudinal pipe shall slope toward an outlet pipe at a minimum rate of one inch per 10 feet. Sections shall be jointed with approved fittings. Dead ends of pipe shall be completely closed by means of caps or plugs. Outlet openings shall be a minimum of 6 inches above the ditch bottom, and shall be protected with rodent screens in accordance with Sec 1013. Outlet pipe openings that are not exposed shall be connected to drain as shown on the plans or directed by the Engineer.

605.3.4 Geotextile shall be used to completely envelope any drainage aggregate in trenches, except a geotextile will not be required when Grade 1 drainage aggregate is used, and only partial envelopment may be required when the underdrain abuts or is overlain by an approved open-graded base course or other drainage medium. A drainage geotextile wrap or sock shall envelope perforated drainage pipe when Grade 1 or Grade 2 drainage aggregate is used, or whenever any portion of a perforated pipe used as a discharge pipe is backfilled with soil.
605.3.5 Porous backfill shall be ponded with water immediately before covering to effect maximum settlement of backfill.

SECTION 605.10 PIPE-AGGREGATE PAVEMENT EDGE DRAIN.

605.10.1 Description. This work shall consist of placing a continuous pipe-aggregate edge drain under the edge of new pavement as shown on the plans or as directed by the Engineer.

605.10.2 Construction Requirements. Aggregate shall be Grade 3, Grade 4 or Grade 5 drainage aggregate. Edge drain pipe shall have a nominal internal diameter of 4 inches unless otherwise shown on the plans.

605.10.2.1 The Contractor shall select plastic pipe meeting these specifications, except that geocomposite drains shall not be used. Pavement edge drains shall be provided with outlet pipe and splash pads in accordance with Sec 605.60.

605.10.2.2 Trenching, placement, and backfill of underdrains shall be performed only after Type 1 or Type 5 base is placed and compacted. Backfill material shall be compacted by three passes of a vibrating pad or drum type compactor approved by the Engineer.

605.10.2.3 If a pipe-aggregate pavement edge drain is used on a pavement rehabilitation project, the Contractor shall not install the drain until all pavement repair and required undersealing have been completed in the area where the edge drain is to be placed.

605.10.2.4 Under new pavement, pipe-aggregate pavement edge drains shall be lined with geotextile and wrapped. Edge drains underneath stabilized permeable base shall have the geotextile wrapped around the outside edge and over the top of the permeable base. The trench for pipe-aggregate pavement edge drains shall be lined and wrapped with a geotextile as shown on the plans.

605.10.2.5 All longitudinal edge drains and outlet pipes installed on the project will be subject to video camera inspection as directed by the Engineer.

605.10.2.5.1 Video inspection shall be conducted by the contractor after all paving is complete. The Engineer may randomly select no less than ten percent of the lateral outlet pipes for inspection and extend inspection to 500 feet of the mainline pipe. Inspection areas shall not overlap each other, if possible. If deficiencies are found, a more extensive video inspection with expanded video coverage shall be conducted, which may inspect any or all of the edge drains on the project, as directed by the Engineer.

605.10.2.5.2 The video camera head shall remain centered in the pipe during the inspection. The camera shall be capable of negotiating a 90° angle from the 4 inch outlet pipe to the 4 inch longitudinal pipe. Camera progress shall be clearly visible on an 8 inch or greater monitor screen. The unit shall be able to record and play back the inspection. The unit shall allow audio dubbing during the inspection. The Contractor shall provide a copy of the video inspection tapes to the Engineer within three working days of inspection.

605.10.2.5.3 If the inspection reveals crushed or compressed pipe, separated joints, obstructions within the pipe that prohibit the passage of the camera head, rips or cracks in the pipe wall, or longitudinal sags which allow silt to collect or water to stand in more than half the pipe depth, repair or replacement of the deficient portions of outlet or longitudinal pipe and the repair of the pavement, which is damaged by improper installation of the drain or the repair of deficient portions of the drain, shall be performed at the Contractor’s expense.

605.10.3 Method of Measurement. Measurement of pipe-aggregate edge drain will be made to the nearest linear foot along the centerline of the drain, center to center of fittings and junctions.
605.10.4 Basis of Payment.

605.10.4.1 Accepted quantities of pipe-aggregate edge drain will be paid for at the contract unit price per linear foot, or at an adjusted contract unit price per linear foot as described herein. No overrun or underrun of contract quantity will constitute the basis for contract adjustment, other than as provided in Sec 605.10.4.2. No direct payment will be made for excavating the trench, backfilling and backfill material, or for video inspection of the outlet and longitudinal pipes. Outlet pipes will not be separately paid for, except in combination with any required splash pad.

605.10.4.2 Adjustments in the contract unit price per linear foot of pipe-aggregate edge drain will be made in accordance with the following schedule where the Engineer directs an increased depth of excavation from that shown on the plans. For purposes of determining the adjusted price, the excess depth of excavation will be averaged for the entire length of the drain if less than 100 feet and, if more than 100 feet, will be subdivided into 100 foot increments plus any remaining fraction. Any required undergrading to provide a 3 inch bedding of drainage aggregate where geotextile trench lining is omitted will not be included in any calculation of excess depth of excavation for pay purposes.

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<thead>
<tr>
<th>Average Excess Depth of Excavation</th>
<th>Adjusted Price</th>
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<td>0 to 6 inches</td>
<td>Contract Price</td>
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<td>&gt; 6 inches</td>
<td>In accordance with Sec 104.3</td>
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SECTION 605.20 GEOCOMPOSITE PAVEMENT EDGE DRAIN.

605.20.1 Description. This work shall consist of furnishing and installing geocomposite pavement edge drain at the locations shown on the plans or as directed by the Engineer.

605.20.2 Construction Requirements.

605.20.2.1 The Contractor shall furnish to the Engineer a copy of the drain manufacturer's printed instructions for installing the edge drain at least two weeks prior to installation. Except as noted herein, the installation of the drain shall be in accordance with the manufacturer's recommendations.

605.20.2.2 The Contractor shall not install the drain until after all pavement repairs and required undersealing have been completed in the area where the edge drain is to be placed.

605.20.2.3 Each length of drain shall be joined to the adjacent length prior to installation. Splices shall keep adjoining lengths in proper alignment and shall not separate during installation. Splices shall have the same or greater compressive strength than the geocomposite edge drain, and shall be sealed against infiltration of the backfill material.

605.20.2.4 The drain shall be placed against the pavement side of the trench and shall be held in place while backfill is placed to a compacted height of 6 inches ± one inch, using a vibratory wheel or plate compactor with a rated impact force of approximately 5000 pounds. The placement of the edge drain and the first lift of backfill shall be accomplished in a single continuous operation. After the first lift of backfill has been placed, the remainder of the backfill shall be placed and compacted by a vibratory compactor to the satisfaction of the Engineer. Material excavated from the trench may be used for backfill, except that all backfill shall pass a 2 inch sieve. At the Contractor's option, Grade 1 drainage aggregate may be used in two lifts and flooded with clean water to compact each lift. If this method is chosen, the drain shall be placed against the shoulder side of the trench.

605.20.3 Method of Measurement. Measurement of geocomposite pavement edge drain will be made to the nearest linear foot along the centerline of the drain, center to center of fittings and junctions.
605.20.4 Basis of Payment. Accepted quantities of geocomposite pavement edge drain will be paid for at the contract unit price per linear foot. No overrun or underrun of contract quantity will constitute the basis for contract adjustment. No direct payment will be made for excavating the trench or backfilling and backfill material. Outlet pipes will not be separately paid for, except in combination with any required splash pad.

SECTION 605.30 PIPE-AGGREGATE PAVEMENT CROSS DRAIN.

605.30.1 Description. This work shall consist of placing metal pipe for sub drainage purposes as shown on the plans or as directed by the Engineer, and shall include excavating the trench and backfilling with material as specified or directed. Pipe-aggregate pavement cross drains shall be non-continuous and will typically be installed laterally beneath the pavement to improve localized drainage problems. Except as otherwise specified, all cross drains shall have a nominal internal diameter of 6 inches and shall be perforated.

605.30.2 Construction Requirements.

605.30.2.1 Porous backfill shall extend a minimum distance of shoulder line to shoulder line of flexible pavements and a minimum of 18 inches outside of each edge of rigid pavement.

605.30.2.2 The pipe shall be firmly bedded in the trench. Dead ends of pipe shall be completely closed by means of caps securely affixed to the pipe. Outlet ends shall be connected to a drain as shown on the plans or as directed by the Engineer.

605.30.2.3 Trenching, placement and backfill of cross drains shall be performed only after Type 1 or Type 5 base is placed and compacted.

605.30.3 Method of Measurement. Measurement of pipe-aggregate cross drain will be made to the nearest linear foot along the centerline of the drain, center to center of fittings and junctions.

605.30.4 Basis of Payment. Adjustments in the contract unit price per linear foot of pipe-aggregate cross drain will be made in accordance with the following schedule where the Engineer directs increased depth of excavation from that shown on the plans. For purposes of determining the adjusted price, the excess depth of excavation will be averaged for the entire length of the drain if less than 100 feet and, if more than 100 feet, will be subdivided into 100 foot increments plus any remaining fraction. Any required undergrading to provide a 3- inch bedding of drainage aggregate where geotextile trench lining is omitted will not be included in any calculation of excess depth of excavation for pay purposes.

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SECTION 605.40 STRUCTURAL UNDERDRAIN.

605.40.1 Description. This work shall consist of installing pipe, generally for draining porous or other backfill adjacent to concrete masonry construction, as shown on the plans or as directed by the Engineer. The Contractor shall select either plastic or metal pipe meeting these specifications, except that geocomposite drains shall not be used and where plastic pipe is used, a concrete splash pad will be required.

605.40.2 Construction Requirements.
605.40.2.1 The pipe shall be laid to the grade and alignment shown. Where a section of pipe is cast into concrete, the remaining pipe shall be joined to these sections with connecting bands. The porous backfill material shall be placed such that the pipe will not become displaced and shall be firmly tamped under and around the entire pipe. Discharge ends shall be protected by approved methods to prevent obstruction until connections to outlets are installed.

605.40.2.2 When the fill above the drainage system is coarse aggregate or rock fill, Grade 3, 4 or 5, drainage aggregate shall be used with no geotextile. When the remaining backfill is sand or soil, any drainage aggregate may be used with the following exceptions. For sand backfill and Grades 3, 4 and 5, drainage aggregate or for earth backfill and Grades 2, 3, 4 and 5 drainage aggregate, the backfill material shall be separated from the drainage aggregate with geotextile.

605.40.2.3 After placement of the drain pipe, the initial lift of backfill material shall be placed around and over the pipe to a compacted depth not to exceed 6 inches above the pipe. This initial lift shall be compacted by two passes of a vibrating pad or drum-type compactor approved by the Engineer. Any remaining porous backfill shall be placed in loose lift thicknesses not exceeding 6 inches and each lift compacted by two passes of the same equipment.

605.40.3 Method of Measurement. Measurement of structural underdrain will be made to the nearest linear foot along the centerline of the drain, center to center of fittings and junctions.

605.40.4 Basis of Payment. Accepted quantities of structural underdrain will be paid for at the contract unit price per linear foot. No direct payment will be made for excavating the trench or backfilling and backfill material. Outlet pipes will not be separately paid for, except in combination with any required splash pad.

SECTION 605.50 FRENCH UNDERDRAIN.

605.50.1 Description. This work shall consist of installing a drain, laterally across a pavement, using a trench, geotextile lining, and Grade 3 or Grade 4 drainage aggregate.

605.50.2 Construction Requirements.

605.50.2.1 French underdrains shall be constructed in the subgrade and through the shoulders to provide drainage at locations shown on the plans. French underdrains shall have a trench of the dimensions shown on the plans, filled with porous backfill material. For that part of the trench in shoulders, the trench above the porous backfill shall be filled with suitable earth, well compacted.

605.50.2.2 Unless otherwise specified, both the trench width and depth of drainage aggregate shall be no less than 18 inches. Where directed, the trench above the drainage aggregate shall be backfilled with well compacted suitable earth.

605.50.2.3 Drainage aggregate shall be placed in lifts not to exceed 18 inches in thickness and compacted in a manner meeting the approval of the Engineer.

605.50.2.4 All french underdrains shall be daylighted at discharge ends with minimum 10 foot lengths of perforated 6 inch diameter metal pipe placed at or within 3 inches of the flow line.

605.50.3 Method of Measurement. Measurement of french underdrain will be made to the nearest linear foot along the centerline of the drain.

605.50.4 Basis of Payment. Accepted quantities of french underdrain will be paid for at the contract unit price per linear foot.
SECTION 605.60 OUTLET PIPES AND SPLASH PADS.

605.60.1 Description. This work shall consist of furnishing and installing outlet pipes and splash pads for pipe aggregate pavement edge drain, geocomposite pavement edge drain, and structural underdrain, when four inch plastic pipe is used, at the locations shown on the plans or as directed by the Engineer.

605.60.2 Construction Requirements.

605.60.2.1 Unless otherwise shown, outlet pipes shall be installed perpendicular to the drain, with a two percent gradient.

605.60.2.2 Concrete for splash pads shall be air-entrained and Class B, B-1 or concrete of a commercial mixture in accordance with Sec 501.

605.60.2.3 Construction requirements for the splash pads shall be in accordance with Sec 609. If the excavation is done to neat lines, forming will not be required. Pre-cast splash pads may be substituted for cast-in-place splash pads where approved by the Engineer.

605.60.2.4 Outlet pipes shall be 4 inch diameter, non-perforated, schedule 40 or SDR 23.5 PVC pipe. Outlet connections to pipe-aggregate pavement edge drains shall be with wye connectors or 90-degree elbows as shown on the plans.

605.60.2.5 Outlet pipe trenches shall not be cut prior to installation of the edge drain. Outlet installation shall be completed promptly and, in all cases, within 72 hours of edge drain installation except with written approval from the Engineer. The trench shall not be backfilled until the installation is inspected and approved by the Engineer.

605.60.2.6 Backfilling of excavations for outlet pipe and splash pads shall be performed in accordance with Sec 203. If additional material is needed to complete the backfill, suitable material meeting the approval of the Engineer shall be provided by the Contractor at the Contractor’s expense.

605.60.3 Method of Measurement. Measurement of outlet pipes and splash pads will be made per each.

605.60.4 Basis of Payment. Payment for plan quantity of outlet pipes and splash pads, in combination, will be made at the contract unit price for each of the items included in the contract.

SECTION 605.70 AGGREGATE DRAINS.

605.70.1 Description. This work shall consist of trenching and placing granular filler material wrapped with geotextile as shown on the standard plans or as directed by the Engineer. Construction of aggregate drains shall be after completion of granular base courses on new pavement or at least two weeks prior to shoulder work or pavement repair during pavement rehabilitation.

605.70.2 Construction Requirements.

605.70.2.1 The trench shall be constructed to the width and depth as shown on the standard plans. The bottom of the trench shall be no higher than the bottom of pavement or granular base. The trench shall be smooth, firm and furnish a clean exposure to the pavement bottom or granular base course.

605.70.2.2 Any remaining trench shall be backfilled and compacted with suitable material in accordance with Sec 203. When erodible aggregate material such as recycled glass, tire chips or fine aggregate, are used, the in slope or exposed area shall be covered with a minimum of 6 inches Grade 3, Grade 4, or Grade 5 aggregate, in accordance with Sec 1009.
605.70.3 Method of Measurement. Final measurement of aggregate drains will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement of aggregate drains will be made to the nearest linear foot along the centerline of the drain from the edge of pavement to the end of the trench top.

605.70.4 Basis of Payment. Accepted quantities of aggregate drain, complete in place, will be paid for at the contract unit price per linear foot. Payment will be considered full compensation for all labor, equipment, materials, and incidentals to complete this work, including excavation and geotextile wrap.
SECTION 606
GUARDRAIL AND ROADWAY BARRIERS

606.1 Description. This work shall consist of furnishing and installing guardrail, crashworthy end terminals, one-strand access restraint cable or three-strand guard cable as shown on the plans or as directed by the Engineer.

606.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

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<th>Item</th>
<th>Section</th>
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<tr>
<td>Concrete</td>
<td>501</td>
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<tr>
<td>Guardrail, End Terminals, Crash Cushions, One-Strand Access Restraint Cable and Three-Strand Guard Cable</td>
<td>1040</td>
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606.2.1 Concrete. Concrete shall be placed, finished and cured in accordance with Sec 703.

606.2.2 Cold Weather. During cold weather, the weather limitations of Sec 502 will apply to concrete work.

606.2.3 Aesthetic Guardrail. When specified, aesthetic guardrail shall be in accordance with NCHRP 350, Test Level 3 criteria and shall be of new stock. End terminals and crash cushions for aesthetic guardrail shall be fabricated and installed in accordance with Sec 606.30.3.

606.3 Construction Requirements.

606.3.1 General. Work on guardrail or guard cable removal and replacement when the adjacent travel or auxiliary lane is open to traffic during non-working hours shall adhere to the following requirements:

(a) The Contractor shall provide a schedule of work prior to the beginning of work.

(b) Remove no more guardrail or guard cable than can be replaced in the same day.

(c) Schedule guardrail and guard cable installation to ensure guardrail beam or guard cable is properly attached to all installed posts at the end of each work day.

(d) Ensure end sections or terminals exposed to traffic meet current standards.

(e) Notify the Engineer prior to delivery of the material to the project.

606.3.1.1 If guardrail or three-strand guard cable cannot be replaced the same day as removal, traffic control measures meeting the approval of the Engineer shall be provided. The Contractor will not be compensated for any additional traffic control items required to perform this work.

606.3.1.2 The shoulders and slopes shall be in accordance with all standards shown on the plans or shall be as directed by the Engineer before the installation of any guardrail, guard cable or end treatments.

606.3.2 Field Repair of Galvanizing. Galvanized material shall be handled in a manner to avoid damage to the surface. No punching, drilling, cutting or welding will be permitted after galvanizing, except as approved by the Engineer to provide for lapped beams, or for changes in location of splices necessitated by field clearances. Any galvanized material on which the galvanizing has been damaged will be rejected or may, with the Engineer’s approval, be repaired in accordance with Sec 1080.

606.3.3 Posts for Guardrail and One-Strand Access Restraint Cable.
606.3.3.1 Posts may be wood or steel as shown on the plans. The same material shall be used for all new installations within a single project, except for end treatments. If the project requires an extension of existing guardrail, the new post material for the extension shall match the existing material.

606.3.3.2 Wood posts for end anchors shall be installed as shown on the plans.

606.3.3.3 Posts may be installed by either drilling or driving.

606.3.3.3.1 Posts installed by drilling shall have sufficiently sized holes to permit thorough compaction of backfill material around the posts. The backfill material shall be compacted in layers not exceeding 12 inches high.

606.3.3.3.2 Posts installed by driving may be driven by a power hammer or any other method approved by the Engineer. Any mushrooming on the top of the post shall be removed. Damaged zinc coating on galvanized posts shall be field repaired in accordance with Sec 1081. If, in the judgment of the Engineer, the exposed portion of a wood post is split or the driving process noticeably worsens the check cracking, the post shall be replaced by the Contractor at the Contractor’s expense.

606.4 Basis of Payment. The accepted quantities of grading at barrier locations will be paid for at the contract unit price for each of the pay items included in the contract.

SECTION 606.10 GUARDRAIL.

606.10.1 Description. This work shall consist of furnishing and installing guardrail as shown on the plans or as directed by the Engineer.

606.10.2 Construction Requirements.

606.10.2.1 Beams. Beams shall be spliced by lapping in the direction of traffic. The use of 12’-6” or 25 foot sections of beam rails and channels, if required, will be permitted where true line and grade can be maintained.

606.10.2.2 End Anchors. End anchors shall be installed on ends of guardrail runs where crashworthy end terminals are not required.

606.10.2.3 Delineators. Delineators shall be placed on all guardrail located 2 feet or less from the edge of the shoulder. Delineators shall be spaced at 50 foot intervals.

606.10.2.3.1 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

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<tr>
<td>Delineators</td>
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606.10.2.3.2 Construction Requirements.

606.10.2.3.2.1 Delineator reflector colors shall correspond with pavement marking. Delineators shall be sheeted on one side, facing oncoming traffic, unless otherwise specified. Where guardrail divides opposing lanes of travel, the delineators shall have retro-reflective sheeting on both sides corresponding to adjacent pavement markings. Guardrail located on off ramps shall have red reflective sheeting placed on the reverse side of the reflector. The use of the red sheeting on the back side of guardrail delineators may be used wherever there is a need to discourage wrong way driving. Guardrail located on two lane roads shall have retro-reflective sheeting on both sides
corresponding to the adjacent pavement markings. If there are not edge lines present, white retroreflective sheeting shall be used.

606.10.2.3.2.2 Delineators shall be installed according to manufacturer’s recommendations or as shown on the plans.

606.10.2.3.2.3 Any damaged or missing delineators shall be replaced by the Contractor at the Contractor’s expense.

606.10.3 Method of Measurement.

606.10.3.1 Measurement of guardrail will be made to the nearest 1/2 linear foot for each increment along a line passing through the centerline of each post, and totaled to the nearest linear foot for the sum of the increments in the contract. The length will be measured separately for each guardrail type, as shown on the plans, excluding bridge anchor sections, end anchors, transition sections and bullnose guardrail systems. Bridge anchor sections, end anchors, transition sections and bullnose guardrail systems will be measured per each item furnished and installed.

606.10.3.2 Measurement for MGS Guardrail will be made to the nearest 1/2 linear foot for each segment measured along the center of the W-beam rail from the centerline of the mid-span lap splice to the centerline of the mid-span lap splice totaled to the nearest linear foot for the sum of the increments in the contract. The length will be measured for each type of guardrail, as shown on the plans, excluding vertical barrier transitions, end terminals, MGS height and block transitions, MGS long span, and embedded anchor transitions. Vertical barrier transitions, end terminals, MGS height and block transitions, MGS long span, and embedded anchor transitions will be measured per each item furnished and installed.

606.10.4 Basis of Payment. The accepted quantities of guardrail, bridge approach transitions, end anchors, MGS height and block transitions, MGS Long Span Guardrail, and bullnose guardrail systems, complete in place, will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for end sections or terminal connectors. No direct payment will be made for setting posts in rock. No direct payment will be made for guardrail delineators provided on new guardrail. Delineators specified for installation on existing guardrail will be measured and paid for per each.

SECTION 606.20 BLANK.

SECTION 606.30 CRASHWORTHY END TERMINALS.

606.30.1 Description. This work shall consist of furnishing and installing crashworthy end terminals as shown on the plans or as directed by the Engineer.

606.30.2 Material.

606.30.2.1 Equipment and material shall be of new stock and in accordance with Sec 1040.

606.30.2.2 All Type A end terminal installations shall be a minimum of 50 feet long. Additional Type A or MGS guardrail shall be provided by the Contractor, at the Contractor’s expense, to increase the Type A end terminal to a length of 50 feet. If the end terminal is to be installed on MGS rail, the additional guardrail supplied shall be MGS rail.

606.30.3 Construction Requirements. End terminals and crash cushions shall be fabricated and installed in accordance with the manufacturer’s approved shop drawings, recommendations and as shown on the plans. Any units damaged during the term of the contract shall be replaced immediately at the Contractor’s expense.
606.30.3.1 Where a specific end terminal or crash cushion is shown by product name, that unit shall be used as shown on the plans. No substitutions will be permitted without prior approval from the Engineer.

606.30.3.2 The Contractor shall not install flared Type A end terminals in medians or on curbs.

606.30.3.3 The Contractor shall not install Type B end terminals on paved surface locations, unless the location is temporary and the paved area is to be resurfaced after removal of the system.

606.30.3.4 The Contractor may use Type C, D, and E end terminals where Type B units are specified or shown on the plans.

606.30.3.5 Crashworthy end terminals located 12 feet or less from the edge of the traveled way shall be furnished with a modified Type 3 object marker. The marker size, shape, method of attachment and placement shall be approved by the Engineer prior to installation.

606.30.4 Method of Measurement. Measurement for crashworthy end terminals will be made for each unit assembled, installed and complete in place. Grading for crashworthy end terminals will be measured in accordance with Sec 203 when roadway and drainage excavation is included in the contract, otherwise grading will be considered incidental to the contract.

606.30.5 Basis of Payment. The accepted quantities of Type A, B, C, D and E crashworthy end terminals, complete in place, will be paid for at the contract unit price. Payment will be considered full compensation for complete installation including any backup assemblies or other items necessary for proper installation of the end terminal or crash cushion as required. Grading for end terminals will be paid for at the contract unit price for roadway and drainage excavation if included in the contract; otherwise grading will be considered incidental to the contract. If the Contractor elects to use a flared Type A crashworthy end terminal, additional embankment as shown on the plans shall be provided at the Contractor's expense.

SECTION 606.40 ONE-STRAND ACCESS RESTRAINT CABLE.

606.40.1 Description. This work shall consist of furnishing and installing one-strand access restraint cable as shown on the plans or as directed by the Engineer.

606.40.2 Construction Requirements. The cable shall be strung directly from the reel and pulled tight after the initial anchoring. The cable shall then be attached to the second anchor assembly with all turnbuckles fully opened. The cable shall be completely anchored before attaching to the line posts. Only one splice will be permitted between anchors, located between the line posts. Splices will not be permitted in spans adjacent to the anchor and cable end assemblies.

606.40.3 Method of Measurement. Measurement of one-strand access restraint cable will be made to the nearest 1/2 linear foot for each increment, from center of end post to center of end post, and totaled to the nearest linear foot for the sum of the increments on the project.

606.40.4 Basis of Payment. The accepted quantities of one-strand access restraint cable, end anchors, posts and hardware, complete in place, will be paid for at the contract unit price for each of the pay items included in the contract.

SECTION 606.50 THREE-STRAND GUARD CABLE.

606.50.1 Description. This work shall consist of furnishing and installing three-strand guard cable, including all hardware, appurtenances and aggregate bedding, as shown on the plans or as directed by the Engineer.
606.50.2 Construction Requirements.

606.50.2.1 Line Posts. All posts shall be driven unless otherwise directed by the Engineer. Driving shall be accomplished with approved equipment and methods that will leave the posts in the final position, free from any distortion, burring or other damage. All posts shall be aligned to a tolerance of 1/4 inch for plumb and grade line. If rock is encountered when setting line posts, the Contractor may set line posts with or without a soil plate. Line posts set with a soil plate shall be installed by digging or boring a hole into the rock to the required depth and of sufficient size for the post to be set with the soil plate attached. Line posts set without the soil plate shall be installed by drilling a hole to the required depth not to exceed 5 inches in diameter. Following placement of the post, the hole shall be backfilled with a cohesive soil or sand in accordance with Sec 1005.3, and thoroughly tamped.

606.50.2.2 Anchor Assemblies. The specified type of anchor assembly shall be constructed at each end of a run of guard cable. If intermediate end anchors are required, the cable assembly shall be overlapped as shown on the plans. The location of all intermediate anchor assemblies shall be determined by the Contractor and approved by the Engineer. The concrete anchor shall be cast in place with the centerline normal to the line of the guard cable. The top 12 inches of the anchor below finished ground line shall be formed, unless the Engineer determines soil conditions permit excavation to be made to the neat lines of the anchor and the anchor cast against the undisturbed vertical soil face. Anchors shall be constructed on firm, stable, undisturbed soil to the minimum dimensions shown on the plans. Anchor bolts and anchor post slip bases shall be firmly held in the proper position supported at the top by a template during concrete placement. Backfill shall be thoroughly compacted with mechanical tampers with care taken to prevent damage to the finished concrete. Backfill shall be brought up level with the finished grade line. The anchor may be cast in place or precast as either one or two units.

606.50.2.3 Cables. Cables shall be attached to the line posts, anchor posts, cable transition brackets and anchor brackets as shown on the plans. Where compensating devices or turnbuckles are required, the cables shall be attached to the end anchor with turnbuckles fully opened. Compensating devices and turnbuckles shall be installed such that no interference with the functions of any other part of the system occurs. Individual cables may be spliced with a device approved by the Engineer. Each cable shall be stretched taught by mechanical means to eliminate sag between the posts. The Contractor may tighten cable hook bolts after final cable tensioning is complete to allow cable slack to be adequately taken up. Prior to final acceptance, the cables shall be tensioned in accordance with the temperature and spring compression table shown on the plans and all cable hook bolts tightened.

606.50.2.4 Aggregate Bedding. Material for aggregate bedding shall consist of a durable crushed stone, shot rock or broken concrete with approximately 20 percent of the pieces being between 1 inch and 3 inches in diameter but none greater than 3 inches. The remainder of the material shall be such that provides a uniform, angular appearance. Acceptance by the Engineer will be made by visual inspection.

606.50.2.5 Delineators. Delineator spacing and reflector colors shall be in accordance with Sec 606.10.

606.50.3 Method of Measurement.

606.50.3.1 Three-Strand Guardrail. Measurement of three-strand guard cable will be made from center of line post to center of line post, totaled to the nearest linear foot.

606.50.3.2 Anchor Assemblies. Measurement of anchor assemblies will be made per each.

606.50.3.3 Aggregate Bedding. Aggregate bedding material will be measured to the nearest cubic yard of material.

606.50.4 Basis of Payment. The accepted quantities of three-strand guard cable, end anchors, posts, hardware and aggregate bedding will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for setting posts in rock. No direct payment will be made for guard cable delineators.
provided on new guard cable. Delineators specified for installation on existing guard cable will be measured and paid for per each.
SECTION 607
FENCING

607.1 Description. This work shall consist of furnishing and installing fences and gates as shown on the plans or as directed by the Engineer.

607.2 Material. All material shall be in accordance with Division 1000, Material Details.

607.3 Construction Requirements.

607.3.1 Resident Notification. Prior to removing an existing fence, the contractor shall notify the effected resident, so they have an opportunity to secure children, pets, or livestock.

607.3.2 Temporary Fencing. When an existing fence is removed the Contractor shall provide and install either a 4 foot high chain link fence or a properly secured 4 foot high orange plastic safety fence as the temporary replacement, unless a specific type and/or size of fence is specified. Suppling, installing, and maintaining the temporary fencing will be incidental to the contract.

607.3.3 Installation. All fencing shall be installed according to the manufacture’s recommendations, or to the requirements in the project plans and specifications.

607.4 Field Repair of Galvanizing. Galvanized material shall be handled in a manner to avoid damage to the surface. Any galvanized material on which the galvanizing has been damaged will be rejected or may, with the Engineer’s approval, be repaired in accordance with Sec 1080.

607.5 Removing and Reinstalling Existing Fences. Prior to removing an existing fence or gate the contractor shall review and document the existing condition of the fence with the Engineer. Any damaged sections shall be noted. When the plans call for removing and reinstalling an existing fence the Contractor shall use care in removing the existing fence. The Contractor shall store the fence in a manner to prevent damage to the fence. Any damage to the fence will be repaired or replaced at the Contractor’s expense. The Contractor can replace the fence with new fence materials that match the existing fence when approved by the Engineer. The Contractor shall install the fence to a condition equal to or better than the original condition of the fence at the commencement of the construction activities, unless otherwise noted.

607.6 Fencing Submittals. For new fencing the Contractor shall submit shop drawings, manufacture’s data, and manufacture’s recommendations to the Engineer for review.

SECTION 607.10 CHAIN-LINK FENCE

607.10.1 Description. This work shall consist of furnishing and erecting chain-link fence and gates, complete in place, in conformity with the lines shown on the plans, or as established by the Engineer.

607.10.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
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<tbody>
<tr>
<td>Chain link Fence</td>
<td>1043</td>
</tr>
<tr>
<td>Pipe Handrails</td>
<td>1043</td>
</tr>
</tbody>
</table>
607.10.2.1 The contract will specify either zinc-coated steel, aluminum-coated steel, aluminum alloy, or vinyl coated steel fencing material, except that the same kind of material shall be used throughout the project. Walk gates and drive gates, if required, shall be of the same kind of material as that selected for the fence.

607.10.3 Construction Requirements.

607.10.3.1 The Contractor shall fill, cut, or trench where necessary to produce a smooth and uniform ground surface so the bottom of the fabric is not more than 1 inch above the finished ground line. Posts shall be set plumb, true to line and grade in concrete footings, and shall be located as shown on the plans or as directed by the Engineer. Footings shall be of Class B concrete, concrete of a commercial mixture, or quick setting polyurethane foam. The concrete shall be of a uniform thickness around the post, and the footings shall have cone or dome shaped tops. The Contractor may, at its option, drive line posts in lieu of setting in concrete or polyurethane. If the Contractor elects to drive line posts, they shall be of the length and driven to the depth shown on the plans. If posts cannot be driven to depths indicated because of rocky soils or other conditions, they shall be removed and placed in footings. Post tops shall be protected against damage and all posts damaged during installation shall be removed and replaced. When anchor bolts are required for fence posts, they will be cast in place. The Contractor may drill and install expanding anchors for the bolts when approved by the Engineer.

607.10.3.2 Fabric shall not be attached to posts until the concrete in the footings is at least 5 days old, and shall be attached to the posts on the side indicated on the plans. Fabric shall be securely attached to end, corner, gate, and pull posts in accordance with manufacturer’s recommendations. It shall be attached to top rails and line posts with wire ties or bands, and spaced in accordance with manufacturer’s recommendations. All fabric shall be taut before it is attached to line posts or top rails. Top rails shall be continuous from terminal post to terminal post, connected with self-centering couplings, every fifth one of which in any continuous length shall be a slip coupling. Tension wire shall be installed along the bottom of the fence. The fence shall be securely attached to the tension wire with hog rings.

607.10.3.3 Walk gates and drive gates complete with hinges, latches, braces, stops, and locking devices shall be installed at locations shown on the plans. Drive gates shall have an approximate 180° opening swing. Walk gates shall have positive stops to prevent the gates from swinging into the right-of-way.

607.10.4 Method of Measurement. Measurement of chain-link fence will be made to the nearest linear foot measured along the slope of the fabric. Unless gates are a specific bid item, they shall be included in the measurement of the fence.

607.10.5 Basis of Payment. The accepted quantity of chain-link fence, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for concrete footings or for post hole excavation or for excavation and embankment necessary to smooth the area under the fence. There shall be no direct payment for the installation and removal of the temporary fencing. All costs resulting from the maintenance of the temporary fencing shall be borne by the Contractor.

SECTION 607.20 WOVEN WIRE FENCE

607.20.1 Description. This work shall consist of furnishing and erecting woven wire fence, complete in place, in conformity with the plans, and at locations as designated on the plans or established by the Engineer.

607.20.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

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<th>Item</th>
<th>Section</th>
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Wrought Iron Handrails: 1043
607.20.3 Construction Requirements

607.20.3.1 Wood corner, end, brace, and pull posts shall be set in drilled or dug holes. At the option of the Contractor, steel or wood line posts may be set in drilled or dug holes, or may be driven into place provided the method of driving meets the approval of the Engineer and does not damage the post. All wood posts set in drilled or dug holes shall have the butt end down, and shall be backfilled with suitable material thoroughly tamped. Wood line posts that are to be driven shall have the butt end machine pointed at the plant before being treated.

607.20.3.2 If surfaces of treated wood posts have been damaged, or if framing at the site is required, such injuries or cuts shall be field treated with two liberal brush coats of commercially available preservative of the same type used for the original treatment. The second coat shall be applied after the first coat is absorbed.

607.20.3.3 Posts shall be set plumb, true to line and grade. Corner post assemblies shall be set at all horizontal angle points greater than 15 degrees in the line of fence. Pull post assemblies shall be set at all vertical angle points greater than 15 degrees but at not greater than 660 foot intervals. Footings for steel posts and braces shall be of Class B concrete, concrete of a commercial mixture, or, at the Contractor’s option, quick setting polyurethane foam for footings. The foam shall have a minimum compressive strength of 80 psi in the direction of rise, when tested in accordance with ASTM D 1621 and shall have a minimum density of 4 lb/cu. ft. when tested in accordance with ASTM D 1622-63. The foam shall not be placed in water. Polyurethane foam, when used, shall be per manufacturer’s instructions.

607.20.3.4 Fabric and barbed wire shall be pulled taut by approved hand powered mechanical means before they are attached to any line post. The bottom of the fabric shall be not more than 1 inch above the ground at any point, and necessary excavation along the fence shall be performed to obtain the specified clearance. Filling of depressions will not be permitted except where old channels are backfilled after drainage has been relocated. Any space left by depressions shall be filled by spacing strands of barbed wire as indicated on the plans.

607.20.3.5 Walk gates and drive gates complete with hinges, latches, braces, stops, and locking devices shall be installed at locations shown on the plans. They shall be constructed in accordance with the requirements of gates for chain-link fence, except the filler shall be woven wire fabric of the same kind as used for the fence. Direction of swing of gates shall be as indicated on the plans or as directed by the Engineer.

607.20.3.6 Water gates shall be installed at locations shown on the plans and the Contractor shall modify the typical installation to fit the conditions encountered.

607.20.4 Method of Measurement. Measurement of woven wire fence will be made to the nearest linear foot measured along the slope of the fabric. Unless gates are a specific bid item, they shall be included in the measurement of the fence.

607.20.5 Basis of Payment. The accepted quantity of woven wire fence, complete in place, will be paid for at the contract unit bid price per linear foot which will include all materials, excavating for posts, backfilling, clearing of fence row, trenching for fabric, placing extra strands of barbed wire for depressions, and all other incidental work or material. There shall be no direct payment for the installation and removal of the temporary fencing. All costs resulting from the maintenance of the temporary fencing shall be borne by the Contractor.

607.20.5.1 No direct payment will be made for construction or installation of water gates.

SECTION 607.30 HANDRAILS
**607.30.1 Description.** This work shall consist of furnishing and erecting galvanized pipe handrails and wrought iron handrails, complete in place, in conformity with the plans and at locations as established on the plans or designated by the Engineer.

**607.30.2 Materials.** Pipe shall be galvanized pipe of sizes as detailed. Wrought iron railing shall be constructed of bar sections as detailed.

**607.30.3 Construction Requirements.** When anchor bolts are required for handrail posts, they will be poured in place using a template provided by the Engineer; at Contractor’s option, holes for rail post may be formed or drilled. Rails shall be installed as detailed using aluminum oxide mortar grout meeting the requirements of Sec 1066. A commercial expansive grout will be permitted with prior approval of the Engineer.

**607.30.4 Method of Measurement.** Measurement of handrails will be made to the nearest linear foot measured along the slope of the rail.

**607.30.5 Basis of Payment.** The accepted handrail, complete in place, will be paid for at the contract unit bid price per linear foot which will include all rail, grout, labor, and all other incidental work or material.

**SECTION 607.40 WOODEN FENCES**

**607.40.1 Description.** This work shall consist of reinstalling existing wooden or furnishing and erecting new wooden fences, complete in place, in conformity with the lines shown on the plans, or as established by the Engineer.

**607.40.2 Materials.** The Contractor shall supply all new materials for new fences. When shown on the plans to reinstall existing fence the Contractor shall use new fasteners to secure the fence material to the posts.

**607.40.3 Construction Requirements.** When indicated on the plans, relocated and new fencing shall be constructed in accordance with the details in the plans. The Contractor shall fill, cut, or trench where necessary to produce a smooth and uniform ground surface so the bottom of the fabric is not more than 1 inch above the finished ground line. Posts shall be set plumb, true to line and grade. All wood posts shall be set in drilled or dug holes, and shall be backfilled with suitable material thoroughly tamped.

**607.40.4 Method of Measurement.** Measurement of wooden fence will be made to the nearest linear foot measured along the slope of the fence. Unless gates are a specific bid item, they shall be included in the measurement of the fence.

**607.40.5 Basis of Payment.** The accepted quantity of wooden fence, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for concrete footings or for post hole excavation or for excavation and embankment necessary to smooth the area under the fence. There shall be no direct payment for the installation and removal of the temporary fencing. All costs resulting from the maintenance of the temporary fencing shall be borne by the Contractor.

**SECTION 607.50 VINYL FENCE**

**607.50.1 Description.** This work shall consist of reinstalling existing vinyl fence or furnishing and erecting new vinyl fence, complete in place, in conformity with the lines shown on the plans, or as established by the Engineer.

**607.50.2 Materials.** The Contractor shall supply all new materials for new fences. When shown on the plans to reinstall existing fence the Contractor shall provide new materials when the existing materials cannot be reused.

**607.50.3 Construction Requirements.** When indicated on the plans, relocated and new fencing shall be constructed in accordance with the details in the plans. The Contractor shall fill, cut, or trench where necessary to produce a
smooth and uniform ground surface so the bottom of the fabric is not more than 1 inch above the finished ground line. Posts shall be set plumb, true to line and grade. All posts shall be set in drilled or dug holes, and shall be backfilled with suitable material thoroughly tamped.

607.50.4 Method of Measurement. Measurement of vinyl fence will be made to the nearest linear foot measured along the slope of the fence. Unless gates are a specific bid item, they shall be included in the measurement of the fence.

607.50.5 Basis of Payment. The accepted quantity of vinyl fence, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for concrete footings or for post hole excavation or for excavation and embankment necessary to smooth the area under the fence. There shall be no direct payment for the installation and removal of the temporary fencing. All costs resulting from the maintenance of the temporary fencing shall be borne by the Contractor.

SECTION 607.60 WOOD SPLIT-RAIL FENCE

607.60.1 Description. The work shall consist of supplying and installing a wooden fence with 48 to 56 inch tall (exposed height) vertical posts and 3 horizontal rails with an approximate length of 10 to 11 feet. The length of the horizontal rails and the height of the posts will be allowed to vary somewhat depending on manufacturer.

607.60.2 Materials. The Contractor shall supply all new materials for new fences. When shown on the plans to reinstall existing fence the Contractor shall provide new materials when the existing materials cannot be reused.

607.60.2.1 The fence materials are allowed to vary as well. Line posts and corner posts shall be one of the following wood species: Locust, Cedar, Redwood, or pressure treated Pine. The rails shall be one of the following wood species: Cedar, Redwood, Spruce, Hemlock, or pressure treated Pine.

607.60.3 Construction Requirements. There are two allowable styles of fences which are approved.

607.60.3.1 Three Rail Cedar Split Rail. The first is the traditional style of split rail fence which shall conform to the approximate dimensions as illustrated in the following detail:

607.60.3.2 West Virginia Lap Rail Fence. The other allowable fence style is West Virginia Lap Rail Fence. Often called 'split rail fence', West Virginia Lap Rail is not truly split since it is cut at a sawmill. One side of the rail is often 'half-round' while the other side shows where the rail was put through a saw. Typically, the half round side is faced out and the cut-side in. The posts are also run through a sawmill; the inside and outside of the post are often cut and
the sides may be cut or be a natural half-round. A West Virginia Lap Rail Fence for use on the project as “Wood Split-Rail Fence” shall conform to the approximate dimensions as illustrated in the following detail.

607.60.3.3 Substitutions. Other types of three rail wood fences may be considered as allowable substitutes on a case by case basis.

607.60.3.4 When an existing fence is removed the Contractor shall provide and install either a 4 foot high chain link fence or a properly secured 4 foot high orange plastic safety fence as the temporary replacement, unless a specific type and/or size of fence is specified.

607.60.4 Method of Measurement. Measurement of wood split-rail fence will be made to the nearest linear foot measured along the slope of the fence. Unless gates are a specific bid item, they shall be included in the measurement of the fence.

607.60.5 Basis of Payment. The accepted quantity of wood split-rail fence, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for concrete footings or for post hole excavation or for excavation and embankment necessary to smooth the area under the fence. There shall be no direct payment for the installation and removal of the temporary fencing. All costs resulting from the maintenance of the temporary fencing shall be borne by the Contractor.
SECTION 608
CONCRETE MEDIAN, MEDIAN STRIP, SIDEWALK, CURB RAMPS, STEPS AND PAVED APPROACHES

608.1 Description. This work shall consist of constructing concrete medians, median strips, sidewalks, steps, and paved approaches in conformity with the lines, grades, dimensions, and typical sections indicated on the plans, or as directed by the Engineer. Concrete median shall consist of a paved median constructed on a prepared subgrade. Concrete median strip shall consist of a paved median strip laid over and doweled to a previously constructed pavement.

608.2 Materials. All materials shall conform to, Materials Details, and specifically as follows:

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<tr>
<th>Item</th>
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<tbody>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
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<tr>
<td>Steel Welded Wire Reinforcement for Concrete Pavement</td>
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<td>Epoxy Resin Material</td>
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<td>Red Concrete Tinting Material</td>
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<tr>
<td>Materials for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Truncated Domes</td>
<td>1067</td>
</tr>
</tbody>
</table>

608.2.1 Concrete sidewalks, curb ramps, and steps shall be constructed of Class B concrete, pavement concrete, or an EMPC pavement concrete per Sec 511, except that all fine aggregate used for concrete sidewalks, curb ramps, and steps shall contain only Finish Sand or Meramec Sand.

608.2.2 Concrete medians, median strips, and paved approaches 6 inches thick or greater shall be constructed of pavement concrete. Concrete medians, median strips, and paved approaches less than 6 inches thick shall be constructed of either Class B concrete, pavement concrete, or an EMPC pavement concrete per Sec 511. All fine aggregates used for paved approaches shall contain only Finish Sand or Meramec Sand.

608.2.3 Material, proportioning, air entraining, mixing, slump and transporting concrete shall be in accordance with Sec 501, Sec 502, and Sec 703.

608.2.4 Pipe handrails indicated at step locations shall be constructed of 2 inch galvanized schedule 40 pipe and anchored as indicated.

608.3 Construction Requirements.

608.3.1 All items shall be constructed on a subgrade compacted to the required density of the applicable subgrade material. The subgrade shall be checked by means of a template prior to placing concrete. Large rocks and boulders found in the subgrade shall be removed to a minimum of 6 inches below the proposed concrete, and the space shall be refilled with suitable materials. Forms shall be metal or sound, dressed lumber, straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the item to be constructed. Wood forms shall have a minimum nominal thickness of 2 inches except where flexible forms are used. Flexible metal forms or wood forms having a nominal thickness of 1 inch will be required for all curved form lines, except that straight steel form sections 10 feet or less in length may be used for form lines having a radius greater than 200 feet. Straight steel form sections 5 feet in length will be acceptable for form lines having a radius of not less than 100 feet. The forms shall be thoroughly cleaned, well-oiled securely staked, braced, and held to the required line and grade.

608.3.2 Required reinforcement and tie bars shall be held in the designated position by bar chairs or other approved devices during the placing of concrete.
Concrete median strip shall be doweled to the pavement with epoxy-coated tie bars as shown on the plans. When the median strip is to be built on pavement constructed on a previous project or on pavement that has been used by traffic before the median strip is placed, the Contractor shall drill 1 inch diameter holes, 6 inches deep on 24 inch centers using 10 inch, No. 5 epoxy-coated dowels grouted in place 24 hours in advance of placing concrete. Where the median strip is included with the paving contract and will be constructed before the pavement is opened to traffic, the Contractor may insert the tie bars into the pavement immediately after it has been finished or may pre-form the holes and grout in the tie bars when the median strip is constructed. The holes shall be thoroughly cleaned just before the tie bars are grouted in place.

Joints. Joints for all items shall be constructed at such intervals and locations as shown on the plans or as directed by the Engineer.

Transverse joint for concrete median shall be sawed joints of the same dimensions as required for concrete pavement spaced approximately the same as transverse joints in non-reinforced concrete pavement. Load transfer devices will not be required. Longitudinal joints between the median and curb shall be constructed of 1/2 inch non-extruding preformed joint material. Sawed joints shall be sealed in accordance with Sec 502.5.4.

Transverse joints in concrete median strip shall be constructed of 1/2 inch non-extruding preformed joint material extending from top to bottom. Joints shall be constructed over each joint and major crack in the pavement, but at not less than 10 feet intervals.

Transverse joints for concrete sidewalks shall be 1/2 inch deep dummy joints made with a finishing tool. Preformed fiber joints shall be at 25 feet intervals. Regardless of other details and notes shown on the plan, a mastic joint will be required in all new sidewalk construction at the right-of-way line. Other plans and specification requirements regarding joint placement may be varied as directed.

Longitudinal joints between the medians or curbs or sidewalks or concrete pavements shall be constructed of 1/2 inch non-extruding preformed joint material extending from top to bottom. The non-extruding preformed joint material shall be ground-down ½ inch deep and sealed in accordance with Sec 502.5.4.

Concrete shall be placed on the prepared and sprinkled subgrade and shall be compacted and struck off to the required thickness. Mechanical compacting and finishing equipment may be used provided satisfactory results are obtained. The concrete shall be tamped or vibrated sufficiently to eliminate all voids and to bring the mortar to the top after which the surface shall be uniformly finished. All edges shall be rounded with an edging tool having a 1/4 inch radius. After free water has left the surface, a hand broom finish will be applied. After finishing, the concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane shall be used in lieu of pigmented membrane.

Americans With Disabilities Act (ADA) Pedestrian Facilities. The Contractor shall comply with all laws pertaining to the Americans with Disabilities Act (ADA) during construction of pedestrian facilities on public rights of way. MoDOT’s ADA Checklist will be utilized by the Contractor for verifying compliance with the ADA law. The Contractor is expected to be familiar with the plans involving pedestrian facilities and the ADA Post Construction Checklist prior to performing the work.

ADA Checklist. The Contractor can locate the ADA Checklist form on the Missouri Department of Transportation website at www.modot.org. The ADA Checklist is intended to be a helpful tool for the Contractor to use during the construction of the pedestrian facilities and a basis for the county’s acceptance of work. Prior to work being performed, the Contractor shall bring to the Engineer’s attention any planned work that is in conflict with the design or with the requirement shown in the checklist. Situations may arise where the checklist may not fully address all requirements needed to construct a facility to the full requirements of current ADA law. In those situations, the Contractor shall propose a solution to the Engineer that is compliant with current ADA law using the following hierarchy of resources: 2010 ADA Standards for Accessible Design, Draft Public Rights of Way Accessibility

608.3.6.2 It is encouraged that the Contractor monitor the completed sections of the newly constructed pedestrian facilities in attempts to minimize negative impacts that its equipment, subcontractors or general public may have on the work. Completed facilities must comply with the requirements of ADA and the ADA Checklist or have documented reasons for the noncompliant items to remain.

608.3.6.3 Acceptance. The Contractor shall provide the completed ADA Checklist to the Engineer at the semi-final inspection. ADA improvements require final inspection and compliance with the ADA requirements and the ADA Checklist. Each item listed in the checklist must receive either a “YES” or an “N/A” score. Any item receiving a “NO” will be deemed noncompliant and shall be corrected at the Contractor’s expense unless deemed otherwise by the Engineer. Documentation must be provided about the location of any non-compliant items that are allowed to remain at the end of the construction project. Specific details of the non-complaint items, the ADA requirement that the work was not able to comply with, and the specific reasons that justify the exception are to be included with the completed ADA Checklist provided to the Engineer.

608.3.6.4 Slope and grade measurements shall be made using a properly calibrated, 2 foot long, electronic digital level approved by the Engineer.

608.3.7 Truncated Domes. This work shall consist of furnishing and installing detectable warning strips or truncated domes (red in color) within concrete curb ramps or concrete median strip.

608.3.7.1 The truncated domes shall consist of truncated domes meeting the requirements of the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (Proposed Guidelines). The truncated domes shall be colored “brick red” and be cast or imbedded into the concrete. The truncated domes shall be installed in strict accordance with the manufacturer’s recommendations. Products that are bonded to the surface of the concrete shall not be allowed in new installations. Stamped concrete truncated domes will not be allowed.

608.3.7.2 Truncated domes shall be installed flush along the surface of the ramp or concrete cut-through.

608.3.7.3 All truncated domes shall be covered during application of curing compound.

608.3.7.4 For curb ramps located at public side streets, signalized commercial entrances, or as shown on the plans, a detectable warning strip 24 inches deep by the width of the ramp shall be installed. Where both ends of the bottom grade break are 5.0 feet or less from the back of curb, the detectable warning shall be located on the ramp surface at the bottom grade break. Where either end of the bottom grade break is more than 5.0 feet from the back of curb, the detectable warning shall be located on the lower landing at the back of curb.

608.3.7.5 Truncated domes shall be aligned on a square or radial grid pattern, 24 inches deep in the direction of travel, and the full width of curb ramp, landings or blended transition, exclusive of flares.

608.3.8 Tinted Concrete. Where the plans indicate concrete construction to be tinted, tinting materials used shall meet the requirements of Sec 1056.

608.3.8.1 Concrete shall be tinted by applying the tinting material uniformly over, and working it into, the surface of the fresh concrete to a depth of ¼ to ½ inch in a manner and quantity required to obtain a uniform color density meeting the approval of the Engineer, after which the final finishing operations shall proceed. The tinting mixture shall be a 2 to blend of tinting material to cement. This mixture shall be applied at the rate of approximately 45 pounds per 100 square foot of surface. The actual quantity required to obtain the desired color density may vary from this estimated quantity. Tinted concrete shall be cured in accordance with the curing requirements for the contract item for which tinting is specified, except that white pigmented membrane curing material shall not be
used. When the Contractor elects to use membrane curing for those items where its usage is permitted, it shall be of the clear or transparent type.

608.3.9 After the concrete has sufficiently set, the forms shall be removed and where necessary, the area adjacent to the concrete shall be backfilled with suitable material, compacted and finished in a satisfactory manner.

608.3.10 During cold weather, the limitations and protection requirements of Sec 502.4.1 and Sec 502.4.2 shall apply to this work.

608.4 Method of Measurement

608.4.1 Measurement of concrete median and median strip will be made to the nearest 1/10 square yard or to the nearest linear foot as indicated in the contract. Final measurement of the completed concrete median and median strip will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

608.4.2 Concrete sidewalk will be measured to the nearest 1/10 square yard. No additional payments will be made for constructing curb ramps.

608.4.3 Paved approach will be measured from the beginning of the return on one side of the approach to the end of the return on the other side of the approach to the nearest 1/10 square yard. Integral curb constructed on paved approaches will not be measured and paid for separately, but will be included in the contract unit price for paved approaches. Final measurement of the completed paved approach will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

608.4.4 All excavation and all work necessary in preparing the subgrade and backfilling will be paid for as one or more of the classifications of roadway excavation. Final measurement of excavation will not be made except as set out in Sec 203.

608.5 Basis of Payment

608.5.1 The accepted quantity of concrete steps will be measured and paid for at the unit bid price to the nearest 1/10 square foot.

608.5.2 The accepted quantities of concrete median, median strip, sidewalk, and paved approach, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract.

608.5.3 No direct payment will be made for the following:

(a) Furnishing and/or installing reinforcement.

(b) Any incidental work required for furnishing and installing tie bars.

(c) Excavating or preparing the subgrade for any item contained in this specification.

(d) Tinting of concrete surface as required in the plans.

(e) Vertical curbs or flares constructed as part of the curb ramp or landing.

(f) Truncated dome construction or installation.
SECTION 609.10 CONCRETE CURB, GUTTER AND PAVED DITCH.

609.10.1 Description. This work shall consist of constructing curb, gutter, or combination curb and gutter, and paved ditches in conformity with the lines, grades, dimensions, and typical sections indicated on the plans, or as directed by the Engineer.

609.10.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

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<tr>
<th>Item</th>
<th>Section</th>
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</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
<td>1036</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055.2</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
</tbody>
</table>

609.10.2.1 Materials, proportioning, air entraining, mixing, slump, and transporting of Portland cement concrete shall be in accordance with Sec 501. Concrete shall be Class B, or pavement concrete, or an approved EMPC pavement concrete per Sec 511 and shall be placed, finished, and cured in accordance with the applicable provisions of Sec 703.

609.10.3 Construction Requirements.

609.10.3.1 These items shall be placed on a prepared subgrade of uniform density. Forms shall be metal or sound, dressed lumber, straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the item to be constructed. Wood forms shall have a minimum nominal thickness of 2 inches except where flexible forms are used. Flexible forms of metal or wood (with a nominal thickness of 1 inch) will be required for all curved form lines, except that straight steel form sections 10 feet or less in length may be used for form lines having a radius greater than 200 feet. Straight steel form sections 5 feet in length will be acceptable for form lines having a radius of not less than 100 feet. The forms shall be thoroughly cleaned, well oiled, securely staked, braced, and held to the required line and grade. Hangers used for face forms on curb must be entirely supported from the back form.

609.10.3.1.1 In lieu of the forming requirements specified in Sec 609.10.3.1 slip form methods may be used for placement of concrete curb, concrete gutter, curb and gutter, and paved ditch providing proper lines, grades and typical sections are maintained. Paving requirements will be the same as Sec 502.10.

609.10.3.2 Required reinforcement and tie bars shall be held in the designated position during the placing of concrete by bar chairs or other approved devices. For paved ditch and creek channels, reinforcing steel will be firmly supported on full size concrete brick or block. No additional payment will be allowed for meeting this requirement. Joints shall be constructed at intervals and locations shown on the plans or as directed by the Engineer.

609.10.3.3 Concrete shall be placed on the prepared and sprinkled subgrade, compacted and struck off to the required thickness. Concrete shall be tamped or vibrated sufficiently to eliminate all voids and to bring mortar to the top, after which the surface shall be finished smooth and even. All edges shall be rounded with an edging tool having a 1/4 inch radius. Faces of curb shall be rounded at the top and bottom, by means of an approved tool, to the radius shown. The curb face forms will be stripped when the concrete is sufficiently set and the face of the curb will be rubbed using grout necessary to fill any voids and air bubbles. After the rubbing operation, a brush finish will be applied. After finishing, concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane shall be used on paved ditch.
**609.10.3.3.1** The finished curb shall be true to line, grade, and cross section, with the top and face finished smooth and brushed. The top edges of the curb shall be rounded with an approved edging tool. Curing shall be accomplished in the same manner as required for concrete pavement. At 60 feet intervals, joints of preformed material shall be placed through the curb to within 1/4 inch of the top and face of the curb. At all other joint locations, a matching saw joint will be allowed, provided that it is completely sawed through and sealed.

**609.10.3.4** During cold weather, the limitations and protection requirements of Sec 502.4.1 and Sec 502.4.2 shall apply to this work.

**609.10.3.5** Curb straightedged parallel to the centerline shall not show a variance greater than 1/2 inch from a 10 foot straightedge. Failure to comply with this provision will require complete removal and replacement of the affected area. No area less than 10 feet will remain in place.

**609.10.4 Method of Measurement.**

**609.10.4.1** Curb, gutter, and combination curb and gutter will be measured to the nearest linear foot along the curb face or along the flowline of gutters. Unless otherwise specifically provided for in the contract, the quantities shown for combination curb and gutter have been carried across private and commercial concrete entrances and include the gutter pan shown in the Standard Drawings. However, if the gutter pan section is constructed monolithically with the paved approach, it will be added to the approach quantity for payment with a corresponding amount deducted from the curb, and curb transitions on paved approaches will not be measured nor paid for separately, but will be considered a part of the paved approach. Curbs carried full height on paved approaches will be measured and paid for under the applicable curb item. No deductions will be made for wheelchair ramps.

**609.10.4.2** Paved ditches will be computed by measuring from the top of the exposed surface on the slope to the bottom of exposed surface on the slope to the nearest 1/10 square yard.

**609.10.5 Basis of Payment.** The accepted quantities of curb, gutter, curb and gutter, and paved ditch, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for excavation, or for any work necessary for preparing the subgrade and backfilling the completed item. No direct payment will be made for furnishing or installing reinforcement, or for excavating toewall.

**SECTION 609.20 INTEGRAL CURB.**

**609.20.1 Description.** This work shall consist of curb constructed on the edge of concrete pavement in conformity with the typical section shown on the plans.

**609.20.2 Materials.** All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
</tbody>
</table>

Integral curb shall be constructed of concrete conforming to that required for concrete pavement except that coarse aggregate of the classification required for pavement but conforming to the gradation requirements of Sec 1005 may be used. The quantity of coarse aggregate in the mix may be reduced to obtain better workability.

**609.20.3 Construction Requirements.**

**609.20.3.1** The curb is to be an integral part of the supporting concrete pavement and may be placed immediately after all slab finishing operations have taken place and before the slab has taken its initial set, or tie bars may be set in the freshly finished slab to serve ultimately as a tie between the slab and the curb, which may be constructed...
later. When necessary for paving equipment to be backed up near a construction joint, the relatively short distance will be drilled and curb dowels will be grouted 24 hours prior to placing curb. All curb will be constructed 6 inches in height unless otherwise specified. Dowelled on curb will only be allowed when approved by the Engineer.

609.20.3.2 Metal forms joined neatly and tightly, set accurately to alignment and grade, and securely held in place by connections and bracing shall be used for this work. Forms for curved form lines shall be provided in a manner similar to that required for concrete pavement in Sec 502.3.1

609.20.3.2.1 In lieu of the forming requirements of Sec 609.20.3.2 slip form methods may be used for placement of integral curb providing all other requirements of Sec 609.20.3 are met.

609.20.3.3 The finished curb shall be true to line, grade, and cross section, with the top and face finished smooth and brushed. The top edges of the curb shall be rounded with approved edging tools. Curing shall be accomplished in the same manner as required for concrete pavement. At all other joint locations, a matching saw joint will be allowed, provided that it is completely sawed through and sealed.

609.20.3.4 Where the tie bars are set in the freshly finished pavement surface, and membrane curing is used on the pavement, care shall be taken to avoid spraying the membrane on the protruding tie bars or the area on which the integral curb is to be placed. Another of the alternatives of Sec 502.6 shall be used for curing this area of the pavement.

609.20.3.5 Integral curb straightedged parallel to the center line shall not show a variance greater than 1/2 inch from a 10 foot straightedge. Failure to comply with this provision will require complete removal and replacement of the affected area. No area less than 10 feet will remain in place.

609.20.4 Method of Measurement. Integral curb will be measured to the nearest linear foot along the curb face, exclusive of paved approaches. Final measurement of the completed integral curb will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

609.20.5 Basis of Payment. The accepted quantity of integral curb, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. Payment for curb constructed on paved approaches will be included in the unit bid price for paved approaches.

SECTION 609.30 ASPHALT CURB

609.30.1 Description. This work shall consist of constructing a curb of asphaltic concrete in conformity with the lines, grades, and dimensions shown on the plans or established by the Engineer. All applicable provisions of Sec 401, Bituminous Pavements and Base, shall apply to this construction.

609.30.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate</td>
<td>1002</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1002</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1002</td>
</tr>
<tr>
<td>Asphalt Cement</td>
<td>1015</td>
</tr>
</tbody>
</table>

609.30.3 Composition of Mixture. The asphaltic concrete mixture shall consist of aggregates, filler if needed, and asphalt cement combined in such proportions that the composition by weight of the finished mixture shall be within the limits specified for BP-1 mixture in accordance with Sec 401.3. The Contractor shall submit in writing, for
approval, the job mix it proposes to use for asphalt curb. The BP-1 job mix approved for asphaltic concrete pavement shall not be used for asphalt curb.

**609.30.3.1** An approved commercial mixture may be used as approved by the Engineer. If the Contractor elects to use such a mixture, they shall furnish the Engineer, for approval, a statement setting out the source and the job mix formula of the mixture they propose to furnish. If the proposed mixture and plant are approved by the Engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish a certification in triplicate that the material and mixture are in conformance with the approved proposal.

**609.30.4 Construction Requirements.**

**609.30.4.1** The curb shall be placed in position on a clean, tacked surface by means of an approved automatic curb machine that shapes and compacts the mixture to the designated cross section. The placement temperature of the mixture shall be approximately 260°F. Any required joints shall be carefully made in such manner as to insure a continuous bond between the old and new sections of the curb.

**609.30.4.2** The newly laid curb shall be protected from traffic by barricades or other suitable methods until the heat of the asphalt mixture has dissipated. Immediately after the asphalt curb has hardened, it shall be backfilled where required with suitable material.

**609.30.4.3** If painting of the asphalt curb is required by the contract, a light coat of commercial grade asphalt base aluminum paint shall be first applied.

**609.30.5 Method of Measurement.** Asphalt curb will be measured to the nearest linear foot.

**609.30.6 Basis of Payment.** The accepted quantity of asphalt curb will be paid for at the contract unit bid price. No direct payment will be made for cleaning and priming prior to placing of the curb, or for painting the completed curb.

**SECTION 609.40 Not Used**

**SECTION 609.50 Not Used**

**SECTION 609.60 DITCH LINER.**

**609.60.1 Description.** This work shall consist of constructing ditch liner at the locations indicated on the plans, or as directed by the Engineer.

**609.60.2 Materials.** All materials shall conform to Division 1000, Materials Details, and specifically as follows: Concrete shall be Class B or B-1, or a concrete of commercial mixture meeting the requirements of Sec 501. Air entrained concrete will be required. Direct placement of concrete by pumping equipment acceptable to the Engineer will be permitted. To facilitate pumping, an increase in the percentage of fine aggregate will be allowed.

**609.60.3 Construction Requirements.**

**609.60.3.1** Ditch liners shall be constructed by placing concrete directly on the prepared subgrade.

**609.60.3.2** The ditch liner shall be placed on a subgrade of reasonably uniform density to the thickness shown on the plans.
609.60.3.3 Forms will not be required. Concrete shall be consolidated and struck off to the required thickness and shape.

609.60.3.4 Weather limitations and protection requirements of Sec 502.4.1 and Sec 502.4.2 shall apply to the placing of concrete and grout.

609.60.3.5 Concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane may be used in lieu of pigmented membrane.

609.60.3.6 After the concrete has sufficiently set the Contractor shall, where necessary, backfill adjacent to the ditch liner with suitable material, compacted and finished in a satisfactory manner.

609.60.4 Method of Measurement. Ditch liner will be measured to the nearest square yard of surface.

609.60.5 Basis of Payment. The accepted quantity of ditch liner, complete in place, will be paid for at the contract unit bid price. No direct payment will be made for excavation below the upper surface of the ditch liner, or for any work necessary for preparing the subgrade and backfilling the completed item.
SECTION 610
PAVEMENT SMOOTHNESS

610.1 Description. This work shall consist of measuring the smoothness of the final pavement surface. Smoothness shall be measured using the International Roughness Index (IRI). The following pavement types shall comply with this specification:

a) Multi-lift asphalt construction greater than 3 inches contained in Sec 401.

b) Concrete pavement construction contained in Sec 502.

c) Combination of surface planing, such as diamond grinding or milling, and single lift asphalt construction or multi-lift asphalt construction less than or equal to 3 inches contained in Sec 401.

d) Single lift asphalt construction contained in Sec 401.

610.2 Material Requirements.

610.2.1 Inertial Profiler. IRI shall be computed from profile data collected with an inertial profiler (IP) that meets the requirements of AASHTO M 328.

610.2.2 ProVAL Software. The ProVAL software program shall be used to compute IRI smoothness and locate areas of localized roughness (ALR) in accordance with MoDOT TM-59.

610.2.3 Straightedge. A rolling 10 foot straightedge shall be used for checking longitudinal elevation changes. A 4 foot straightedge shall be used for checking transverse elevation changes.

610.3 Certification. All inertial profilers used to collect data on St. Charles County projects shall be annually certified at the MoDOT certification site in accordance with TM-59. The operator of the IP shall be certified through the MoDOT technician certification program.

610.4 Construction Requirements.

610.4.1 Smoothness Increments. Length of pavement shall be defined in the following increments for the purpose of smoothness acceptance:

a) Section – A section is a day’s paving and shall begin and terminate at the construction joints. Interruptions designated by the Engineer which cause placement to cease and begin at a new location will considered as a separate section for that day’s operation if the separate section is greater than 250 feet.

b) Segment – Sections shall be divided into segments of 0.1-mile lengths with the exception of the last segment. If the last segment is greater than 250 feet and less than 0.1 mile, then the segment shall be measured for smoothness as an independent segment. If the last segment is 250 feet or less, the profile for that segment shall be included in the evaluation for the previous segment. The combined segment IRI shall be weighted for the length.

610.4.2 Profiling Areas.

610.4.2.1 Profiling will be applicable to the surface of all the following:

a) Mainline paving
b) Auxiliary lanes, turning lanes and ramps for projects or combination of projects, consisting of more than 0.5 mile of total profilable pavement.

c) Bituminous shoulders greater than 4 feet. Bituminous shoulders less than 4 feet will be included in the adjacent lane’s profile.

610.4.2.2 Profiling will not be required for the following exceptions:

(a) Bridge decks, bridge approach slabs and concrete approach pavements.

(b) Pavement on horizontal curves with centerline radius of curve less than 400 feet.

(c) Pavement on vertical curves having a "K" value less than 45.

(d) Pavement width transitions.

(e) Fifty feet in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

(f) Fifty feet in direction of travel on each side of intersecting routes with special grade transitions.

(g) Portland cement concrete shoulders.

(h) Interruptions designated by the Engineer which provide independently placed sections shorter than 50 feet.

(i) The last 15 feet of any section where the prime Contractor is not responsible for the adjoining surface.

(j) Any lane which abuts an existing lane not constructed under the same contract.

(k) Stages of construction as set in the contract documents less than 1000 feet of continuous pavement. Contractor initiated changed to the staging plan with segments less than 1000 feet of continuous pavement will be tested.

610.4.3 Longitudinal Straightedging. Any pavement surface not measured with an inertial profiler shall be measured with a 10 foot straightedge. The straightedge path in the longitudinal direction for driving lanes will be located three feet from the outside edge and for shoulders will be located in the center. Additional paths with suspect roughness may be selected at the Engineer’s discretion. Shoulders that are paved integrally with an adjacent driving lane will not require straightedging. The Engineer also has discretion to use a straightedge for spot checking pavement that had been measured with an inertial profiler. Any variations in the longitudinal direction exceeding 1/4 inch in 10 feet on shoulders and 1/8 inch in 10 feet on all other pavements shall be marked for correction in a manner approved by the Engineer.

610.4.4 Transverse Straightedging. The Engineer shall randomly check driving lanes, regardless of the smoothness measurement method used, for variations in the transverse direction with a 4 foot straightedge. Any variations in the transverse direction more than 1/4 inch shall be marked for correction in a manner approved by the Engineer.

610.4.5 Full Depth Pavement and Multi-lift Overlays > 3 Inches. These construction procedures apply to pavement treatments described in Sec 610.1 (a) and (b).

610.4.5.1 Testing. The Contractor shall perform testing on all eligible profiling areas and provide a hard copy of the profilogram and electronic files for smoothness data in .PFF file format to the Engineer in accordance with the testing and reporting procedures in MoDOT TM-59. Reported IRI for each segment is the average of both wheel
paths. Furnishing inaccurate test results may result in decertification of the inertial profiler operator. Average segment IRIIs shall meet the threshold requirement in Table 1.

### 610.4.5.2 Areas of Localized Roughness

An area of localized roughness (ALR) is any length of pavement with a continuous 25 foot average IRI measured in the right wheel path that exceeds the maximum threshold set in Table 1. ALRs shall be corrected.

### 610.4.5.3 Method of Correction

Corrective action to eliminate ALRs and improve the average IRI shall be accomplished by a method approved by the Engineer. Diamond grinding may be used for bumps, but the use of an impact device, such as a bush hammer, will not be permitted. Total grinding depth shall be limited to ¼ inch. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements. All corrective work shall be completed prior to determination of pavement thickness. The Contractor shall reprofile the corrected lengths to verify smoothness compliance and submit an electronic data file in .PFF format to the Engineer within 48 hours after testing.

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Maximum Segment IRI (in/mi)</th>
<th>Maximum ALR IRI (in/mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Depth Pavement</td>
<td>80.0</td>
<td>175.0</td>
</tr>
<tr>
<td>Multi-Lift Overlay &gt; 3 inches</td>
<td>80.0</td>
<td>175.0</td>
</tr>
<tr>
<td>Multi-Lift Overlay ≤ 3 inches</td>
<td>125.0</td>
<td>175.0</td>
</tr>
</tbody>
</table>

#### 610.4.5.3.1 Corrections to Bituminous Pavements

If a bituminous pavement surface is corrected by diamond grinding, the ground surface shall be treated according to the table below:

<table>
<thead>
<tr>
<th>Size of Pavement Correctiona</th>
<th>Surface Treatment</th>
<th>Treatment Areac</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10% of the project pavement b</td>
<td>The ground surface shall be covered with an approved asphalt-based sealer.</td>
<td>Entire width of lane or shoulder.</td>
</tr>
<tr>
<td>Between 10% and 50% of the project pavement b</td>
<td>The ground surface shall be covered with an asphalt surface treatment per Sec 413.20.</td>
<td>Entire width of lane or shoulder.</td>
</tr>
<tr>
<td>&gt; 50% of the project pavement b</td>
<td>The ground surface shall be covered with an asphalt surface treatment per Sec 413.20.</td>
<td>The entire project pavement from edge of pavement to edge of pavement.</td>
</tr>
</tbody>
</table>

a The ground surface area will be measured along the center of each lane multiplied by the lane width. Shoulders less than 4 feet will be included in the adjacent lane. Gaps between ground surfaces less than 100 feet will be considered a ground surface, will be measured as a ground surface, and shall also be treated to provide a uniform surface.

b The total area of project pavement will be calculated by summing the areas of the bituminous pavements which are to be profilographed, and straighthedged.

c The Contractor shall treat the areas as noted, making the transverse start and stopping points straight and neat, as directed by the Engineer. Gaps between ground surfaces less than 100 feet will be considered a ground surface and shall also be treated.

### 610.4.6 Multi-treatment Overlays or Multi-lift Overlays ≤ 3 Inches

These construction procedures apply to pavement treatments described in Sec 610.1 (c).
610.4.6.1 Testing. The requirements are the same as Sec 610.4.5.1, except that segment average IRI s shall meet the threshold requirements for multi-lift overlays less than or equal to 3 inches in Table 1.

610.4.6.2 Areas of Localized Roughness. All ALRs, as defined in Sec 610.4.5.2, that exceed the maximum threshold set in Table 1 shall be corrected.

610.4.6.3 Method of Correction. Corrective action to eliminate ALRs and improve the average IRI shall be accomplished with a method approved by the Engineer. Diamond grinding bumps shall only be permitted for a 1½ inch or greater single lift overlay. Grinding depth shall be limited to ¼ inch. The Contractor shall reprofile the corrected lengths to verify smoothness compliance and submit an electronic data file in .PFF format to the Engineer within 48 hours after testing.

610.4.6.3.1 Corrections to Bituminous Pavements. If a bituminous pavement surface is corrected by diamond grinding, the ground surface shall be treated according to the Sec 610.4.5.3.1.

610.4.7 Single Lift Overlays. These construction procedures apply to pavement treatments described in Sec 610.1 (d).

610.4.7.1 Pre-Construction Quality Control Testing. Prior to performing any surface work or pavement repairs, the Contractor shall profile the right wheel path in accordance with TM-59. This control profile will serve as the baseline for calculating percent improvement for the project.

610.4.7.2 Post-Construction Testing. As soon as practical after resurfacing, the Contractor shall profile the right wheel path again. The same stationing shall be used to ensure a direct comparison with the pre-construction profile.

610.4.7.3 Method of Correction. Corrective action to improve the average IRI shall be accomplished with a method approved by the Engineer. Diamond grinding bumps shall only be permitted for a 1½ inch or greater single lift overlay. Grinding depth shall be limited to ¼ inch. The final surface texture of corrected pavement shall be comparable to adjacent sections that do not require correcting.

610.4.7.3.1 Corrections to Bituminous Pavements. If a bituminous pavement surface is corrected by diamond grinding, the ground surface shall be treated according to the Sec 610.4.5.3.1.

610.5 Basis of Payment.

610.5.1 Fixed Value Improvement. The following basis of payment procedures shall apply to all pavement treatments described in Sec 610.1 (a), (b) and (c).

610.5.1.1 Smoothness Adjustment. Smoothness adjustments will be paid per segment based on the IRI before any corrections. Any segment with an IRI above the maximum limit in Tables 1 must be corrected through a method approved by the Engineer to achieve the desired smoothness. When paving widths are greater than the travel lane widths, incentive payment will apply to the driving lane design width only.

610.5.1.2 Incentives/Penalties. Incentive payment and penalties for smoothness shall be based on Table 3. Constant width acceleration and deceleration lanes shall be considered as mainline pavements.

| Table 3 |
|------------------|------------------|
| International Roughness Index, Inches Per Mile | Percent of Contract Price |
| 70.0 or less | 103 |

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610.5.2 Percent Improvement. The following basis of payment procedures shall apply to all pavement treatments described in Sec 610.1 (d).

610.5.2.1 The contract price for resurfacing will be adjusted based on the improvement in profile index according to Table 4 for each segment with an initial IRI greater than 60 inches per mile. Any segment with an initial IRI less than or equal to 60 inches per mile shall receive no percent improvement price adjustment if the segment IRI after placement of the overlay is also less than or equal to 60 inches per mile. Any segment with an initial IRI less than or equal to 60 inches per mile that has an IRI greater than 60 inches per mile after placement of the overlay shall be paid at 97 percent of the contract unit price for pavement, but no correction shall be required.

<table>
<thead>
<tr>
<th>Percent Improvement (Change in IRI / Initial IRI) X 100</th>
<th>Percent of Contract Unit Price For Pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.0 or greater</td>
<td>103</td>
</tr>
<tr>
<td>20.0 to 34.9</td>
<td>100</td>
</tr>
<tr>
<td>0.0 to 19.9</td>
<td>97(^{b})</td>
</tr>
</tbody>
</table>

\(^{b}\)After correction to 0.0 or greater

610.5.3 Testing Cost. The contract unit price for pavement will be considered as full compensation for all items entered into the construction of the pavement including the cost of smoothness testing.
SECTION 611
EMBANKMENT PROTECTION

SECTION 611.10 ROCK LINING.

611.10.1 Description. This work shall consist of constructing rock lining at the locations indicated on the plans or as directed by the Engineer.

611.10.2 Material. The material for rock ditch liner shall consist of a predominantly one-sized, durable stone, shot rock or broken concrete. Acceptance by the engineer may be made by visual inspection. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile Fabric</td>
<td>1011</td>
</tr>
</tbody>
</table>

611.10.2.1 Type 1 Rock Ditch Liner shall consist of material with a predominant rock size of 3 inches, a maximum rock size of 6 inches and a gradation such that no more than 15 percent will be less than one inch.

611.10.2.2 Type 2 Rock Ditch Liner shall consist of material with a predominant rock size of 6 inches, a maximum rock size of 10 inches and a gradation such that no more than 15 percent will be less than 3 inches.

611.10.2.3 Type 3 Rock Ditch Liner shall consist of material with a predominant rock size of 12 inches, a maximum rock size of 20 inches and a gradation such that no more than 15 percent will be less than 4 inches.

611.10.2.4 Type 4 Rock Ditch Liner shall consist of material with a predominant rock size of 19 inches, a maximum rock size of 28 inches and a gradation such that no more than 15 percent will be less than 6 inches.

611.10.2.5 Bedding material shall be used under Type 3 and Type 4 Rock Ditch Liner. Bedding material shall consist of crushed stone or gravel with a gradation consisting of 100 percent passing the 3-inch sieve, 30 to 70 percent passing the 1 1/2-inch sieve and 0 to 15 percent passing the No. 4 sieve.

611.10.3 Construction Requirements. The rock lining material shall be placed by dumping, and shall be left in a rough condition to the approximate shape of the channel flow line. The rock lining shall be underlain with an approved geotextile fabric unless otherwise directed by the Engineer.

611.10.4 Method of Measurement. Measurement will be made to the nearest cubic yard of material in place in the completed rock lining. Final measurement of the completed rock lining will not be made except for authorized changes during construction, or where appreciable errors are found in contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

611.10.5 Basis of Payment. The accepted quantity of rock lining in place will be paid for at the contract unit price. No direct payment will be made for any excavation required to place the rock lining. No direct payment will be made for the geotextile fabric. No separate payment will be made for furnishing the rock lining.

SECTION 611.20 Not Used

SECTION 611.30 ROCK BLANKET.

611.30.1 Description. This work shall consist of constructing a protecting blanket of rock or broken concrete on slopes or stream banks.
611.30.2 Materials. The material for rock blanket shall be durable stone or broken concrete containing a combined total of not more than 10 percent of earth, sand, shale, and non-durable rock. It is preferable that the material contains a large percentage of pieces as large as the thickness of the blanket will permit, with enough smaller pieces of various sizes to fill the larger voids. For Type 1 Rock Blanket, at least 40 percent of the mass shall be of pieces having a volume of 1 cubic foot or more. For Type 2 Rock Blanket, at least 60 percent of the mass shall be of pieces having a volume of 1 cubic foot or more. Acceptance of quality and size of material will be made by visual inspection at the job site. Rock blanket shall be underlain with an approved geotextile fabric unless otherwise directed by the Engineer. All reinforcement steel or wire shall be cut off flush with any broken concrete used.

611.30.3 Construction Requirements. A trench at the toe of the slope shall be excavated to the elevation as shown on the plans, or to a depth of 2 feet if not shown. The slopes shall conform to the proper cross section and be compacted to a uniform density as required for adjacent material. The rock or broken concrete shall be placed on the slope, to the specified thickness, elevation and extent, and manipulated so that most of the flat sides are in contact, thereby eliminating large voids. The finished surface of the rock blanket shall present an appearance free from segregation and with proportionate quantity of the larger pieces showing.

611.30.4 Method of Measurement. Measurement will be made to the nearest cubic yard of material in place in the completed blanket.

611.30.5 Basis of Payment. Payment for furnishing and placing rock blanket will be made at the contract unit bid price per cubic yard. No direct payment will be made for excavating the trench or for backfilling the toe wall and cutoff walls, when required as specified in Sec 611.50.3.2. No direct payment will be made for the geotextile fabric.

SECTION 611.40 Not Used

SECTION 611.50 REVETMENT.

611.50.1 Description. This work shall consist of slope or bank protection and drainage ditches constructed at locations shown on the plans or as directed by the Engineer, and shall be of the type or types included in the contract.

611.50.2 Materials. Acceptance of quality and size of material will be made by visual inspection at the job site.

611.50.2.1 Stone for light stone revetment shall be sound, durable, and free from cracks and other structural defects that would cause it to deteriorate. It shall not contain any soapstone, shale, or other material easily disintegrated. The stone shall be in blocks at least 7 inches in thickness perpendicular to the slope and have approximately rectangular faces 7 inches or more in width. All blocks shall weigh not less than 25 pounds, and at least 75 percent shall weigh not less than 50 pounds.

611.50.2.2 The stone for heavy stone revetment shall conform to the requirements of Sec 611.50.2.1, except that the blocks shall be at least 12 inches in thickness perpendicular to the slope and all blocks shall weigh not less than 50 pounds and at least 60 percent shall weigh not less than 100 pounds.

611.50.2.3 At the Contractor's option, concrete blocks may be substituted for stone, provided the concrete blocks meet the size and weight specifications for stone. The blocks shall be made of either Class B concrete or concrete of a commercial mixture with material, proportioning, mixing, slump and transporting of concrete in accordance with Sec 501. Blocks may be precast and then laid in the required location, or the blocks may be cast in place on the slope, provided joints are spaced such that the joints will completely sever the concrete into blocks no larger than 2 x 4 feet with the long dimension horizontal and with vertical joints broken. If cast in place, concrete shall be placed, finished and cured in accordance with Sec 703.
611.50.2.4 The Contractor may use broken concrete as blocks for revetment provided all protruding reinforcement, trash, asphaltic concrete, and other extraneous materials are removed prior to placement in waters of the United States, and their associated floodplains.

611.50.2.5 Broken Concrete. Broken concrete used as revetment shall be reasonably well graded, and contain a combined total of no more than 15 percent of soil or gravel. The gradation shall consist of pieces ranging in volume from 0.1 cubic foot to 1 cubic foot. The Contractor shall break larger slabs to conform to this requirement. The maximum volume of any piece shall not exceed 3 cubic feet. Acceptance of the quality and size of this material will be made by visual inspection at the job site.

611.50.3 Construction Requirements.

611.50.3.1 Unless otherwise approved, the slopes upon which revetment is to be placed shall conform to the section shown on the plans. The slopes shall be compacted to a uniform density as required for adjacent material and lined with an approved geotextile fabric. The revetment shall be started in a trench below the toe of the slope shown on the plans and shall progress upward. Each stone or block of broken concrete shall be laid perpendicular to the slope, shall be firmly bedded against the slope and against adjoining stones or broken concrete, and shall be laid with well broken joints. After revetment has been placed, the voids shall be filled with spalls or small stone in such a manner that all revetment stones or broken concrete are tightly wedged. The finished surface shall present a uniform appearance true to line, grade, and section.

611.50.3.2 Cut-off wall required around revetment: regardless of the details shown on plans, a 2 feet deep cut-off wall, measured from the bottom of the revetment, will be required around the entire perimeter of the revetment blanket except where it abuts headwalls, flared end sections, or inlet sills. No direct payment will be made for construction of the cut-off wall.

611.50.4 Method of Measurement. Measurement will be made to the nearest square yard.

611.50.5 Basis of Payment. The accepted quantity of revetment will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for excavating the trench or for any backfilling required. No direct payment will be made for the geotextile fabric.

SECTION 611.60 CONCRETE SLOPE PROTECTION.

611.60.1 Description. This work shall consist of constructing a concrete slope protection by depositing concrete on the finished earth slope, in conformity with the lines and grades shown on the plans.

611.60.2 Materials. Slope protection shall be of Class B concrete with materials, proportioning, mixing, slump, and transporting of concrete conforming to Sec 501. Concrete shall be placed, finished, and cured in accordance with the applicable provisions of Sec 703.

611.60.3 Construction Requirements.

611.60.3.1 Concrete slope protection shall be 4 inches in thickness and reinforced with No. 4 reinforcing steel on 12 inch centers each direction unless specified otherwise in the contract. The concrete shall be placed on a prepared compacted subgrade of uniform density, and shall be consolidated and struck off to the required thickness. Joints shall be the full depth of the concrete and shall consist of ½ inch material conforming to Sec 1057.6. Joint spacing will be in accordance with Standard Drawings.

611.60.3.2 The surface of the paved slope shall have a broom or burlap drag finish and shall be cured in the same manner as required for concrete pavement, except that transparent membrane shall be used in lieu of pigmented membrane.
611.60.3.3 During cold weather, the limitations and protection requirements of Sec 502.4.1 and Sec 502.4.2 shall apply to this work.

611.60.4 Method of Measurement. Measurement will be made to the nearest 1/10 square yard. Final measurement of the completed slope protection will not be made except for authorized changes during construction or when appreciable errors are found in contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

611.60.5 Basis of Payment. The accepted quantity of concrete slope protection will be paid for at the contract unit bid price. No direct payment will be made for any excavating or for other work necessary in preparing the subgrade or for any backfilling required.

SECTION 611.70 GABIONS.

611.70.1 Description. This work shall consist of furnishing, filling with stones, and placing on a constructed base, open mesh wire mattresses in accordance with the lines, grades, and dimensions shown on the plans or as established by the Engineer during construction.

611.70.2 Materials. The gabion baskets shall be constructed of welded wire fabric or hexagonal triple twist mesh with heavily galvanized steel wire.

611.70.2.1 The baskets shall be in accordance with ASTM A 974 for welded wire fabric gabions and ASTM A 975 for twisted hexagonal mesh gabions. The mesh wire diameter for the galvanized gabions shall not be less than 0.1181 inch, approximately U.S. Gage No. 11. The mesh edge wire and selvedge wire shall not be less than 0.1535 inch, approximately U.S. Gage No. 9. The lacing steel wire for binding gabion units together shall not be less than 0.0866 inch, approximately U.S. Gage No. 13 1/2.

611.70.2.2 The mesh steel wire diameter for PVC coated gabions shall not be less than 0.1063 inch, approximately U.S. Gage No. 12. The mesh edge wire and selvedge wire shall not be less than 0.1338 inch approximately U.S. Gage No. 10. The lacing wire shall not be less than 0.0866 inch, approximately U.S. Gage No. 13 1/2. The PVC coating shall not be less than 0.015 inch. Care shall be exercised during installation to avoid damage to the PVC coating.

611.70.2.3 Where the length of the gabion exceeds 4 feet the gabion shall be divided by diaphragms, of the same length mesh and gage as the body of the gabions, into cells of equal length and width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary.

611.70.2.4 Concrete for the construction of the base pad, if required, shall consist of Class B or B-1, or concrete of a commercial mixture meeting the requirements of Sec 501. Clean stone for base construction as required shall be hard and durable of the same size required in the gabion baskets.

611.70.2.5 Filter fabric shall be a woven polypropylene material meeting the following strength requirements:

<table>
<thead>
<tr>
<th>Filter Fabric Strength Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Burst Strength</td>
<td>490 psi</td>
</tr>
<tr>
<td>Minimum Trapezoidal Tear Strength</td>
<td>100# x 55#</td>
</tr>
<tr>
<td>Minimum Puncture Strength</td>
<td>130#</td>
</tr>
</tbody>
</table>

611.70.2.6 Gabion rock shall be 10 inch maximum size (95% to 100%) passing a 10 inch screen, and a 4 inch minimum size.
611.70.3 Mesh Dimensions. The maximum linear dimension of the mesh opening shall not exceed 4 1/2 inches and the area of the mesh opening shall not exceed 8 square inches. Gabions shall be supplied, as specified, in various lengths and heights. The nominal lengths shall be 6 feet, 9 feet, or 12 feet as required. The horizontal width shall be 36 inches.

611.70.3.1 Dimensions for heights, lengths, and widths are subject to a tolerance limit of plus or minus 3 percent of manufacturer’s stated sizes.

611.70.4 Certificate of Compliance with Specifications. Each shipment of gabions to a job site shall be accompanied by a certification that states that the material conforms to the requirements of these specifications. A shipment shall consist of all material arriving at the job site at substantially the same time. The certification shall be on company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

611.70.5 Construction Requirements. Prior to the placement of gabion baskets, the ground surface shall be smoothed and leveled to the line shown on the plans by the construction of a base pad of Portland cement concrete or compacted clean stone, or by a combination of these materials. The Engineer will select the method or methods to be used on each installation based on the character and soundness of the subsurface material exposed by the excavation. Generally, gabions to be place on uneven solid rock surfaces will require a concrete pad not less than 2 inches or more than 4 inches thick. Gabions to be constructed on surfaces other than solid rock will normally be placed on a 12 inches thick base constructed of clean, hard, durable stone of the same type and size required in the gabion baskets. The Engineer reserves the right to select the type of base construction considered most advantageous and desirable from the standpoint of structural adequacy and economy. The thickness of the base may be varied considerably, or the base may be stepped to take advantage of continuous formations of solid rock exposed by excavation.

611.70.5.1 The gabions are supplied folded flat, tied in pairs, and packed in bundles. The gabions are identified by color stripes and by labels indicating their code size and dimensions. The lacing wire is supplied in coils. All gabions on the channel bottom and lowest 3 feet in height on the walls shall be PVC coated.

611.70.5.2 For assembly, remove a single gabion from the bundle and proceed to unfold it on a hard, flat surface. Stretch the gabion and stamp out all kinks. Fold the front and back panels to a right angle by stepping on the base along the crease. Fold up the end panels and fasten them to the front and back panels using the heavy gage wire projecting from the upper corners of each panel. Assure all baskets are properly squared with the top of all panels even. Securely lace all vertical edges of ends and diaphragms.

611.70.5.3 The baskets shall be securely laced along all the perimeter of all contact surfaces with other baskets. Cut a length of lacing wire approximately one and one half times the distance to be laced but not exceeding 5 feet. Secure the wire terminal at the corner by looping and twisting, then proceed lacing with alternating single and double loops at approximately 5 inch intervals. Securely fasten the other lacing wire terminal. Baskets should be placed so the vertical joints are staggered.

611.70.5.4 Set assembled gabion baskets in their proper location and lace the perimeters of all contact surfaces. The base of empty gabions placed on top of a completed row must also be tightly wired to the latter. Anchor the first gabion basket by completely filling it to no more than 2 inches above the top. The gabion rock shall be hand placed along and immediately next to exposed faces. When a 3 foot high gabion is used, it shall be filled in three equal lifts. Two connecting wires are to be placed between each lift in each cell of all exposed faces from front to back. The wires shall be looped around two meshes and tensioned.

611.70.5.4.1 After anchoring the first gabion, apply tension to the other end of baskets with a come-along or other approved means in order to help achieve proper alignment. While the gabions are being stretched, inspect all corners for open “V’s” which will result if corners were not properly secured. Replace any openings that occur. Keep
gabions under tension while being filled. Leave last gabion temporarily empty to allow for each lacing of the subsequent assembly. Protect the vertical panels from being bent during the filling operation by temporarily placing and lacing reinforcing bars along the upper edges of the ends and diaphragms, or by other approved means.

611.70.5.4.2 After the hand placement of exposed front faces with rock, the remainder of gabion rock fill may be placed mechanically throughout, provided care is taken to ensure that it is tightly packed with a minimum of voids. Insure tension wires are placed each 1 foot in height. When the gabions are slightly overfilled to allow for settlement, the lids shall be folded down into position so that the lid and the gabion edges meet closely without gaps. Secure the lids at the corner with the wire projecting from the lid. Securely lace the lid shut starting with the front face and the ends. Adjacent lids may be wired to vertical panels in one operation. Lacing procedure should be as previously described, every 5 inches. Gabions shall be built with an offset or batter as shown on the project plans.

611.70.5.5 In general, the gabions may be cut to form curves or to allow pipe connections. When this is done, cut or bent edges of the mesh shall be fastened securely to another part of the gabion structure by lacing with wire.

611.70.5.6 The filter fabric shall be placed between the gabions or clean aggregate, if installed, and earth on all the unexposed sides. The material shall extend completely beneath the base row of gabions and up the sides of the bottom mat. All unexposed sections of counter forts shall be wrapped with filter material. The seams between adjoining rolls of filter material shall be made with a 12 inch overlap and the seams secured to the baskets every 18 inches to ensure tightness prior to backfilling. The filter fabric shall be cut even with the top of the wall. Fill or sod shall not extend over the top basket of the wall.

611.70.5.7 Areas beyond the pay lines established on the plans for the excavation item shall be backfilled with approved earth, or a mixture of clean sand and gravel if such is available from the creek bed.

611.70.6 Method of Measurement. The excavation limits and wall details shown on the cross-sections and the included sketch are based on the construction of the wall foundation to the elevations shown on the plans. However, as noted before, it is not intended to excavate sound, unweathered rock and replace it with gabions. It is therefore anticipated that the base of the new wall will be stepped or otherwise varied by the Engineer during construction depending on the location and character of the rock encountered in the excavation.

611.70.6.1 A subsurface report when included in the plans is for the Contractor’s information only. Unless an attempt has been made to separate or classify excavation quantities for this project, all excavation will be considered unclassified.

611.70.6.2 Final excavation quantities of unsuitable materials below the normal excavation line will be determined by the Engineer after the wall has been completed.

611.70.6.3 Gabions shall be measured in their final positions to the nearest cubic yard. Concrete if used, in the construction of the wall base, is considered incidental and will not be measured.

611.70.6.4 No measurement will be made for filter fabric or material used for backfilling areas around the completed wall.

611.70.7 Basis of Payment. Payment for gabions will be made at the contract unit price per cubic yard and will be full compensation for all labor, equipment and material to complete the described work. No direct payment will be made for normal excavation, filter fabric or for backfill material or for any concrete used for the base. Replacement of unsuitable material below the normal excavation line will be paid in accordance with Sec 206.
SECTION 613
PAVEMENT REPAIR

613.1 Description. This work shall consist of performing full depth pavement repair, partial depth pavement repair, retrofitting dowel bars, or cross-stitching pavement at locations as shown on the plans or as directed by the Engineer.

613.2 Material. All material, unless specified otherwise in this specification, shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy or Polyester Bonding Agents for Dowels</td>
<td>1039</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
</tbody>
</table>

613.3 Construction Requirements.

613.3.1 All pavement repair subsequent to sawing or removal of any pavement shall be accomplished in the same day, except as follows. If approved by the Engineer, sawing may be accomplished the day before removal, but shall be repaired the following working day. Any damage caused to the pavement due to pre-sawing, such as edge spalling, shall be repaired by the Contractor at the Contractor’s expense.

613.3.2 Repairs shall be made to only one lane at a time, unless the traffic control plan specifies otherwise. Any material that cannot be recycled shall be disposed of at a location furnished by the Contractor, or at locations on the right of way approved by the Engineer. If the material is disposed of outside the right of way, an acceptable written agreement with the property owner on whose property the material is placed shall be submitted to the Engineer by the Contractor.

613.3.3 If the repaired area is not to be resurfaced, the overcut from the sawing operation shall be filled with an expansive mortar, epoxy, polyester or joint material as approved by the Engineer.

613.3.4 Weather limitations shall be in accordance with Sec 502 for placement of concrete material and Sec 401 for placement of bituminous material.

613.3.5 All repaired areas shall be finished to provide a smooth ride, and to the satisfaction of the Engineer. Repaired areas shall be checked by stringline if required by the Engineer. When stringlined, the surface of the repaired area shall not vary more than 1/8 inch per 10 feet from a straight line between the surface of the existing pavement on each side of the repaired area, regardless of whether the repair is to be resurfaced or not.

613.3.6 Any damage to the existing pavement, joints and cracks adjacent to the pavement repair, caused by the Contractor’s operation shall be repaired at the Contractor’s expense.

SECTION 613.10 FULL DEPTH PAVEMENT REPAIRS.

613.10.1 Description. Full depth pavement repairs shall consist of removing specified areas of existing variable thickness Portland cement concrete pavement and subsequent bituminous overlays and replacing the removed material with non-reinforced Portland cement concrete as shown on the plans.

613.10.2 Construction Requirements.
613.10.2.1 Specified areas of full depth pavement repair shall be saw cut full depth around the perimeter of the patch prior to removal, except that cuts along the shoulder line may be waived by the Engineer when the pavement can be removed without damage to the shoulder. An approved saw, such as a diamond saw, shall be used for perimeter cuts. A rock saw shall not be used for a perimeter cut, but may be used to make cuts through the interior portion of the area to be removed for stress relief. The full depth of the pavement shall be removed without mechanically breaking in place, and with a minimum disturbance of sound base. Any aggregate base disturbed by the Contractor shall be recompacted or removed. Unstable base aggregate shall be removed and replaced in accordance with Sec 304 as directed by the Engineer. Subgrade compaction shall be performed in areas of unstable subgrade in accordance with Sec 210, if directed by the Engineer. If subgrade compaction is performed, the aggregate base shall be replaced. Compaction shall be to the satisfaction of the Engineer and inspection will be made visually.

613.10.2.2 All full depth pavement repairs exceeding 30 feet in length shall be constructed with tie bars along the longitudinal centerline joint in accordance with Sec 502. Dowel bars, tie bars and holes shall be as shown on the plans. Dowel bars and tie bars shall be epoxy coated. Bar holes shall be drilled to the specified diameter and to the depth shown on the plans. Equipment designed to drill multiple holes simultaneously will only be allowed provided such equipment causes no damage to existing pavement. The holes shall be blown clean and allowed to dry. The holes shall be injected with an approved epoxy or polyester bonding agent in accordance with Sec 1039.30 and shall fill the voids around the bar. The bonding agent shall be thoroughly mixed in accordance with the manufacturer’s recommendations prior to injection into the holes. The bonding agent shall be injected into the hole by inserting the injection device to the back of the hole and slowly withdrawing the device while dispensing sufficient material to completely fill the void around the bar when inserted. Other methods may be used as approved by the Engineer. The Contractor shall use a method to prevent the bonding agent from flowing from the hole during placement of the bar and to create an effective face at the entrance of the hole. The bar shall be inserted into the hole with a twisting motion so the material in the back of the hole is forced up and around the bar. The bars shall be placed parallel to the surface and the centerline of the traveled way and shall not vary more than ¼ inch in alignment. Bars shall be firmly seated prior to placing concrete.

613.10.2.3 All material, proportioning, air-entraining, mixing and transporting of concrete shall be in accordance with Sec 501 as applicable to pavement concrete. The concrete may contain Type III cement, calcium chloride, an accelerator or other admixtures approved by the Engineer.

613.10.2.4 Construction of full depth repairs shall be in accordance with Sec 502 except as follows.

613.10.2.4.1 The concrete shall have a minimum 28-day strength of 4000 psi. The design strength shall be verified by compressive strength testing of cylinders cured under the same conditions as the full depth repair patches. The Engineer will cast three 4- by 8 inch or two 6- by 12 inch cylinders of concrete from a single batch at a minimum of 500 square yards of full depth repair. The compressive strength shall be the average of the cylinder breaks.

613.10.2.4.2 The concrete shall have an air content in accordance with Sec 501.9.2. The air content shall be measured once for every day’s production.

613.10.2.4.3 The concrete opening strength to all traffic shall be 2500 psi. The opening strength shall be verified by either compressive strength testing of cylinders in accordance with Sec 613.10.2.4.1, or in accordance with MoDOT TM-7 using a rebound hammer. If MoDOT TM-7 is used, the minimum rebound ratio number (RNN) for opening strength shall be 60.

613.10.2.5 If the concrete pavement has been previously resurfaced, the repair area shall be filled with Portland cement concrete to the surface of the existing bituminous overlay, even when the existing surface is to be removed by milling, unless contract provisions allow the milling to occur prior to the pavement repair operation.
613.10.2.6 When the concrete pavement requires all milled areas to be resurfaced in the same work day prior to opening the pavement to traffic, pavement repairs identified after milling will be marked for future repair, and the area shall be resurfaced as planned for that work day. No additional lifts of hot-mix asphalt will be allowed until the marked pavement is repaired. The pavement repair shall be performed in accordance with Sec 613.10.2.5.

613.10.2.7 Immediately after finishing and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods.

613.10.2.7.1 If the existing pavement has been or is to be resurfaced, an asphalt emulsion shall be applied at a rate of 0.1 gallon per square yard, or as directed by the Engineer.

613.10.2.7.2 If the existing pavement surface is concrete and will not be resurfaced, curing shall be in accordance with Sec 502.

613.10.2.7.3 When the ambient air temperature is below 50°F, insulated curing mats, approved by the Engineer, shall be used throughout the curing period. Curing compound or asphalt emulsion shall be applied prior to placing the insulated blankets. The insulated curing mats shall not be applied until the curing material has dried sufficiently to prevent adhesion.

613.10.2.8 Sawing of internal transverse and longitudinal joints and mitigation of uncontrolled cracking shall be in accordance with Sec 502.5.

613.10.3 Method of Measurement.

613.10.3.1 Measurement for full depth sawing will be made to the nearest linear foot for the combined length of perimeter diamond saw cuts and of internal transverse saw cuts at 6 foot or greater intervals.

613.10.3.2 Measurement for furnishing and placing Portland cement concrete will be made to the nearest 1/10 square yard.

613.10.4 Basis of Payment. Accepted quantities of full depth pavement repair will be paid for at the contract unit price for each of the pay items included in the contract. The will be no direct payment for drilling dowel or tie bar holes and furnishing and installing dowels or tie bars, compaction of subgrade, and installation of aggregate base.

SECTION 613.20 CLASS A PARTIAL DEPTH PAVEMENT REPAIRS.

613.20.1 Description.

613.20.1.1 Class A partial depth pavement repair shall consist of repairing spalled areas or reestablishing joints or cracks in concrete pavement. Reestablishment of a joint or crack shall consist of removing concrete on each side of the joint or crack, placing a compressible insert to reestablish the joint or crack, and filling the area with Portland cement concrete, elastomeric concrete or epoxy mortar. This work shall be performed on concrete pavements that have not been resurfaced and are either not to be resurfaced as part of the contract work or the resurfacing is to be less than 3 inches thick.

613.20.1.2 If dowel bars are structurally damaged during the removal process, if the concrete below one half of the slab depth is unsound or damaged during removal, or if the area indicates pumping, movement of the subbase, or structural pavement failure, full depth pavement repair shall be performed in accordance with Sec 613.10.

613.20.2 Material.
613.20.2.1 Concrete coarse aggregate for Portland cement concrete shall be Gradation E or Grade F in accordance with Sec 1005 or an optimized aggregate gradation approved by the Engineer. The optimized aggregate gradation shall have 100 percent passing the ¾ inch sieve. Portland cement concrete mix shall have an air content in accordance with Sec 501.9.2.

613.20.2.2 Elastomeric concrete components shall be in accordance with manufacturer recommendations. The Engineer shall be consulted for product approval.

613.20.2.3 Epoxy mortars shall be in accordance with Sec 623.

613.20.2.4 Compressible inserts shall be rectangular and shall have a minimum thickness of ¼ inch. The material shall be preformed fiber expansion joint filler in accordance with Sec 1057 or, if approved by the Engineer, other material may be used.

613.20.2.5 Type 2, Class B liquid membrane-forming compounds, in accordance with AASHTO M 148, shall be used for curing Portland cement concrete patch material. Prior to use, the Contractor shall provide to the Engineer the manufacturer’s certification that the curing material is in accordance with this specification. Elastomeric concrete and epoxy mortar patch materials shall be cured in accordance with manufacturer recommendations.

613.20.3 Construction Requirements.

613.20.3.1 Removal of Concrete. Repair limits shall extend beyond the delaminated or spalled area by one to two inches. Boundaries of any removal shall be kept square or rectangular. If repair areas are less than 2 feet apart, the areas shall be combined as one repair. The maximum amount of spalling allowed on the edges of the channel will be ⅜ inch. The minimum depth of removal shall be 2 inches for Portland cement concrete and according to manufacturer’s recommendations for elastomeric concrete and epoxy mortar. The maximum depth of removal shall not exceed half the slab thickness. Concrete shall be removed by a milling process. Residue slurry from milling operations shall be removed in accordance with Sec 622.30.3.8. If the top of dowel bars are exposed but not structurally damaged, the exposed section of the dowel bar shall be coated with an approved bond breaker.

613.20.3.1.1 Milling. Milling equipment shall be in accordance with Sec 622.10, and shall be equipped with a device for stopping at a preset depth. Milling may be performed either across lanes or parallel to the pavement centerline. After milling, the bottom of the repair area shall be checked by sounding to ensure all unsound material has been removed. Any unsound material remaining shall be chipped free. All transverse sides of the removal shall be uniform and tapered 30° to 60° from vertical by milling or chipping. If excessive concrete is removed, or dowel bars are damaged to the extent to require full depth pavement repair, the cost for the repair shall be at the Contractor’s expense.

613.20.3.1.2 Full Depth Pavement Repair Required. If during the removal of material for partial depth pavement repair the pavement constituted full depth pavement repair in accordance with Sec 613.20.1.2, removal operations shall cease at that location. The Contractor may conduct full depth pavement repair at that time, or temporarily patch the area and perform full depth pavement repair at a later date. If the location is opened to traffic prior to the full depth pavement repair, all loose material shall be removed and either a bituminous material approved by the Engineer or a concrete mixture in accordance with Sec 613.20.2 shall be used to patch the location. Reestablishing joints or cracks in temporary repairs by sawing will not be required. Material provided for temporary patches shall be provided at the Contractor’s expense.

613.20.3.2 Cleaning. The exposed faces of the concrete shall be free of loose particles, oil, dust, traces of bituminous material and any other contaminants before repair material is placed. The procedure shall produce a clean, roughened surface, such as can be produced by sandblasting or, shot blasting. Containment and disposal of material from sandblasting or shot blasting shall be in accordance with Sec 202.2. All remaining loose material shall be
removed with air blasting equipment just prior to placement of material. The air from the air blasting equipment shall be free of contaminants.

**613.20.3.3 Joint and Crack Preparation.**

**613.20.3.3.1 Transverse Joints and Cracks.** When placing a partial depth pavement repair directly against a transverse joint or crack, a compressible insert shall be placed against the joint or crack to form a bond breaker between the patch material and joint or crack. A pliable material shall be used to reform cracks along the existing paths. The new joint or crack shall be formed to the same width as the existing joint or crack. The compressible insert shall be placed into the existing joint to a minimum depth of one inch below the bottom of the repair and shall extend a minimum of one inch beyond each end of the prepared repair boundaries.

**613.20.3.3.2 Longitudinal and Centerline Joints.** When placing a partial depth pavement repair directly against the centerline or an adjacent lane joint, a compressible insert, a thin polyethylene strip no less than ⅛ inch thick or asphalt impregnated roofing felt shall be placed along the joint prior to placing the patching material.

**613.20.3.3.3 Shoulder Joints.** When placing a partial depth pavement repair along a lane and shoulder joint, the repair edge shall be formed if the shoulder is either soil, aggregate or bituminous material. The form shall be placed even with the surface and slightly below the repair depth. If the shoulder is concrete, then the repair interface at the joint shall be in accordance with Sec 613.20.3.3.2.

**613.20.3.3.4 Reestablishment of Joint and Cracks.** At locations where repairs include existing pavement joints, both longitudinal and transverse, the initial reestablishment of the joint in the plastic concrete shall be accomplished with an approved preformed joint filler and shall be made to the same width as the existing joint. Existing cracks shall be reestablished using a compressible insert of a width equal to the existing crack width, except the insert shall be no less than ¼ inch thick. The material insert shall be placed into the existing joint or crack to a minimum depth of one inch below the bottom of the repair, shall extend the full length of the joint or crack and shall extend to the top of the proposed pavement profile. The material shall prevent the concrete from flowing into the existing joint or crack. Sawing to reestablish the joint or crack will not be permitted.

**613.20.3.4 Material Placement.**

**613.20.3.4.1 Bonding Material.** Bonding material shall be applied in a thin even coat, shall cover the entire area, including the repair walls, shall overlap the pavement surface and shall be in accordance with the following.

**613.20.3.4.1.1** For Portland concrete, Type II or Type III epoxy resin material in accordance with Sec 1039 or grout shall be used. When epoxy material is used, the concrete shall be placed while the epoxy is still tacky. If the epoxy sets prior to placement of the concrete, the hardened epoxy material shall be removed and the pavement repair area shall be cleaned in accordance with Sec 613.20.3.2. When grout is used, mortar shall be in accordance with Sec 1066, except it shall consist of equal parts of cement and sand. If the grout dries prior to placing the concrete, the dried or hardened grout shall be removed and the pavement repair area shall be cleaned in accordance with Sec 613.20.3.2.

**613.20.3.4.1.2** For elastomeric concrete, the bonding material properties and application shall be in accordance with manufacturer recommendations.

**613.20.3.4.1.3** For epoxy mortar, a neat low viscosity epoxy in accordance with Sec 623.20 shall be used.

**613.20.3.4.2 Placement of Repair Material.** Epoxy mortar shall not be used to repair spalls caused by reinforcing steel corrosion. No standing water shall be present at the time of placement of the material. Retempering of the Portland cement concrete mixture with water will not be permitted. Concrete material shall be placed into the channel and consolidated with a small spud vibrator. Vibrators with diameters greater than one inch will not be
permitted. Care shall be taken not to touch the compressible insert with a vibrator. On very small repairs and as approved by the Engineer, hand tools may be used to work the repair material and attain adequate consolidation. Elastomeric concrete shall be handled, prepared and mixed in accordance with manufacturer recommendations. Epoxy mortar components shall be handled, prepared and mixed in accordance with Sec 623. Any segregated areas shall be removed and replaced at the Contractor’s expense.

613.20.3 Finishing and Texturing. Repair material shall be finished to match the cross section of the existing pavement. The repair material shall be screed from the center of the repair out to the repair boundaries. Excess patch material from finishing may be used to fill any saw cut run-outs that extend beyond the repair perimeter, if the material can fully penetrate the run-outs, otherwise, an approved low viscosity epoxy shall be used to fill the saw cut run-outs. After finishing, the repair shall be appropriately textured to approximate the texture of the existing pavement.

613.20.3.4.4 Sealing and Curing. For Portland cement concrete patch material the repair and slab interface shall be sealed by painting the repair perimeter with a 1:1 cement-water grout. Concrete repair material shall be cured in accordance with Sec 502.6.1, except a double application of curing material in accordance with Sec 613.20.2.5 shall be placed over the repaired area. Elastomeric concrete shall be cured in accordance with Sec 623. Epoxy mortar shall be cured in accordance with Sec 623.

613.20.3.5 Opening to Traffic. Traffic shall not be permitted on the repaired pavement until the patch material has attained a minimum compressive strength of 2,500 psi, but shall be a minimum of two hours after placement or the time recommended by the manufacturer.

613.20.3.6 Acceptance. All pavement repairs will be sounded by the Engineer prior to acceptance. Sounding will not be performed until the repair material has reached design compressive strength and the repair has been open to traffic for a minimum of 30 days. If sounding indicates unsound material, the entire pavement repair shall be removed to the limits designated by the Engineer and replaced by the Contractor at the Contractor’s expense.

613.20.4 Method of Measurement.

613.20.4.1 Measurement for repairing spalled areas, cracks or joints will be made to the nearest 1/10 square yard. Any material removed beyond the repair area designated by the Engineer due to the removal methods used by the Contractor will not be included in the measurement for pavement repair. Measurement of all concrete material furnished and placed in the repair of spalled areas, cracks or joints will be made to the nearest 1/10 cubic yard.

613.20.4.2 If an area designated for partial depth pavement repair requires full depth pavement repair in accordance with Sec 613.20.1.2, measurement for material removed as part of the partial depth pavement repair work at that location will be made to the nearest 1/10 square yard.

613.20.5 Basis of Payment. The accepted quantities for Class A partial depth pavement repair will be paid for at the contract unit price for each of the pay items included in the contract. Full depth pavement repairs required due to negligence by the Contractor will be at the Contractor’s expense. All other full depth pavement repairs will be paid for in accordance with Sec 613.10.

SECTION 613.30 CLASS B PARTIAL DEPTH PAVEMENT REPAIRS.

613.30.1 Description.

613.30.1.1 Class B partial depth pavement repair shall consist of removing areas of unsound concrete or bituminous material to a maximum depth of one half of the concrete pavement thickness and replacing the unsound material
with an approved bituminous mixture. This work shall be performed on projects that include resurfacing as part of the contract.

613.30.1.2 If dowel bars are structurally damaged during the removal process, if the concrete below one half of the slab depth is unsound or damaged during removal, or if the area indicates pumping, movement of the subbase or structural pavement failure, full depth pavement repair shall be performed in accordance with Sec 613.

613.30.2 Material. The material used for Class B partial depth pavement repairs shall be either the bituminous surface mix specified in the contract for resurfacing the existing pavement or a bituminous commercial mix in accordance with Sec 401.5.3. Tack material shall be in accordance with Sec 407.2.

613.30.3 Construction Requirements.

613.30.3.1 Removal of Bituminous and Concrete Material.

613.30.3.1.1 At areas shown on the plans or where unsuitable material is exposed during coldmilling operations and identified by the Engineer to be repaired, all loose and unsuitable bituminous material shall be removed by milling or other approved methods. Concrete material shall be removed in accordance with Sec 613.20.3.1. Around the perimeter of the repair, the sides shall be relatively vertical, and concrete surfaces shall have a roughened face, such as can be produced by milling or other means approved by the Engineer. The minimum depth of the repair shall be 2 inches. The area shall be cleaned to remove loose material and shall have a relatively uniform depth. If the top of dowel bars are exposed but not structurally damaged, the exposed section of the dowel bar shall be coated with an approved bond breaker.

613.30.3.1.2 If during the removal of material for partial depth pavement repair, the pavement constitutes full depth pavement repair in accordance with Sec 613.30.1.2, removal operations shall cease at that location. The Contractor may conduct full depth pavement repair at that time, or the Contractor may temporarily patch the exposed area in accordance with Sec 613.20.3.1.2, and perform full depth pavement repair at a later date.

613.30.3.2 Cleaning. The exposed faces of the concrete shall be free of loose particles, dust and any other contaminants before repair material is placed. The procedure shall produce a clean, roughened surface, such as can be produced by sandblasting, or shot blasting. Containment and disposal of material from sandblasting or shot blasting shall be in accordance with Sec 202.2. All remaining loose material shall be removed with air blasting equipment just prior to placement of material. The air from the air blasting equipment shall be free of contaminants.

613.30.3.3 Placement of Repair Material. The repair area shall be suitably tacked on the sides and bottom to ensure bonding of any remaining loose material, as well as bonding of the repair material. There shall be no ponding of the tack liquid at the time the area is filled. The repair area shall be filled with an approved bituminous surface mixture, and thoroughly compacted over the entire repair area to a density approved by the Engineer. Areas greater than 3 inches in depth shall be filled in two lifts, each thoroughly compacted. Reestablishing of joints by sawing will not be required.

613.30.4 Method of Measurement.

613.30.4.1 Measurement of Class B partial depth pavement repairs for removing material will be made to the nearest 1/10 square yard. Any material removed beyond the repair area designated by the Engineer due to the removal methods used by the Contractor will not be included in the measurement for pavement repair. Measurement for furnishing and placing the bituminous material will be made to the nearest 0.1 ton.

613.30.4.2 If an area designated for partial depth pavement repair requires full depth pavement repair in accordance with Sec 613.30.1.2, measurement for material removed as part of the partial depth pavement repair work at that location will be made to the nearest 1/10 square yard.
613.30.5 Basis of Payment. The accepted quantities for Class B partial depth pavement repair will be paid for at the contract unit price for each of the pay items included in the contract. Payment for tack liquid is incidental to the pay item for furnishing and placing bituminous material. Full depth pavement repairs required due to improper means and methods by the Contractor will be at the Contractor’s expense. All other full depth pavement repairs will be paid for in accordance with Sec 613.10.

SECTION 613.35 CLASS C PARTIAL DEPTH PAVEMENT REPAIR

613.35.1 Description. Class C partial depth pavement repair shall consist of performing repairs in asphalt pavements, including composite pavements that have an asphalt surface. This work includes removal of unsound pavement to the depth specified on the plans, or as directed by the Engineer, and replacement with an approved asphalt mixture.

613.35.2 Material. The material used for Class C partial depth repairs shall be the asphalt surface mix specified in the contract, or a mix approved by the Engineer.

613.35.3 Construction Requirements.

613.35.3.1 Removal of Bituminous Material. All unsuitable pavement shall be removed by milling or other method approved by the Engineer. For composite pavements, the repair may extend into the underlying concrete pavement if deterioration is found at that depth. The minimum depth of repair shall be 2 inches. The repair area shall be square or rectangular in shape. The exposed faces of the repair area shall be cleaned to remove loose material. Material removed from the repair area shall be disposed of off right of way unless otherwise approved by the Engineer.

613.35.3.2 Placement of Repair Material. The repair area shall be adequately tacked on the sides and bottom to ensure bonding of the repair material. The repair area shall be filled with the approved asphalt mixture and thoroughly compacted over the entire area to a density approved by the Engineer. Areas greater than 3 inches in depth shall be filled and thoroughly compacted in two lifts. For pavements that will receive a final overlay, the final compacted surface of the repair shall be level with, or not more than ¼ inches above, the surrounding pavement. If the repair will be the final driving surface, smoothness shall be in accordance with Sec 610.4.3 and Sec 610.4.4.

613.35.4 Method of Measurement.

613.35.4.1 Removal of Bituminous Material. Measurement of removal for Class C partial depth repairs will be made to the nearest 1/10 square yard. For composite pavements, this removal includes both asphalt and concrete material. Any material removed beyond the repair area designated by the Engineer due to the removal methods used by the Contractor will not be included in the measurement.

613.35.4.2 Furnishing and Placement of Repair Material. Measurement for furnishing and placing the asphalt repair material will be made to the nearest 0.1 ton.

613.35.5 Basis of Payment. The accepted quantities for Class C partial depth pavement repair will be paid for at the contract unit price of the pay items included in the contract. Payment for tack liquid is incidental to the pay item for furnishing and placing bituminous material.

SECTION 613.40 DOWEL BAR RETROFIT.

613.40.1 Description of Work. This work shall consist of sawing partial depth slots across cracks, cleaning the slots, placing dowel bars in the slots, placing a joint forming insert to reestablish the crack and backfilling the slots with concrete.
613.40.2 Material.

613.40.2.1 Repair Material. Rapid set concrete patching material shall be used. The maximum aggregate size in the gradation shall be ½ inch. Prior to use, the material shall be approved by the Engineer. Material having completed current testing through AASHTO’s NTPEP will be considered for qualification upon submittal of a written request by the manufacturer with accompanying documentation. The material shall be handled, prepared and mixed in accordance with the manufacturer’s recommendations. The Contractor shall supply a manufacturer’s certification to the Engineer for each lot of material furnished. Certification shall include the name of the manufacturer and a manufacturer’s certification statement that the material supplied is the same as the material that was qualified.

613.40.2.2 Dowel Bars. Dowel bars shall be 1½ x 18 inches and in accordance with Sec 1057, except the entire dowel bar shall be coated.

613.40.2.3 Expansion Caps for Dowel Bars. Caps shall be tight fitting and made of ¼ inch thick non-metallic material that will allow ¼ inch movement at each end of the dowel bar.

613.40.2.4 Joint Insert. To re-establish the crack, a compressible insert, in accordance with Sec 613.20.2.4, shall be used. The material shall fit tight around the dowel bar and to the bottom and edges of the slot. The material shall be capable of remaining in a vertical position and tight to all edges during placement of the repair material to prevent the concrete backfill from flowing into the existing crack and pavement voids.

613.40.2.5 Bar Chairs. Bar chairs may be metal epoxy-coated chairs or a non-metallic material.

613.40.3 Construction Requirements.

613.40.3.1 Preparation of Slots. Two saw cuts shall be made in the pavement to outline the longitudinal sides of each dowel bar slot. The slots shall be sawed to a depth and length that allows the center of the dowel to be placed at mid-depth in the pavement slab. The slots shall be 2½ inches wide. The Contractor shall provide a method, approved by the Engineer, that will align the slots parallel to centerline of the roadway with a maximum variation of ¼ inch from a true parallel line. Slots in a wheel path shall be created by using saws with gang mounted diamond blades, capable of simultaneously making six saw cuts for three dowel bar slots at the desired slot spacing. Equipment shall not cause damage to the existing pavement. All saw slurry shall be removed from the slot and pavement. No water residue or paste shall be allowed to flow onto lanes open to traffic or into closed drainage systems. If pneumatic hammers or other equipment used during concrete removal operations cause damage to pavement that is to remain, the concrete removal operations shall be discontinued and shall not resume until the Contractor has taken corrective measures. The pneumatic hammer will not be permitted to break through the concrete, and if this occurs, a full depth pavement repair shall be conducted at the Contractor’s expense. The bottom of slots shall be flat. The edges of the slots shall be cleaned by sandblasting to produce a rough surface. Blasting operations shall not damage the surrounding pavement. Containment and disposal of material from sandblasting shall be in accordance with Sec 202.2. The newly exposed concrete surface shall be free of spalls, burrs, latence and all contaminants detrimental to achieving an adequate bond. The maximum amount of spalling allowed on the edges of the slots will be ⅜ inch. The point of curvature at the bottom of either end of the slot shall be ¾ inch beyond the dowel bars end.

613.40.3.1.1 After the construction of a slot, the pavement shall not be opened to traffic until all six retrofit dowel bars are in place, cured, and the work is completed at that location. The tires of construction vehicles will not be permitted to travel on slots where concrete has been removed.

613.40.3.1.2 Multiple saw cuts parallel to the centerline within the slot removal boundaries may be sawed to allow removal of material from the dowel bar slots and to provide a level surface for the feet of the dowel bar chairs.
**613.40.3.1.3** All slots shall be cleaned with moisture-free, oil-free, compressed air to remove any remaining dust, residue, debris and moisture. The Contractor shall then seal the existing transverse joint and all cracks at the bottom and the sides of the dowel bar slot with a silicone sealant to prevent any repair material from entering into these areas.

**613.40.3.2 Placement of Dowel Bars, Joint Inserts and Repair Material.**

**613.40.3.2.1** Prior to inserting a dowel bar in a slot, expansion caps shall be placed on each end of the bar. A minimum ⅛ inch gap shall be maintained in the expansion caps. A dowel bar chair shall hold the bar firmly centered in the slot and at a minimum of ½ inch above the bottom of the dowel slot. The dowel bar chairs shall not allow movement of the dowel.

**613.40.3.2.2** When placing the dowel bar in the slot, care shall be taken to avoid getting any graphite grease onto the sides or bottom of the slot. If the debonding agent on the dowel bar contaminates any of the surfaces of the slot, the dowel bar shall be removed and the slot sandblasted to remove the contamination.

**613.40.3.2.3** The dowel bar shall be inserted into the slot such that the chair legs are in the saw cut kerfs at the bottom of the slot. The bars shall vary no more than ¼ inch from the pavement surface and shall be parallel to the centerline of the pavement. Bars shall be firmly centered in the slot at the midpoint of the pavement slab. The legs of the bar chairs shall be snug against the slot wall.

**613.40.3.2.4** A joint insert shall be placed into the slot as a filler material to maintain the crack as shown on the plans. When in place, the insert shall extend from the bottom of the slot to the surface of the pavement, with half the dowel length extending on each side of the insert. If for any reason the insert or dowel bars shift during placement of the repair material, the work will be rejected and shall be redone at the Contractor’s expense.

**613.40.3.2.5** Just prior to placement of the repair material, one or more passes of an air blast shall be used to provide a dust free, clean slot.

**613.40.3.2.6** The rapid set concrete patching material shall be placed in the slot, consolidated, textured and cured as recommended by the manufacturer.

**613.40.3.3 Opening to Traffic.** Traffic shall not be permitted on the repaired pavement until the rapid set concrete patching material has attained a minimum compressive strength of 1,600 psi, but shall be a minimum of 2 hours or the time recommended by the manufacturer.

**613.40.4 Basis of Payment.** The accepted quantity for dowel bar retrofit will be paid for at the contract unit price per dowel bar, complete in place.

**SECTION 613.50 CROSS STITCHING.**

**613.50.1 Description of Work.** The work shall consist of repairing longitudinal pavement cracks by pinning the pavement slabs together with a series of alternating tie bars.

**613.50.2 Material.**

**613.50.2.1 Tie Bars.** Tie bars shall be in accordance with Sec 1057 and as shown on the plans.

**613.50.2.2 Epoxy.** Epoxy or Polyester Bonding Agents for Dowels shall be in accordance with Sec 1039.

**613.50.3 Construction Requirements**
613.50.3.1 At each cross-stitch location, holes shall be drilled at a 35-degree angle to the pavement surface, starting a variable distance from the longitudinal joint, in a direction perpendicular to the crack. The drill bit diameter shall not exceed 1⅛ inch. Drilling shall alternate back and forth on either side of the longitudinal crack from hole to hole. Drilled holes shall not penetrate through the bottom of the slab. Drilled holes shall contain no loose debris and be completely clean.

613.50.3.2 Epoxy shall be injected or poured into each hole. A tie bar shall be inserted in each hole such that the epoxy material is evenly distributed around the bar and extruding from the surface opening. Each bar shall be inserted far enough to allow 1½ inch of cover as shown in the plans.

613.50.3.3 The pavement surface shall have all excess epoxy removed and have a flush finish.

613.50.3.4 Traffic shall not be permitted on the repaired pavement until the epoxy bonding material has cured in accordance with the manufacturer’s recommendations.

613.50.4 Method of Measurement. Measurement of cross stitching will be made per tie bar at each individual location.

613.50.5 Basis of Payment. The accepted quantity for cross stitching will be paid for at the contract unit price per cross stitch tie bar, complete in place. No direct payment will be made for any drilling, cleaning or epoxy material necessary to complete the work.
SECTION 614.10 GRATES AND BEARING PLATES

614.10.1 Description. This work shall consist of furnishing and installing grates and bearing plates of the size and design shown on the plans.

614.10.2 Materials. Grates and bearing plates shall be constructed of structural steel meeting the requirements of ASTM A 36 or AASHTO M 183, or carbon steel castings meeting the requirements of ASTM A 27, or gray iron castings meeting the requirements of ASTM A 48 as indicated on the plans.

614.10.3 Construction Requirements. Grates and bearing plates shall be fabricated as shown on the plans. Welds shall be of full section and sound throughout. Obvious dimensional defects and structural discontinuity of welds will be cause for rejection. All welding residue shall be removed by chipping, brushing, or other suitable means. If grates are to be galvanized, all tightly contacting surfaces shall be completely sealed by welding. Removal of welding beads will not be required except on bearing surfaces. Grates and bearing plates shall be hot-dip galvanized.

614.10.3.1 If galvanized grates and bearing plates are furnished, they shall be galvanized in accordance with the requirements of AASHTO M 111. Bolts, nuts, and washers shall be galvanized in accordance with the requirements of AASHTO M 232, or they may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence, and quality requirements shall conform to AASHTO M 232, Class C. Damaged spelter coating shall be repaired in accordance with Sec 606.3.2.

614.10.3.2 Gray Iron Castings for manhole or inlet frames and covers or gratings shall be fabricated of Class 30B cast iron. Bearing surfaces between manhole or inlet frames and covers or gratings shall be such that the cover or grating shall seat in any position onto the frame without rocking. Bearing surfaces for standard manhole frames and covers shall be machined.

614.10.3.3 Settings of Castings, Frames, and Fittings. All castings, frames, and fittings shall be placed in the positions shown in the project plans or as directed, and shall be set true to line and to correct elevation upon two complete rows of 1 inch thick flexible rubber mastic sealant. A full bed of mortar may be allowed if approved by the Engineer. If frames or fittings are to be bolted or anchored in concrete or brick masonry, all anchors or bolts shall be set and held in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has hardened to adequate strength.

614.10.3.4 When frames or fittings are to be placed upon previously constructed masonry, the bearing surface of masonry shall be brought true to line and grade to present an even bearing surface clean and free of debris particles. The unit shall be set on two complete rows of 1 inch thick flexible rubber mastic sealant. All units shall be firmly and securely seated.

614.10.3.5 Frames and cover, frames and graters, or other similar pairs of items shall have true common bearing surfaces such that covers or graters will seat firmly without rocking or shifting. The graters or covers shall be placed after the frames or fittings have been installed and after the concrete or mortar has been allowed to harden for at least twenty-four hours and will not be damaged.

614.10.4 Basis of Payment. No direct payment will be made for furnishing or installation and will be considered incidental to the structure.
SECTION 614.30 MANHOLE FRAME AND COVER

614.30.1 Description. This work shall consist of furnishing and installing manhole frames and covers, or any items of similar nature. They shall be of the size and type necessary to fit appurtenant details shown on the plans, shall be of a standard design, and shall meet the approval of the Engineer.

614.30.2 Materials. These items shall be constructed of Class 30 cast iron meeting the requirements of ASTM A 48 and AASHTO M 105. Gray Iron Castings for manholes and covers shall be fabricated of Class 30B cast iron. Specific classes and types, when required, will be shown on the plans.

614.30.3 Construction Requirements. Bearing surfaces between manhole frame and covers gratings shall be such that the cover shall seat in any position onto the frame without rocking. Bearing surfaces for standard manhole frames and covers shall be machined. The fixture shall be set securely as shown on the plans to prevent displacement during the placing of concrete. All concrete placed adjacent to the fixture shall be thoroughly vibrated.

614.30.4 Basis of Pavement. No direct payment will be made for furnishing or installation and will be considered incidental to the structure.
616.1 Description. This work shall consist of furnishing, installing, operating, maintaining, cleaning, relocating and removing temporary traffic control devices and equipment, and the removal and relocation or covering and uncovering of existing signs and other traffic control devices in accordance with the contract documents or as directed by the Engineer. For purposes of this specification, the work zone will be defined as the area between the first and last temporary traffic control device as shown on the plans for the work being performed.

616.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

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<tr>
<th>Item</th>
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<tr>
<td>Roadway Sign Material</td>
<td>1042</td>
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<tr>
<td>Temporary Traffic Control Devices</td>
<td>1063</td>
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616.3 Safety Requirements.

616.3.1 All traffic control devices shall be in accordance with the MUTCD current edition and any applicable safety and design codes.

616.3.2 The Contractor shall furnish a manufacturer’s certification of crashworthiness, per NCHRP 350 or AASHTO Manual for Assessing Safety Hardware (MASH) Evaluation Criteria, for FHWA Category 1 traffic control devices and appurtenances. The Contractor shall furnish the FHWA acceptance letter for FHWA Category 2 and Category 3 traffic control devices and appurtenances. The FHWA acceptance letter shall indicate that the device and appurtenance complies with the crash test requirements of NCHRP 350 or (MASH), Test Level 3 (TL-3). Regardless whether the device meets NCHRP 350 or (MASH) criteria, the Engineer reserves the right of final approval. Installation of a device prior to the Engineer’s approval will be at the Contractor’s risk.

616.4 Construction Requirements.

616.4.1 The Contractor shall furnish, install, maintain, clean, and relocate all signs, drums, cones, barricades, object markers, flashing arrow panels, channelizing devices, lights, and other traffic control devices shown on the plans, or as directed by the Engineer. Any unacceptable device shall be replaced or cleaned, by the Contractor as soon as possible, but not to exceed 24 hours after the Contractor has been notified by the Engineer. All signs and traffic control devices shall be kept legible, in alignment, and in good repair. All signs, except the project information signs, shall be covered, set aside, turned, removed, or relocated as work progresses or is completed and their necessity ceases to exist. All traffic control devices shall be removed after completion of construction and shall remain the property of the Contractor unless specified otherwise.

616.4.2 Minimum Requirements. The contract will indicate the minimum requirements for traffic control. The Contractor may, at its expense, add to the traffic control plan any standard signs or traffic control devices it considers necessary to adequately protect the public and the work.

616.4.2.1 Blasting Traffic Control. Signs and sign quantities for blasting areas are not included in the contract traffic control plan. It shall be the Contractor’s responsibility and expense to furnish, install, maintain, and remove blasting zone signing in accordance with the MUTCD. Placement of blasting area signing shall be subject to the Engineer’s approval.

616.4.2.2 Staged Construction Traffic Control. Some projects require establishment of stage construction, and the traffic control plans are developed accordingly. Work in any of the specified construction stages or other unrelated items of work may be accomplished concurrently with another specified stage provided that no interference with
the prescribed handling of traffic procedures will occur. The Contractor shall submit traffic control plan revisions to
the Engineer should they choose to deviate from the stages shown in the contract. All changes to the traffic control
plan are subject to the Engineer’s approval and shall be verified in writing prior to implementation. Sign and device
quantities shall be adjusted accordingly.

616.4.2.3 Roadway Closures. Regardless of whether or not road closures are explicitly permitted in the project
staging plan, traffic control plan, or special provisions, the Contractor will be required to request in writing
permission to completely close any portion of the roadway. This request must be received at least 7 days prior to
the anticipated closure date and must include a signage plan and details regarding the work to be completed and
the anticipated length of closure.

616.4.2.4 Additional Traffic Control. If the Engineer determines the need for additional signs or other traffic control
devices not included in the traffic control plan, the Contractor will be notified in writing to provide the additional
signs or devices. Reimbursement for authorized changes to the traffic control plan will be made in accordance with
contract unit prices or as agreed upon by the County Engineer.

616.4.2.5 Implementation of Traffic Control Plans. When the traffic control plan is initially implemented, and each
time a significant change occurs in the plan or a new stage of the traffic control plan is implemented, the Contractor
and the Engineer shall review the traffic flow through the project. Together, they shall drive through the traffic
control zone(s) of the project in both directions, at least once each direction during both daylight and nighttime
conditions within the next twenty-four hour period, to determine that traffic can safely and efficiently pass through
the area covered by the traffic control plan, that all signs and traffic control devices are in place, visible and
functioning properly, and that there are no hazards to traffic in or adjacent to the roadway which should be moved,
eliminated or corrected. If it is determined that a deficiency exists, the Contractor shall take corrective action as
directed by the Engineer. No additional payment shall be made for the Contractor’s compliance with this
specification if the corrective action is within the requirements of the traffic control plan. The Contractor will be
compensated for any corrective action which is in addition to the requirements of the traffic control plan. A
nighttime review of the traffic control devices is not required when only beginning and ending construction signs
are in place.

616.4.2.6 Contractor Traffic Control Inspections. The Contractor shall make a visual inspection of the traffic control
devices on sections of the project which are open to traffic and on sections which are adjacent to those sections
open to traffic. This shall occur after the traffic control devices are in place to the satisfaction of the Engineer and
the Contractor. This inspection shall ascertain that all traffic control devices and signs are in place and functioning
properly, and that there are no deficiencies or corrections needed in the work zone. A brief written summary of this
inspection shall be made and shall include but not necessarily be limited to the time of the inspection, the person
performing the inspection, the general weather, roadway conditions and visibility and any deficiencies detected
and changes or corrections made. If it is determined in this inspection that a deficiency exists in the traffic control
plan, the Contractor shall report it verbally to the Engineer. The Contractor shall submit a written summary of
inspections performed to the Engineer on a weekly basis.

616.4.2.6.1 All traffic control devices shall be inspected at least daily with the following exceptions:

(a) Non-portable construction signs and pavement markings on sections of the project with no project
imposed speed limit restrictions shall be inspected at least weekly.

(b) Portable construction signs, including cones, flashing arrows and channelizers used with the signs, shall
be inspected a minimum of two times each day. The interval between inspections shall not exceed six hours
during active work.

(c) Traffic control devices in the work zone shall be reinspected after finding any physical evidence or other
information suggesting an accident has occurred in the work zone.
616.4.2.7 Work Zone Accidents. The Contractor shall give written notice to the Engineer of any pedestrian or vehicular accident where physical evidence or other information suggests an accident has occurred in the work zone. The Contractor shall obtain and provide to the Engineer copies of law enforcement accident reports for any accidents in the work zone which may come to the Contractor’s attention.

616.4.3 Lane Closures. The length of time that the Contractor may maintain lane closures or one-way traffic operations shall be kept to a minimum and shall be subject to the Engineer’s approval. The Contractor shall furnish the Engineer a traffic control plan indicating the proposed method to achieve temporary stoppage of all traffic lanes if construction operations require such. The plan shall indicate any advance warning or regulatory signs, if used, and their locations; flagmen, if used, and their locations; and all other traffic control devices and their locations which may be used to temporarily stop all traffic. A one-time payment for traffic control devices used to temporarily stop all traffic will be made at the unit price for those like items contained in the contract. No direct payment will be made for removing or reusing these particular signs as an indeterminate number of occasions for their use may occur. Traffic control devices used by the Contractor which do not have a specific pay item in the contract shall be supplied, installed, maintained, and removed by Contractor at its expense.

616.4.4 Vehicles, Equipment, and Materials. The Contractor will not be allowed to park vehicles or equipment nor store materials within 12 feet of the edge of pavement carrying traffic, unless the equipment, vehicles, or materials are located in a properly protected area or an off-site storage area or as otherwise directed by the Engineer. If the contract specifies time periods that the Contractor will not be permitted to perform work, no vehicles or equipment utilized in the construction of the project shall enter or leave the construction area via the pavements handling traffic nor be operated on the pavements handling traffic within the construction area.

616.4.5 Traffic Control for Open Trenches. All open trench within ten feet of the travel way or low shoulder adjacent to the travel way, shall be marked by the use of reflectorized object markers or 42 inch tall tubular markers spaced at intervals of not more than 50 feet as determined by the MUTCD latest revision. Object markers or tubular markers shall be placed as soon as those conditions exist and shall remain in place until all trench has been filled to the level of the travel way and the adjacent shoulder has been leveled sufficiently to be used safely by traffic. During active operations object markers or tubular markers may be removed where work is in progress. They shall be reset as soon as operations have ceased or moved to new areas if hazards require their use remain.

616.4.6 Crossovers. Crossovers for hauling material will be permitted only at locations indicated in the traffic control plan or as authorized by the Engineer. Modifications to specified locations shall be in accordance with applicable portions of Sec 104. Crossovers shall be signed in accordance with the traffic control plan or the MUTCD when not specifically referenced. When the project has been completed, temporary crossovers shall be removed and the area restored to original condition. Existing crossovers shall be restored to original condition, including surface material. Flaggers per Sec 616.5.1 will be required when equipment is crossing a road that is open to vehicular traffic.

616.4.7 Contractor Responsibility. The requirements of this specification shall not relieve the Contractor of its responsibility for protecting both the public and the work. Should the Contractor fail to clean, repair, replace, or otherwise maintain the traffic control devices within 24 hours after the Contractor has been directed to do so by the Engineer, one or more of the following actions will be taken:

(a) The Engineer may employ another agency to correct deficiencies in signing or warning devices and deduct the cost from the Contractor’s pay estimate.

(b) Suspension of all pay invoices until deficiencies are corrected.

616.5 Traffic Control Devices. This work will consist of furnishing, placing, and maintaining flags, channelizers, signs, pavement markings and furnishing flagmen in accordance with the contract and as directed by the engineer. This specification also covers the design and responsibility for temporary signs required to be in place only during active
construction operations and are not to remain during non-work hours. These signs include warning and regulatory measures necessary to advise the traveling public and to protect the contractor’s assets during specific phases of the work. All traffic control devices must comply with the current MUTCD - Manual on Uniform Traffic Control Devices. No direct payment will be made for relocating, maintaining, or removing traffic control devices. Since these signs impose legal obligations or restrictions on traffic, prior approval for their use must be obtained from the engineer and they will be placed at locations approved by the engineer.

616.5.1 Flaggers. The Contractor shall furnish flaggers to be used when the roadway is partially or wholly blocked by workers or equipment. Flaggers must comply with OSHA regulations requiring workers to wear Class Two or Three ANSI/ISEA 107-2004 personal protective safety apparel, depending upon the available daylight at the time. All Contractor workers in or near the roadway must wear OSHA required safety apparel pertaining to their type of work. Flaggers shall be located far enough from the work zone so the vehicles have sufficient distance to slow down or stop before entering the work area. Under no circumstances will the Contractor's flaggers be allowed to direct traffic unless adequately protected by proper advanced warning signs. Flaggers shall be properly attired to perform their duties, shall be courteous, and shall use an approved "stop and slow" sign to control traffic.

616.5.1.1 On resurfacing projects requiring handling two-way vehicular traffic over a single lane, each flagger involved in controlling traffic through and along the work area shall be equipped with a portable transceiver radio and a stop-slow hand signaling device meeting the requirements of the MUTCD.

616.5.1.2 Hand Signaling Devices. Hand signaling devices, flagger attire, flagging procedures, and flagger stations shall be in accordance with the latest revision of the MUTCD.

616.5.1.2.1 Stop/Slow Paddles. The STOP/SLOW paddle shall have an octagonal shape on a rigid handle permanently attached 12 inch plastic handle and 60 inch detachable, plastic staff with safety-tip. Bottom of sign to top of staff is 6 feet. STOP/SLOW paddles shall be at least 18 inches wide with letters at least 6 inches high and should be fabricated from light semi rigid material. The background of the STOP face shall be red with white letters and border. The background of the SLOW face shall be orange with black letters and border. When used at night, the STOP/SLOW paddle shall be retro reflectorized. The STOP/SLOW paddle may be modified to improve conspicuity by incorporating white flashing lights. Two lights may be installed and centered vertically above and below the STOP legend, or centered horizontally on either side of the STOP legend. Instead of the above twilight arrangement, one light may be centered below the STOP legend.

616.5.1.2.2 Emergency Only. Flags may be used in an emergency situation and only at low-speed and/or low-volume locations which can best be controlled by a single flagger. Flags shall be a minimum of 24 inches square, made of a good grade of red material, and securely fastened to a staff that is approximately 36 inches in length. The free edge of a flag should be weighted so the flag will hang vertically, even in heavy winds. When used at nighttime, flags shall be retro reflectorized red.

616.5.1.3 Automated Flagger Assistance Devices, Portable Signal Flagging Device and Pilot Vehicle Operations. All flagging, automated flagger assistance devices, portable signal flagging device and pilot vehicle operations shall be in accordance with the MUTCD. Flaggers and pilot vehicles shall be provided as shown on the plans or as approved or directed by the Engineer. When not specified in the plans, the Contractor may use a Type B (Red/Yellow Lens) automated flagger assistance devices, portable signal flagging device or pilot vehicle to supplement the flagging operation upon approval from the Engineer. When two-way traffic is maintained over a single lane, each flagger, automated flagger assistance devices operator, if used in tandem, and pilot vehicle operator involved in the traffic flagging operation shall be equipped with a portable, two-way, communication system approved by the Engineer. When the automated flagger assistance devices or portable signal flagging device are not in use they shall be removed from the motorist roadside view.

616.5.1.4 Basis of Payment. No direct payment will be made for flagging, automated flagger assistance devices, portable signal flagging device and pilot vehicle operations, unless specified in the contract.
616.5.2 Channelizers. This work shall consist of furnishing, placing and maintaining reflectorized, flexible, non-metallic channelizers, clean and serviceable, used for traffic control as specified in the contract or as directed by the Engineer.

616.5.2.1 Materials. The channelizers shall meet the requirements of the Manual on Uniform Traffic Control Devices (MUTCD), current edition. Any unacceptable device shall be replaced by the contractor as soon as possible, but not to exceed 24 hours after the contractor has been notified by the engineer. Channelizers shall be kept clean of dirt and debris. They shall be and cleaned or replaced by the contractor when found to be noncompliant with all requirements and within 24 hours’ notice from the engineer.

616.5.2.2 Basis of Payment. The accepted quantities of channelizers will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for the maintenance or relocation of the channelizers.

616.5.3 Object Markers. Object markers and their usage are defined in the MUTCD.

616.5.3.1 Basis of Payment. The accepted quantities of object markers will be paid for at the unit price for each pay items included in the contract. No direct payment will be made for the maintenance or relocation of the object markers.

616.5.4 Project Information Signs.

616.5.4.1 Description. This work shall consist of the furnishing and installing of project information signs at the time physical construction work begins on the contract.

616.5.4.2 Construction Requirements.

616.5.4.2.1 Project information signs shall consist of two types. The first will be the “1/2 Cent” funding sign provided by the County. The Contractor will install the sign at a location designated by the County. The second type shall be the Contractor “ID” sign. These signs shall be a minimum of 24 inches by 48 inches with 4 inch white lettering on a blue background. Sign material shall be either aluminum or plywood, and shall be erected on a minimum of two posts. One sign shall be placed at each end of the project, unless otherwise specified by the County.

616.5.4.2.2 The sign legend for the Contractor “ID” signs should include as a minimum the following language: “This project brought to you by St. Charles County Highway Depart. & Insert Contractor Name”. Additional information, such as a company logo, can be added, but the size of the sign will need to be adjusted accordingly. A sign detail must be provided to the County for approval prior to fabrication.

616.5.4.3 Basis of Payment. Project information signs will be paid for at a lump sum price which shall include the installation and maintenance of the “1/2 Cent” signs and the fabrication, installation, and maintenance of the “ID” signs.

616.5.5 Temporary Excavation Fencing.

616.5.5.1 Description. This item will consist of enclosing an open cut excavation or vertical drop to provide protection to pedestrians on the project with a polyethylene fence fabric on a temporary basis. The location of such temporary excavation fencing will be shown on the plans or designated by the Engineer.

616.5.5.2 Construction Requirements.
616.5.5.2.1 Polyethylene fencing of a good commercially available quality, 5 feet in height, fluorescent orange in color, capable of withstanding exposure to the sun and elements will be required to completely enclose open cut trenches or excavations, or vertical drop-offs produced during construction. Temporary posts may be of any kind which will adequately support the attached fence fabric free of distortion, sagging, gaping and open areas at the bottom of the fence. Temporary posts must be driven in place and the subsequent hole backfilled upon removal. Additional fence post installation may be required by the Engineer when deemed necessary. Fencing shall be placed to completely enclose all designated and unsafe areas.

616.5.5.2.2 All open cut excavation areas within 10 feet of the back of curb or edge of pavement and over 3 feet in depth must be fenced in accordance with the provisions of this section. Areas where vertical cuts exist and are accessible to pedestrians with a depth greater than 3 feet must be fenced along the top of the cut. These requirements are in addition to other standard safety practices required by the contract and shall not in any manner be construed to relieve the Contractor of any liability incumbent on its part. A minimum compliance with the requirements of these sections and the Manual on Uniform Traffic Control Devices will always be required.

616.5.5.3 Method of Measurement and Basis of Payment. No direct payment will be made for this work or materials.

616.5.6 Advanced Warning Arrow Board Display.

616.5.6.1 Description. The advanced warning arrow board shall be of a moveable design, generally trailer mounted, and shall be capable of operation from a fixed power source or from a self-contained power source. The arrow board shall be located as shown on the plans or as approved by the engineer in compliance with the MUTCD.

616.5.6.2 The arrow board shall be at least a MUTCD Type C, 48 inches x 96 inches minimum size. Provision will be made to place the arrow board, while in operation, at a minimum height of 7 feet above the pavement to the bottom of the arrow board. The arrow board should produce a minimum legibility distance of one mile. The arrow board will have the minimum capability of the following mode selections:

(a) Left or right flashing or sequential arrows;
(b) Left or right sequential chevrons;
(c) Flashing double arrows;
(d) One or more flashing Caution modes.

616.5.6.3 Supplying power to the arrow boards will be the contractor’s responsibility, as will acquisition of any necessary permits and payment of power connection fees.

616.5.6.4 The contractor will be responsible for the maintenance of its equipment and must have a backup system available in case of failure of arrow boards. At no time will mechanical failure of the arrow board be an acceptable reason for discontinuing its use as a safety or traffic control device. If repairs or a backup system cannot be effected in a two hour period, work may be suspended or other measures may be required by the engineer. These other measures may include, but not be limited to, requirements for flaggers, guide cars, or arrow boards provided from companies offering such services.

616.5.6.5 Method of Measurement and Basis of Payment. No direct payment will be made for supplying and maintaining the arrow boards.
SECTION 617
CONCRETE TRAFFIC BARRIER

SECTION 617.10 PERMANENT TRAFFIC BARRIER.

617.10.1 Description. This work shall consist of constructing permanent concrete traffic barrier as shown on the plans or as directed by the Engineer. For purposes of this specification, permanent concrete traffic barrier will be defined as Type A, B, C, D or any modification of these types.

617.10.2 Material. All reinforcing steel shall be Grade 60 deformed bar, and all reinforcing steel and dowels shall be epoxy coated. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
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<tr>
<td>Dowel Bars</td>
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<tr>
<td>Preformed Fiber Expansion Joint Material</td>
<td>1057</td>
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<tr>
<td>Joint Sealer</td>
<td>1057</td>
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<tr>
<td>Joint Filler</td>
<td>1057</td>
</tr>
<tr>
<td>Prestressing Strands</td>
<td>AASHTO M 203</td>
</tr>
</tbody>
</table>

617.10.3 Construction Requirements.

617.10.3.1 Permanent concrete traffic barrier shall be constructed of Class B or B-1 concrete. Concrete shall be air-entrained with 28-day compressive strength of 4,000 psi. Material, proportioning, air-entraining, mixing, slump and transporting shall be in accordance with Sec 501. Concrete shall be placed and finished in accordance with Sec 703. Permanent concrete traffic barrier shall be cured in accordance with Sec 502.

617.10.3.2 Permanent concrete traffic barrier shall be constructed using an extrusion machine or forms specifically designed for constructing cast-in-place reinforced concrete traffic barrier. Precast units will not be permitted. Barriers that do not exhibit a consistent surface shall be corrected to the satisfaction of the Engineer.

617.10.3.3 For retrofit installation, dowels shall be installed in accordance with Sec 1039.30.

617.10.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. Where required, measurement for each type of permanent concrete traffic barrier, including barrier height transitions, will be made to the nearest 1/2 linear foot for each continuous length and totaled to the nearest linear foot for the sum of the lengths.

617.10.5 Basis of Payment. Accepted permanent concrete traffic barrier will be paid for at the contract unit price for each of the types specified in the contract. No direct payment will be made for reinforcing steel, dowels, joint filler material, and sawed joints.

SECTION 617.20 TEMPORARY TRAFFIC BARRIER.

617.20.1 Description. This work shall consist of furnishing, installing, relocating and removing temporary traffic barrier as shown on the plans or as directed by the Engineer. For purposes of this specification, temporary concrete traffic barrier will be defined as Type F concrete traffic barrier or approved alternate barrier system that meets MASH or NCHRP 350 criteria and has FHWA acceptance.

617.20.2 Material. All material shall be in accordance with Division 1000 Materials Details and Sec 1064.2.2.1.
617.20.2.1 All Type F temporary barrier shall be in a serviceable condition during installation and relocation as determined by the Engineer.

617.20.2.2 Two-loop or three-loop temporary Type F concrete traffic barrier may be used at the option of the Contractor.

617.20.2.2.1 For two-loop style temporary traffic barrier, as well as two-loop and three-loop styles used in combination, the bottom washer, retainer bolt and nut will be required. Visual cracks in the loop steel will be cause for rejection of the barrier unit by the Engineer.

617.20.2.2.2 Existing two-loop concrete barrier owned by Contractors or previously accepted two-loop concrete barrier in a manufacturer’s stockpile (inventory) will be allowed for use on St. Charles County projects if:

(a) The barrier was fabricated prior to January 1, 2004.

(b) Either the MoDOT acceptance stamp is legible on the barrier or certification is provided by the Contractor stating that the barrier was fabricated prior to January 1, 2004, and in accordance with St. Charles County specifications.

(c) The barrier is in acceptable condition.

617.20.2.3 Other types of temporary traffic barrier will be allowed if the barrier has been approved in accordance with Sec 1064 and meets the project specific need as approved by the Engineer.

617.20.3 Certification. The Contractor shall provide to the Engineer a barrier manufacturer's certification that the barrier furnished is in accordance with the contract documents prior to use.

617.20.4 Construction Requirements.

617.20.4.1 As directed by the Engineer, damaged units shall be immediately replaced and removed from the right of way at the Contractor’s expense.

617.20.4.2 All barrier sections shall remain the property of the Contractor unless specified otherwise in the contract.

617.20.4.3 Equipment or material shall not be stored near temporary barriers within the limits shown on the plans or as approved by the Engineer.

617.20.4.4 Anchoring of Type F temporary concrete traffic barrier shall be as shown on the plans. Other types of temporary traffic barrier shall be anchored in accordance with the manufacturer’s recommendations.

617.20.5 Method of Measurement. Measurement of temporary traffic barrier and relocated temporary traffic barrier will be made to the nearest 1/2 linear foot for each continuous length and totaled to the nearest linear foot for the sum of the lengths. Measurement of temporary traffic barrier height transitions shall be measured as part of the total length of temporary concrete traffic barrier.

617.20.6 Basis of Payment. Accepted temporary concrete traffic barrier and temporary concrete traffic barrier height transitions will be paid for at the contract unit price for the pay items included in the contract. Relocated temporary concrete traffic barrier and relocated temporary concrete traffic barrier height transitions will be paid for at the contract unit price for the pay items included in the contract. If no pay item is included in the contract for the relocation of temporary concrete traffic barrier and temporary concrete traffic barrier height transitions, the relocation of these devices will be considered incidental to unit price of the initial installation.
SECTION 617.30 TRAFFIC BARRIER DELINEATORS.

617.30.1 Description. This work shall include furnishing, installing and maintaining retroreflectorized traffic barrier delineators as shown on the plans or as designated by the Engineer.

617.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
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</thead>
<tbody>
<tr>
<td>Delineators</td>
<td>1065</td>
</tr>
</tbody>
</table>

617.30.3 Construction Requirements.

617.30.3.1 Delineators shall be placed on all traffic barrier spaced at 50 foot intervals.

617.30.3.2 Delineator reflector colors shall correspond with pavement marking. Delineators shall be sheeted on one side, facing oncoming traffic, unless otherwise specified. Where permanent concrete traffic barrier divides opposing lanes of travel, the delineators shall have retroreflective sheeting on both sides corresponding to adjacent pavement marking.

617.30.3.2.1 Delineators mounted on permanent concrete traffic barrier shall be anchored with galvanized mechanical fasteners that prevent movement in accordance with the manufacturer’s recommendations.

617.30.3.2.2 Delineators mounted on temporary concrete traffic barriers shall be mounted to the traffic barrier in accordance with the manufacturer’s recommendations.

617.30.3.3 Any damaged or missing delineators shall be replaced by the Contractor at the Contractor’s expense.

617.30.4 Basis of Payment. No direct payment will be made for traffic barrier delineators provided on new permanent concrete traffic barrier or temporary traffic barrier. Delineators specified for installation on existing permanent concrete traffic barrier will be measured and paid for per each.
SECTION 618
MOBILIZATION

618.1 Description. This item shall consist of the preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the project site, for the establishment of all offices, buildings and other facilities necessary for work on the project, except as provided in the contract as separate pay items, payment for the actual cost of the contract bond and railroad liability insurance and for all other work and operations that must be performed or costs incurred prior to beginning work on the various items on the project site.

618.2 Basis of Payment. Payment for mobilization will be made incrementally as stated herein.

618.2.1 Reimbursement for Contract Bond and Railroad Liability Insurance. The Contractor can receive reimbursement for expenditures incurred for contract bond and railroad liability insurance prior to the first incremental mobilization payment by submitting invoices to the Engineer showing the amount expended for these services. The reimbursement payment will be made on the first estimate following the Contractor’s request. The amount of the reimbursement, not to exceed the contract price for mobilization, will be deducted from the contract price for mobilization and the remaining amount will be used to establish the partial payments defined in Sec 618.2.2.

618.2.2 Partial Payments. Each partial payment will be 25 percent of the contract price for mobilization, after any deductions made in accordance with Sec 618.2.1, or 2.5 percent of the original contract price, whichever is less. For purposes of this calculation, the original contract price will be construed as the total dollar value of all contract line items. The partial payments for mobilization will be paid incrementally as follows:

(a) The first partial payment will be made when five percent of the original contract amount is earned.

(b) The second partial payment will be made when ten percent of the original contract amount is earned.

(c) The third partial payment will be made when 25 percent of the original contract amount is earned.

(d) The fourth partial payment will be made when 50 percent of the original contract amount is earned.

(e) When the Engineer has accepted the contract for maintenance in accordance with Sec 105, any remaining amount will be paid.
SECTION 619
PAVEMENT EDGE TREATMENT

619.1 Description. This work shall consist of the elimination of pavement edge differential.

619.2 Material.

619.2.2 Wedge slope shall be constructed of an approved fill material, a commercially available aggregate base material, a commercially available bituminous mix or an approved preformed unit. Acceptance of wedge slope material will be based on visual examination.

619.3 Construction Requirements. At the Contractor's option, elimination of pavement edge differential may be accomplished by either conducting operations in such a manner that traffic is exposed to no more than a 2 inch differential, by constructing a wedge shaped slope adjacent to the pavement edge or by furnishing and installing temporary concrete traffic barrier.

619.3.1 Wedge slope shall be constructed as shown on the plans or as directed by the Engineer. Slope material, other than preformed units, shall be compacted by a roller, mechanical tamper or other methods approved by the Engineer, until there is no visible evidence of further consolidation.

619.3.2 Wedge slope material shall be removed and the pavement edge returned to a vertical face prior to placement of adjacent shoulder or pavement material. Material used to construct wedge slope shall be disposed of as approved by the Engineer.

619.3.3 Temporary concrete traffic barrier shall be constructed as shown on the plans or as directed by the Engineer.

619.3.4 If grading, base rock, or paving operations occurring adjacent to a lane carrying traffic are shut down or suspended for greater than a 48 hour period (excluding weekends), the Contractor shall be required to place pavement edge treatment as described above, unless said area is behind a protective barrier.

619.3.5 In addition to the requirements above, and regardless of whether pavement edge treatment is required, any excavation or subgrade work that results in a drop off condition adjacent to the lane carrying traffic, unless behind protective barrier, will require the placement of signage noting “Shoulder Drop Off”, or similar message, and shall be spaced every 500 feet where applicable. Signage shall be placed no closer than 2 feet and no more than 6 feet from the travel way.

619.4 Method Measurement.

619.4.1 Measurement will be made to the nearest linear foot along each edge of pavement for all locations actually treated. No location will be measured more than once, regardless of the number of applications.

619.4.2 Final measurement will not be made except for authorized changes during construction or when appreciable errors are found in the contract quantities.

619.5 Basis of Payment. The accepted quantity of edge treatment will be paid for at the contract unit bid price for the units constructed or the units shown in the contract, whichever is greater. Payment shall include all material and labor necessary to eliminate the need for or to construct, maintain, replace, relocate, remove and dispose of edge treatment. No direct payment will be made for more than one application at any location. Payment for the required signs will be in accordance with Sec 616.
SECTION 620
PAVEMENT MARKING

620.1 Description. This work shall consist of furnishing, installing, maintaining and removing temporary and permanent pavement marking as shown on the plans, as specified herein or as directed by the Engineer.

620.2 General.

620.2.1 All roadways open to traffic shall have either temporary or permanent pavement markings. Temporary pavement marking may be used in lieu of permanent marking for no more than 14 days after completion of final paving operations or, in the case of pavement markings placed in rumble strips, for no more than 14 days after completion of rumble strips, except as otherwise allowed in Sec 620.21.3.1.

620.2.2 All pavement marking shall be in accordance with the latest edition of the MUTCD and the FHWA Standard Highway Signs at the time of the bid opening.

620.2.3 All pavement marking shall be uniform in appearance with crisp, well-defined edges and shall be uniform in width and thickness. Surface distribution of the beads shall be uniform.

620.2.4 Longitudinal pavement marking shall not be placed on longitudinal joints.

620.2.5 The Contractor will be responsible for the protection of all liquid pavement marking until the pavement marking has reached a no-track state as determined by the Engineer.

620.2.6 Damage to pavement marking as a result of the Contractor’s operations, including resurfacing of shoulders, shall be repaired or replaced at the Contractor’s expense.

620.2.7 All pavement marking shall be installed in accordance with this specification and all manufacturer’s recommendations. Manufacturer’s written application or installation instructions shall be provided by the Contractor to the Engineer.

620.2.8 When surface preparation is required, the area prepared shall be 1 inch wider than the final pavement marking. The method of surface preparation shall not cause structural damage to the pavement and shall meet the approval of the Engineer.

620.2.9 Layout. The Contractor shall be responsible for laying out pre-marks onto the roadway in the areas to receive permanent pavement markings, as indicated on the pavement marking plans and/or directed by the Engineer. Centerlines on all two-lane roadways shall be pre-marked and permanently marked as close to the center of the roadway as possible, regardless of street width deviations. Off center deviations greater than 6 inches for greater than 100 feet in length may be rejected, requiring their removal and replacement at no cost to the County.

SECTION 620.10 PAVEMENT MARKING REMOVAL

620.10.1 Description. This work shall consist of all necessary operations for removal of existing and temporary pavement markings when no longer required.

620.10.2 Construction Requirements. Removal of all pavement marking within the project limits shall be as shown on the plans or as directed by the Engineer. Pavement marking shall be completely removed to the satisfaction of the Engineer with minimal damage to the pavement. No more than five percent of the existing marking shall remain. The pavement surface shall not be left scarred with an image that might mislead traffic. Any excess damage or scarring of the pavement shall be repaired at the Contractor’s expense. High pressure water blasting shall be used for pavement marking removal unless other methods are approved by the Engineer.
620.10.3 Method of Measurement.

620.10.3.1 Final measurement will not be made, except for authorized changes, during construction or where significant errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

620.10.3.2 Where required, measurement for the removal of pavement markings will be made to the nearest linear foot. Where intermittent lines are specified or existing, deductions will be made for gaps in the removal. Measurement will not be made for removal of pavement marking within the limits of a bypass roadway, or other roadway to be obliterated at the completion of the project. Measurement will not be made for removal of temporary paint striping.

620.10.4 Basis of Payment. No direct payment will be made for the removal of temporary paint striping or for the removal of any striping necessary to ensure that lane markings are clear to the traveling public, unless specified in the contract. This cost shall be included in the cost of the temporary paint striping.

SECTION 620.20 TEMPORARY PAVEMENT MARKINGS

620.20.1 General.

620.20.1.1 Temporary Pavement Marking Following Obliteration of Existing Markings. The Contractor shall place and maintain preformed short-term marking tape or temporary raised pavement markers on pavement undergoing milling, grinding or resurfacing operations. The Contractor shall ensure all pavement marking, temporary or permanent, has been placed prior to leaving the work zone unattended. Pavement marking shall be replaced in the same configuration as the previously existing pavement marking unless otherwise shown on the plans or directed by the Engineer.

620.20.1.2 On two-lane, two-way roadways with "no passing zone" marking, all yellow centerline marking shall be replaced with temporary raised pavement markers with yellow on both sides. White lane line marking on climbing or turn lanes shall be replaced with white/red raised pavement markers with white facing traffic. Temporary raised pavement markers shall be in accordance with Sec 620.23.

620.20.1.3 On resurfacing projects, when the adjacent layer of resurfacing has not been placed and the existing centerline or lane marking has been obliterated, the temporary marking shall be placed on the higher layer at the centerline of the roadway or lane. Any temporary pavement marking damaged, displaced or missing before the final pavement marking is installed shall be replaced at the Contractor's expense within two hours upon notification from the Engineer.

620.20.1.4 If temporary pavement marking is to be in place for more than the time limit specified in Sec 620.2.1, the Engineer may require that temporary paint be placed and maintained at the Contractor's expense. See Sec 620.21 for paint specifications.

620.20.1.5 For temporary marking durations of less than two weeks and when removal of the temporary marking is not required, preformed removable pavement marking tape may be used as specified in Sec 620.24.

620.20.1.6 Temporary Pavement Marking for Traffic Pattern Changes. The Contractor shall place pavement marking paint, preformed removable pavement marking tape or preformed short-term pavement marking tape for bypasses, lane shifts, narrow lanes and other traffic pattern changes as shown on the plans and all other conditions not described in Sec 620.20.1.3. The Contractor shall install and maintain temporary pavement marking until the permanent marking material has been placed as specified in the contract.
620.20.1.6.1 For temporary marking durations of less than two weeks, and when removal of the temporary marking is not required, preformed short term pavement marking tape may be used as specified in Sec 620.25.

620.20.1.6.2 For temporary marking requiring removal of the marking, preformed removable pavement marking tape shall be used as specified in Sec 620.24, unless otherwise shown on the plans. Other pavement marking may be used in lieu of preformed removable pavement marking tape with approval from the Engineer.

620.21 TEMPORARY PAVEMENT MARKING PAINT.

620.21.1 Description. This work shall consist of furnishing and placing temporary pavement marking paint at locations shown on the plans or as directed by the Engineer. The type of paint used for temporary pavement marking shall be standard waterborne, except that high build waterborne may be used in lieu of standard waterborne at no additional cost to the County. The weather limitations for standard and high build waterborne shall be as specified in Sec 620.44.3.3. When ambient air and surface temperatures are below 60°F, cold weather paint may be used in accordance with Sec 620.22 at no additional cost to the County.

620.21.2 Material. Temporary pavement marking material paint and glass beads shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Acrylic Waterborne Pavement Marking Paint</td>
<td>1048.44.2</td>
</tr>
<tr>
<td>Type P Drop-On Glass Beads</td>
<td>1048.30.2</td>
</tr>
</tbody>
</table>

620.21.3 Construction Requirements.

620.21.3.1 Temporary paint may be used as temporary pavement markings for the duration of the project. Retroreflectivity shall be maintained as specified in Sec 620.40.4.1, at the Contractor’s expense, for as long as the temporary pavement marking paint is in place.

620.21.3.2 The minimum thickness of the painted markings shall be no less than 15 mils. Lane lines, edge lines and no-passing lines shall be 4 inches in width. Type P beads shall be applied at a minimum rate of 15 lbs./100 sq.ft. of the painted surface area.

620.21.3.3 When temporary pavement marking paint is used on the final driving surface, and thermoplastic or epoxy pavement markings are to be used for the permanent marking, all temporary paint shall be removed prior to applying the thermoplastic or epoxy pavement marking. Removal will be at the Contractor’s expense unless otherwise specified in the contract. Removal shall be in accordance with Sec 620.10.2.

620.21.3.4 When temporary pavement marking paint is used on the final driving surface and waterborne or acrylic paint is to be used for the permanent marking, all temporary paint shall be installed in the same location and in the same sequence as the final pavement marking such that no temporary pavement marking will be visible after the final pavement marking is installed. Any temporary pavement marking that remains visible after final pavement marking shall be removed at the Contractor’s expense.

620.21.3.5 No-Passing Zones. When paint is used for temporary marking on two-lane, two-way roadways, all no-passing zone lines shall be marked prior to leaving the work zone unattended.

620.21.4 Equipment. All equipment for application of pavement marking paint shall be as specified in Sec 620.40.2.

620.21.5 Method of Measurement. Final measurement of temporary pavement marking paint will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity.
No measurement will be made for any temporary pavement markings, regardless of type, when used as temporary pavement marking due to obliteration of existing markings as defined in Sec 620.20.1.1.

620.21.5.1 Measurement of temporary pavement marking paint, when required, will be measured per linear foot.

620.21.6 Basis of Payment.

620.21.6.1 The accepted quantity of temporary pavement marking paint will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be made for initial installation only and not for repair or replacement.

620.21.6.2 No payment will be made for any temporary pavement markings, regardless of type, when used as temporary pavement marking due to obliteration of existing markings as defined in Sec 620.20.1.1.

620.22 COLD WEATHER PAVEMENT MARKINGS.

620.22.1 Description. Cold weather pavement marking paint is described as cold weather waterborne paint or cold weather acrylic copolymer fast drying paint that is manufactured for use within the weather limitations specified herein.

620.22.2 Applications. Cold weather pavement marking paint may only be used for temporary pavement marking or as a substitute for standard waterborne paint when approved by the Engineer, at no additional cost to the County. Cold weather pavement marking paint shall not be used as a permanent pavement marking in lieu of high build waterborne, epoxy, and thermoplastic paints.

620.22.3 Weather Limitations. Cold weather paint shall not be used except when the ambient air temperature and pavement surface temperature is greater than 35°F but less than 60°F. The pavement surface temperature and ambient air temperature shall be ascending from 35°F before striping operations begin. Cold weather pavement marking shall not be applied if the weather forecast for the eight hour period immediately following final application includes precipitation or temperatures below 35°F.

620.22.4 Material. Cold weather pavement marking paint and glass beads shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type P Drop-On Glass Beads</td>
<td>1048.30.2</td>
</tr>
<tr>
<td>Acrylic Copolymer Fast Dry Pavement Marking Paint</td>
<td>1048.22.1</td>
</tr>
<tr>
<td>Cold Weather Waterborne Pavement Marking Paint</td>
<td>1048.22.2</td>
</tr>
</tbody>
</table>

620.22.5 Construction Requirements. Cold weather pavement marking paint shall be applied to a wet thickness of no less than 15 mils. The mil thickness shall be increased as needed to account for the porosity of the pavement to achieve a target bead embedment of 60%. The wet film thickness of the applied paint may be tested with a paint thickness gauge as directed by the Engineer. Type P beads shall be applied at a minimum rate of 15 lbs./100 sq.ft. of the painted surface area.

620.22.5.1 Paint may be heated before application to a maximum temperature of 120°F for waterborne paint and 125°F for acrylic copolymer paint.

620.22.6 Method of Measurement. Final measurement of cold weather pavement marking paint will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity.
No measurement will be made for any temporary pavement markings, regardless of type, when used as temporary pavement marking due to obliteration of existing markings as defined in Sec 620.20.1.1.

620.22.6.1 Measurement of cold weather pavement marking paint, when required, will be measured per linear foot.

620.22.7 Basis of Payment.

620.22.7.1. The accepted quantity of cold weather pavement marking paint will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be made for initial installation only and not for repair or replacement.

620.22.7.2 No payment will be made for any temporary pavement markings, regardless of type, when used as temporary pavement marking due to obliteration of existing markings as defined in Sec 620.20.1.1.

SECTION 620.23 TEMPORARY RAISED PAVEMENT MARKERS

620.23.1 Description. This work shall consist of installing, maintaining and removing reflectorized temporary raised pavement markers (RPM’s) on roadway lane lines, centerlines or edge lines as shown on the plans or as directed by the Engineer.

620.23.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary Raised Pavement Markers</td>
<td>1048.23</td>
</tr>
</tbody>
</table>

620.23.3 Construction Requirements.

620.23.3.1 Temporary RPM’s shall be of the colors shown on the plans unless otherwise directed by the Engineer. Reflective faces shall be oriented to face traffic. Temporary RPM’s shall be installed according to the manufacturer’s recommendations and placed at approximately 40 foot intervals.

620.23.3.1.1 Type 1 Temporary RPM’s shall be used for surface treatment projects when temporary RPM’s are specified.

620.23.3.1.2 Type 2 Temporary RPM’s shall be used on all projects other than surface treatment projects when temporary RPM’s are specified.

620.23.3.2 On resurfacing projects, temporary RPM’s shall be removed on intermediate lifts of asphalt before additional lifts are laid above them. Temporary RPM’s on final wearing surfaces shall be removed if specified on the plans or as directed by the Engineer.

620.23.4 Method of Measurement. Final measurement will not be made, except for authorized changes, during construction or where significant errors are found in the contract quantity. Where required, measurement of temporary raised pavement markers will be made per each. The revision or correction will be computed and added to or deducted from the contract quantity.

620.23.5 Basis of Payment. The accepted quantity of temporary RPM’s will be paid for at the contract unit price for each of the pay items included in the contract, except when temporary RPM’s are used in accordance with Sec...
then no direct payment will be made. No direct payment will be made for the removal of temporary RPM’s.

SECTION 620.24 PREFORMED REMOVABLE PAVEMENT MARKING TAPE

620.24.1 Description. This work shall consist of furnishing and placing preformed removable marking tape at locations shown on the plans or as directed by the Engineer.

620.24.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preformed Removable Pavement Marking Tape</td>
<td>1048.24</td>
</tr>
</tbody>
</table>

620.24.3 Construction Requirements. All preformed removable pavement marking tape within the project limits shall be maintained by the Contractor at the Contractor’s expense in a manner approved by the Engineer. All preformed removable marking tape shall be installed according to the manufacturer’s recommendations.

620.24.4 Method of Measurement.

620.24.4.1 Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

620.24.4.2 Where required, measurement of 4 inch, 6 inch, 8 inch and 24 inch pavement marking will be made to the nearest linear foot. Where intermittent lines are specified, deductions will be made for the gaps in pavement marking.

620.24.5 Basis of Payment.

620.24.5.1 The accepted quantity of preformed removable pavement marking tape will be paid for at the contract unit price for each of the pay items included in the contract, except when used for temporary pavement marking, payment will be made in accordance with Sec 620.24.5.2.

620.24.5.2 The accepted quantity of temporary pavement marking will be paid for at the contract unit price for each of the pay items included in the contract. Payment will be made for the initial installation only. Repair or replacement of the temporary pavement markings will be at the Contractor’s expense. No direct payment will be made for the removal of the preformed removable marking tape.

SECTION 620.25 PREFORMED SHORT-TERM PAVEMENT MARKING TAPE

620.25.1 Description. This work shall consist of furnishing and placing preformed short-term pavement marking tape at locations shown on the plans or as directed by the Engineer. With approval from the Engineer, pavement marking paint may be used in lieu of preformed short-term pavement marking tape at the Contractor’s expense.

620.25.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preformed Short Term Pavement Marking Tape</td>
<td>1048.25</td>
</tr>
</tbody>
</table>
**620.25.3 Construction Requirements.** Preformed short term marking tape shall be installed according to the manufacturer’s recommendations.

**620.25.4 Method of Measurement.** Measurement of preformed short-term pavement marking tape will be made in accordance with Sec 620.24.4.

**620.25.5 Basis of Payment.** The accepted quantity of preformed short-term pavement marking tape will be paid for at the contract unit price for each of the pay items included in the contract, except as follows. When preformed short term marking tape is used in accordance with Sec 620.20.1.1, then no direct payment will be made. When preformed short term marking tape is used in accordance with Sec 620.20.1.6, payment will be made in accordance with Sec 620.24.5. No direct payment will be made for the removal of the preformed short-term pavement marking tape.

**SECTION 620.30 DROP-ON GLASS BEADS**

**620.30.1 Drop-On Glass Bead Application.** Drop-on glass beads shall be mechanically applied to the pavement marking directly behind the material application guns. The glass beads shall be applied in a manner that prevents the glass bead from rolling and covering the surface of the glass bead with pavement marking material. The application shall result in approximately 60% embedment of the glass beads into the pavement marking. Glass beads shall be applied evenly and shall completely cover the painted area. If beads are not embedding properly all operations shall cease until corrective actions are made.

**620.30.2 Material.** All material shall be in accordance with Division 1000, Material Details, and as specified in Sec 1048.30.

**620.30.3 Type P Glass Beads.** Type P glass beads shall be applied at a minimum application rate of 15 lbs. per 100 sq.ft. of surface area of pavement marking material.

**620.30.4 Type L Glass Beads.** Type L glass beads shall be applied at a minimum application rate of 15 lbs. per 100 sq.ft. of surface area of pavement marking material in order to achieve desired wet reflectivity characteristics.

**620.30.5 Basis of Payment.** No payment will be made for drop-on glass beads. The cost of providing and placing glass beads is included in the cost of pavement marking paint and durable pavement marking.

**SECTION 620.40 PERMANENT PAVEMENT MARKING.**

**620.40.1 General.**

**620.40.1.1** On roadways open to traffic, any pavement marking obliterated by milling, grinding or resurfacing operations shall be replaced with temporary pavement marking in accordance with Sec 620.20.1.1 no later than the end of the same day unless, on the final surface, the permanent pavement marking material specified in the contract is placed by the end of the day. Pavement marking shall be replaced in the same configuration as the previously existing pavement marking unless otherwise shown on the plans or directed by the Engineer.

**620.40.1.2** When installing permanent pavement marking, the Contractor shall begin intermittent pavement marking, starting with the gap, immediately after the last existing intermittent pavement marking to maintain the specified cycle length along the entire length of the intermittent pavement marking line.

**620.40.1.3** When installing permanent pavement marking, the Contractor shall match the pavement marking sequence on the roadway just in advance of the project limits in order to provide a seamless and continuous marking from old to new pavement for future striping operations.
620.40.1.4 If the permanent pavement marking cannot be placed according to these specifications and the road is to be opened to traffic with no permanent pavement marking in place, the Contractor shall, at the direction of the Engineer, place and maintain temporary pavement marking at the Contractor’s expense. The Contractor shall remove temporary pavement marking and place the permanent pavement marking according to these specifications and as directed by the Engineer.

620.40.1.5 Surface Preparation. The surface on which permanent pavement marking is to be placed shall be clean, dry and free of all debris, laitance, curing compound and any other contaminants that may hinder the adhesion of the system to the surface. Permanent pavement marking shall not be applied in damp conditions or if there is any evidence of surface moisture on the pavement.

602.40.1.6 The pavement in the area to have permanent pavement marking applied shall be cleaned by high speed blown air just prior to the placement of the marking material. The cost of air blowing surface preparation shall be included in the cost of the pavement marking.

620.40.2 Construction Requirements.

620.40.2.1 All equipment shall be designed for pavement marking and shall be maintained in such a condition to properly and evenly apply marking paint and drop-on glass beads per these specifications.

620.40.2.2 Paint shall be applied with self-propelled equipment using spray guns designed and adjusted to apply paint at the required thickness and width. Finished markings shall have well-defined edges, uniform cross section thickness and uniform bead distribution across the surface of the line. If there is any evidence of gun clogging, splattering or uneven paint distribution, painting operations shall cease until equipment is restored to proper operation.

620.40.3 Inspection.

620.40.3.1 Permanent pavement marking will be inspected following installation. The Engineer may measure the initial retroreflectivity with a mobile retroreflectometer. Measurements will be taken between seven and forty-five days after application.

620.40.3.2 If the performance inspection discloses any permanent pavement marking that does not meet the acceptance requirements, the Contractor shall repair or replace such work to the satisfaction of the Engineer within 30 days of notification, at the Contractor's expense.

620.40.3.3 Upon completion of the initial performance inspection and after satisfactory completion of any necessary corrections, the Engineer will notify the Contractor, in writing, of the date of acceptance and release the Contractor from further performance responsibility.

620.40.4 Acceptance.

620.40.4.1 Retroreflectivity inspection may be performed by the Engineer using a 30-meter geometry retroreflectometer at 0.1-mile intervals. Retroreflectivity acceptance requirements will be as follows:

<table>
<thead>
<tr>
<th>Retroreflectivity Acceptance Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Material</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Extruded Thermoplastic</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Hot Spray Thermoplastic</td>
</tr>
</tbody>
</table>
620.40.4.2 Visual inspection requirements shall be as follows:

(a) Lateral deviation shall not exceed one inch in 100 feet.

(b) Width of markings shall not deviate more than shown in the following table:

<table>
<thead>
<tr>
<th>Marking Width</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inch</td>
<td>+ 1/4 inch</td>
</tr>
<tr>
<td>6 and 8 inches</td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td>10 inches and above</td>
<td>± 1/2 inch</td>
</tr>
</tbody>
</table>

(c) Length of markings shall not deviate more than 3 inches in 10 feet.

SECTION 620.41 EXTRUDED THERMOPLASTIC PAVEMENT MARKING

620.41.1 Description. This work shall consist of furnishing and placing extruded thermoplastic pavement marking material and drop-on glass beads at locations shown on the plans or as directed by the Engineer. Extruded thermoplastic pavement marking shall be used only on bituminous surfaces.

620.41.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extruded Thermoplastic Marking Material</td>
<td>1048.41</td>
</tr>
<tr>
<td>Drop-On Glass Beads</td>
<td>1048.30.2</td>
</tr>
</tbody>
</table>

620.41.3 Construction Requirements.

620.41.3.1 Equipment. All equipment for application of thermoplastic marking material shall be of such design and maintained in such condition as to properly heat, mix and apply the material.

620.41.3.1.1 Melting Kettle. The melting kettle shall be capable of heating the thermoplastic material to the material’s recommended application temperature without scorching, and shall be capable of maintaining the application temperature. The melting kettle shall have a heat transfer medium and the flame shall not come in direct contact with the material container surface. A temperature gauge shall be visible on the outside of the kettle to indicate the temperature of the thermoplastic material. The melting kettle shall have a continuous mixer or agitator capable of thoroughly mixing the material at such a rate as to maintain homogeneity of material and uniformity of temperature throughout.

620.41.3.1.2 Extruded Thermoplastic Dispensing Devices. Extrusion dispensing devices shall be capable of applying molten thermoplastic material at the widths and thicknesses specified and at the temperature recommended by
the thermoplastic material manufacturer. The extrusion device shall have a visible temperature gauge to allow monitoring of the temperature of the thermoplastic material near the point of application.

620.41.3.1.3 Glass Bead Dispenser. All thermoplastic dispensers shall be equipped with a drop-on type glass bead dispenser. The glass bead dispenser shall be located to drop the glass beads immediately after the molten thermoplastic material is applied to ensure proper bead embedment. The glass bead dispenser shall be adjustable to regulate flow of the beads and shall uniformly dispense the glass beads over the entire width of the line.

620.41.3.2 Surface Preparation. The pavement surface and subsurface on which the thermoplastic material is to be placed shall be clean and dry. If bonding is decreased due to excess moisture, marking operations shall cease until the pavement dries. Applied markings shall have no more than five percent by area of holes, voids or blisters. Pavement surfaces shall be inspected for cleanliness and any dirt, debris or other contaminants on the surface to be marked shall be removed. Existing pavement marking, including temporary pavement marking, that would prevent a bond between the thermoplastic and the pavement shall be removed by methods approved by the Engineer.

620.41.3.3 Weather Limitations. The pavement surface shall have a minimum temperature of 60°F. The air temperature shall be at least 55°F and rising during marking operations. The wind chill temperature shall be at least 45°F and rising during marking operations. The pavement surface temperature, air temperature and wind chill temperature shall be determined before the start of each day of marking operation and at any other time deemed necessary by the Engineer. Pavement surface and air temperatures shall be obtained by the Engineer.

620.41.3.4 Primer Application. Primer will not be required on new bituminous surfaces unless recommended by the thermoplastic material manufacturer. A new bituminous surface will be defined as a surface that is less than 2 months old. If primer is recommended, the primer shall be applied and cured in accordance with the recommendations of the manufacturer of the thermoplastic material.

620.41.3.5 Thermoplastic Application.

620.41.3.5.1 Thermoplastic marking material for use on any bituminous surfaces shall be alkyd thermoplastic.

620.41.3.5.2 The temperature of the thermoplastic at the time of application shall be 400°F to 425°F. The temperature of the thermoplastic material shall be checked at the point of application with a calibrated thermometer at the beginning of each day's marking, after material is added to the dispensing device, after delays in the marking operation and when requested by the Engineer. Discoloration of material will be cause for rejection.

620.41.3.5.3 Thermoplastic material shall not be heated above 450°F. Only the quantity of thermoplastic that can be used within 4 hours shall be heated. In no case shall any thermoplastic material be heated for more than 4 hours at the maximum application temperature, including initial heating. No material shall be reheated more than twice.

620.41.3.6 Drop-on Glass Bead Application. Drop-on glass beads shall be mechanically applied to the molten thermoplastic directly behind the extruder. Glass beads shall be applied at a rate required to meet the provisions of Sec 620.40.4.1. For stop lines, arrows, words and symbols, glass beads may be applied by hand. Glass beads shall be applied evenly and completely cover the marked area. If beads do not embed properly in the thermoplastic, all marking operations shall cease until corrections are made.

620.41.3.7 Acceptance. Finished marking shall have well-defined edges and lateral deviation shall not exceed one inch in 100 feet. The thickness of long line thermoplastic markings shall be 100 ± 10 mils. The thickness of thermoplastic pavement marking arrows, words, symbols and other intersection markings, excluding lines, shall be a minimum of 125 mils and a maximum of 188 mils. To determine acceptance, the thickness of the marking will be measured above the pavement surface at random points selected by the Engineer. If the thickness at a given
If the location is less than 90 mils, additional measurements will be taken on each side of the location by the Engineer to determine the extent of the unacceptable portion of the marking. Corrections shall be at the Contractor's expense.

### 620.41.3.8 Quality of Work
The applied thermoplastic marking shall be inspected for overall quality. Markings shall have crisp edges. Glass beads shall be uniform on the entire marking surface. If the thermoplastic marking does not provide initial retroreflectivity, adhesion or have the required color, the Contractor shall repair the marking to the satisfaction of the Engineer.

### 620.41.3.9 Method of Measurement

#### 620.41.3.9.1 Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

#### 620.41.3.9.2 Where required, measurement of 4 inch, 6 inch, 8 inch and 24 inch extruded thermoplastic pavement marking will be made to the nearest linear foot. Where intermittent lines are specified, deductions will be made for the gaps in pavement marking.

#### 620.41.3.9.3 Where required, measurement of arrows, words and symbols will be made per each.

### 620.41.3.10 Basis of Payment
The accepted quantity of extruded thermoplastic pavement marking will be paid for at the contract unit price for each of the pay items included in the contract.

#### SECTION 620.42 HOT SPRAY THERMOPLASTIC PAVEMENT MARKING

### 620.42.1 Description
This work shall consist of furnishing and placing thermoplastic pavement marking material applied by the hot spray process at a 45-mil (1.14 mm) thickness as specified on the plans or as directed by the Engineer. Hot spray thermoplastic pavement marking shall be used only on bituminous surfaces.

### 620.42.2 Material
All material shall be in accordance with [Division 1000](#), Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop-On Glass Beads</td>
<td>1048.30.2</td>
</tr>
<tr>
<td>Hot Spray Thermoplastic Pavement Marking Material</td>
<td>1048.42</td>
</tr>
</tbody>
</table>

### 620.42.3 Construction Requirements
Construction requirements shall be in accordance with Sec 620.41.3, except as follows.

#### 620.42.3.1 Hot Spray Thermoplastic Dispensing Devices
The equipment shall be capable of applying molten thermoplastic material at the temperature recommended by the manufacturer of the thermoplastic material in lines from 4 inches to 12 inches wide at the specified thickness. Dispensing devices shall be of the spray-type.

#### 620.42.3.2 Thermoplastic Application

##### 620.42.3.2.1 The temperature of the thermoplastic material at the point of application shall be a minimum of 350°F and a maximum of 425°F. The temperature of the thermoplastic material shall be checked at the point of application with a calibrated thermometer at the beginning of each day's marking, after material is added to the dispensing device, after delays in the marking operation and any time deemed necessary by the Engineer.

##### 620.42.3.2.2 Discoloration of material will be cause for rejection.
620.42.3.2.3 Thermoplastic material shall not be heated above 450°F. Only the quantity of thermoplastic that can be used within four hours shall be heated. In no case shall any thermoplastic material be heated for more than four hours at the maximum application temperature, including initial heating. No material shall be reheated more than twice. Material subjected to these conditions will be rejected.

620.42.3.2.4 The thickness of the thermoplastic marking shall be within 5 mils of the specified thickness. The thickness of the marking will be measured above the pavement surface at random points selected by the Engineer to determine acceptance. If the thickness at a given location is less than the thickness specified in the contract, additional measurements will be taken on each side of the location by the Engineer to determine the extent of the unacceptable portion of the marking. If the measurements show the average thickness to be more than 5 mils below the contract mil thickness, the Contractor shall grind the surface of the unacceptable portions of the markings to reduce the average thickness to approximately 20 mils less than the contract mil thickness. The Contractor shall then apply additional thermoplastic material and beads to bring the thickness of the markings to a minimum of the contract mil thickness and the retroreflectivity to the minimum required values. Corrections shall be at the Contractor’s expense.

620.42.3.2.5 Drop-on Glass Bead Application. Drop-on glass beads shall be mechanically applied to the molten thermoplastic directly behind the spray guns at a rate required to meet the provisions of Sec 620.40.4.1. Glass beads shall be applied evenly and shall completely cover the marked area. If beads do not embed properly in the thermoplastic, all marking operations shall cease until corrections are made.

620.42.4 Method of Measurement. Measurement of hot spray thermoplastic pavement marking will be made in accordance with Sec 620.41.3.9.

620.42.5 Basis of Payment. The accepted quantity of hot spray thermoplastic pavement marking will be paid for at the contract unit price for each of the pay items included in the contract.

SECTION 620.43 EPOXY PAVEMENT MARKING MATERIAL.

620.43.1 Description. This work shall consist of furnishing and placing epoxy pavement marking material and drop-on glass beads at locations shown on the plans or as directed by the Engineer.

620.43.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Pavement Marking Material</td>
<td>1048.43</td>
</tr>
<tr>
<td>Drop-On Glass Beads</td>
<td>1048.30.2</td>
</tr>
</tbody>
</table>

620.43.2.1 Type A Epoxy Marking. Type A epoxy pavement marking shall be a slow-cure material suitable for all applications of pavement marking. When epoxy pavement marking is specified, Type A shall be used on all new pavements not open to traffic and on pavements open to traffic where adequate traffic control can be provided during the curing period as specified in Sec 620.2.5.

620.43.2.2 Type B Epoxy Marking. Type B epoxy pavement marking material shall be a fast-cure material suitable for line applications of pavement marking. Type B epoxy shall be used on bituminous pavement open to traffic where adequate traffic control cannot be provided. Type B epoxy pavement marking material shall not be used on concrete pavement.

620.43.3 Construction Requirements.
620.43.3.1 Equipment. The application equipment shall have a system capable of spraying epoxy pavement marking material in the proportions recommended by the manufacturer. The application equipment shall include the following features.

620.43.3.1.1 Individual material reservoirs or space for storage of Part A and Part B of the epoxy material, equipped with the necessary stirring or blending equipment to ensure delivery of uniformly mixed components to the static mixer unit.

620.43.3.1.2 Heating equipment of sufficient capacity to maintain the individual components at the manufacturer’s recommended temperature and the capability to producing the required amount of heat at the mixing head and gun tip to maintain those temperatures within the tolerances recommended by the manufacturer for spray application.

620.43.3.1.3 Drop-on glass beads shall be mechanically applied to the wet paint directly behind the paint spray. Type L beads shall meet the provisions of Sec 620.40.4.1 and meet or exceed the application rate of 12 lbs per gallon of pavement marking material to achieve wet reflectivity characteristics. For stop lines, arrows, words and symbols, glass beads may be applied by hand. Type L glass beads shall be applied evenly and shall completely cover the painted area. If beads do not embed properly in the paint, all marking operations shall cease until corrections are made.

620.43.3.1.4 Each proportioning unit shall have individual metering devices or pressure gauges and stroke counters to monitor gallon usage. All such devices shall be visible to the Engineer.

620.43.3.1.5 The equipment shall be capable of thoroughly mixing the components to the manufacturer’s recommendations prior to application.

620.43.3.2 Transfer of Material. The Contractor shall provide all necessary equipment to adequately mix each shipping container. At any time that partial shipping containers are transferred to the reservoirs on the striping equipment, complete mixing of that container shall be performed prior to beginning transfer operations.

620.43.3.3 Surface Preparation. The pavement surface on which the pavement marking is to be placed shall be free of all debris, laitance, pavement curing compound, and any other contaminants that may hinder the adhesion of the system to the surface. Whenever grinding, scarifying, sandblasting, shot blasting or other operations are performed, the debris generated shall be contained through vacuum type equipment or equivalent. The pavement surface shall not be left scarred with an image that might mislead traffic. Any excess damage or scarring of the pavement shall be repaired by the Contractor, at the Contractor’s expense.

620.43.3.3.1 Removal and cleaning work shall be conducted in such a manner as to control and minimize airborne dust and similar debris that may become a hazard to motor vehicle operation or a nuisance to property owners.

620.43.3.3.2 Care shall be taken on bituminous and Portland cement concrete surfaces when performing removal and cleaning work to prevent damage to transverse and longitudinal joints.

620.43.3.3.3 After all cleaning operations are completed, the pavement surface shall be power broomed and then blown with compressed air to remove residue and debris resulting from the cleaning work. All such debris shall be properly contained and disposed of as approved by the Engineer.

620.43.3.3.4 Cleaning and surface preparation work shall be confined to the area specified for the application of the pavement marking material, to the surface area of existing pavement markings that are specified for removal on the plans, or to the area specified by the Engineer.

620.43.3.3.5 Surface preparation work shall include cleaning for lines, letters and symbols.
620.43.3.6 The area of preparation shall be the width of the new pavement marking or existing line, plus one inch on each side of the line. For letters and symbols, the area of preparation shall be sufficiently large to accommodate the new marking or to remove existing markings.

620.43.3.7 On new Portland cement concrete pavement, cleaning operations shall not begin until the concrete has attained the minimum design compressive strength, as determined by the County. The extent of the curing compound removal work shall be to clean and prepare the concrete surface such that there is no visible evidence of curing compound and the extent of the removal shall ensure that any laitance is removed from both old and new concrete.

620.43.3.8 On new asphaltic concrete pavement, cleaning operations shall not begin until after the new mat has reached ambient temperature. The extent of cleaning on new asphaltic concrete shall be such that 75 percent of the stone substrate is exposed.

620.43.3.9 All existing pavement marking, except epoxy pavement marking, shall be removed to the extent that 95 to 100 percent of the existing marking is removed. Existing epoxy pavement markings that are in good condition and that will not interfere with or otherwise conflict with newly applied markings, as determined by the Engineer, may remain. Removal operations shall be conducted in such a manner that no more than moderate color or surface texture change results on the surrounding pavement surface. The Engineer will make the determination of acceptable removal.

620.43.4 Application. The pavement marking material shall be applied to the road surface at 25 mils on concrete or asphalt pavement through the use of equipment designed to precisely meter the two components in the ratio recommended by the material manufacturer.

620.43.4.1 The pavement marking shall only be applied during dry weather and on dry pavement surfaces. At the time of installation, the pavement surface temperature and ambient temperature shall be above 45°F.

620.43.4.2 Both components shall be brought to the temperature recommended by the manufacturer, prior to mixing and application and shall remain at that temperature throughout the operation.

620.43.5 Method of Measurement. Measurement of epoxy pavement marking will be made in accordance with Sec 620.41.3.9.

620.43.6 Basis of Payment. The accepted quantity of epoxy pavement marking will be paid for at the contract unit price for each of the pay items included in the contract.

SECTION 620.44 ACRYLIC AND WATERBORNE PAVEMENT MARKING

620.44.1 Description. This work shall consist of furnishing and placing pavement marking paint and drop-on glass beads at locations shown on the plans or as directed by the Engineer. When paint is specified, the Contractor may use either waterborne or acrylic copolymer pavement marking paint at the contract unit price in accordance with this specification and with approval from the Engineer.

620.44.2 Material. Traffic paint shall be used as specified on the plans or as approved by the Engineer. Material for application of traffic marking paint shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop-On Glass Beads</td>
<td>1048.30.2</td>
</tr>
</tbody>
</table>
620.44.3 Construction Requirements.

620.44.3.1 Equipment. All equipment for application of pavement marking paint shall be of such design and maintained in such a condition to properly and evenly apply marking paint and drop-on glass beads.

620.44.3.2 Surface Preparation. The surface on which paint is to be placed shall be clean and dry. Paint shall not be applied in damp conditions or if there is any evidence of surface moisture on the pavement. The surface on which paint is to be placed shall be prepared in accordance with Sec 620.43.3.3.

620.44.3.3 Weather Limitations. The pavement surface temperature and air temperature shall be determined before the start of each day of marking operation and at any other time deemed necessary by the Engineer. Temperatures shall be obtained by the Engineer.

620.44.3.3.1 For waterborne applications, the pavement surface temperature and ambient air temperatures shall be above 50°F. Waterborne paint shall not be applied if the forecast conditions for the eight hours immediately following final application include precipitation or temperatures below 50°F.

620.44.3.3.2 For acrylic copolymer applications, the pavement surface temperature and ambient air temperature shall be above 35°F.

620.44.3.4 Paint Application.

620.44.3.4.1 Paint shall be machine applied using spray guns designed and adjusted to apply paint at the required thickness and width. If there is any evidence of gun clogging, splattering or uneven paint distribution, painting operations shall cease until equipment is restored to proper operation.

620.44.3.4.2 Painting of stop lines, arrows, words and symbols may be applied by hand using paint spray equipment. Equipment shall be capable of applying paint evenly to the required thickness. Dimensions shown on the plans shall be used for arrows, words and symbols.

620.44.3.4.3 High build paint shall be applied to a minimum wet thickness of 30 mils. The wet film thickness of the applied paint shall be tested with a paint thickness gauge as directed by the Engineer. Type L beads shall be used with all high build paint applications.

620.44.3.4.4 Waterborne paint and acrylic copolymer paint shall be applied to a minimum wet thickness of 15 mils. The wet film thickness of the applied paint shall be tested with a paint thickness gauge as directed by the Engineer. Type P beads shall be used with all waterborne paint and acrylic copolymer paint applications.

620.44.3.4.5 Paint may be heated to a maximum temperature of 150°F for waterborne and 125°F for acrylic copolymer before application.

620.44.3.4.6 Finished markings shall have well-defined edges, and lateral deviation shall not exceed one inch in 100 feet.

620.44.3.5 Drop-On Glass Bead Application. Drop-on glass beads shall be mechanically applied to the wet paint directly behind the paint spray guns. Type L beads shall meet the provisions of Sec 620.40.4.1 and meet or exceed the application rate of 12 lbs per gallon of pavement marking material to achieve wet reflectivity characteristics.
Type P glass beads shall be applied at a rate required to meet the provisions of Sec 620.40.4.1. For stop lines, arrows, words and symbols, glass beads may be applied by hand. Glass beads shall be applied evenly and shall completely cover the painted area. If beads do not embed properly in the paint, all marking operations shall cease until corrections are made.

620.44.3.6 Quality of Work. The applied marking paint shall be inspected continually for overall quality. The glass beads shall appear uniform on the entire marking surface. The cured paint shall properly adhere to the pavement surface. If the marking paint does not provide initial nighttime retroreflectivity or if the marking does not have the required minimum thickness or required color, the Contractor shall re-apply the marking paint to the required thickness, at the Contractor’s expense, and shall meet all requirements as described above.

620.44.4 Method of Measurement. Measurement of 4 inch, 6 inch, 8 inch and 24 inch pavement marking paint will be made in accordance with Sec 620.41.3.9.

620.44.5 Basis of Payment. The accepted quantity of pavement marking paint will be paid for at the contract unit price for each of the pay items included in the contract, except when used for temporary pavement marking, payment will be made in accordance with Sec 620.24.5.2.

620.45 DURABLE INTERSECTION PAVEMENT MARKINGS.

620.45.1 Description. This work shall consist of furnishing and placing yield bars, arrows, words and symbols in accordance with the manufacturer’s recommendations at locations shown on the plans or as directed by the Engineer. Glass beads, when required, shall be in accordance with Sec 620.30.

620.45.2 Material. All material shall be in accordance with Division 1000, Material Details, and as specified in Sec 1048.45.

620.45.3 Construction Requirements.

620.45.3.1 Durable Intersection Pavement Markings shall be installed according to the manufacturer’s recommendations. Material used shall be from the MoDOT Qualified Products list available at MoDOT.org. A copy of the manufacturer’s installation instructions shall be provided to the Engineer prior to the intersection pavement marking pre-activity meeting.

620.45.3.2 Intersection markings shall be installed in a groove when recommended by the material manufacturer and at no additional cost to the County. Surface mounting is allowable when that option is listed in the manufacturer’s recommendations and the product is approved for surface mounting on MoDOT’s Qualified Products list.

620.45.3.3 Arrows, words and symbols shall be white and may be formed from one piece or multiple pieces of preformed pavement marking material or a durable liquid marking method specifically designed for intersection marking.

620.45.4 Acceptance. Acceptance for durable intersection pavement markings shall be in accordance with Sec 620.40.4, except that a night time visual inspection will be made in lieu of measurement of retroreflectivity. If, in the opinion of the Engineer, the retroreflectivity appears to be unacceptable, measurement of retroreflectivity will be made per MoDOT Test Method TM 80 for each intersection marking.

620.45.5 Method of Measurement.
620.45.5.1 Final measurement of Durable Intersection Pavement Markings will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

620.45.5.2 Where required, measurement of durable intersection markings will be made per each.

620.45.6 Basis of Payment.

620.45.6.1 The accepted quantity of intersection markings will be paid for at the contract unit price for each of the pay items included in the contract.
SECTION 621
FLOWABLE BACKFILL

621.1 Description. This work shall consist of furnishing flowable backfill as specified on the plans or otherwise permitted for compacted backfill and other cavity filling uses.

621.2 Material.

621.2.1 All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash</td>
<td>1018</td>
</tr>
<tr>
<td>Cement</td>
<td>1019</td>
</tr>
<tr>
<td>Admixtures</td>
<td>1054</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

621.2.2 Fine aggregate shall be in accordance with Sec 1005.3, except for the percent passing the No. 200 sieve. Aggregate shall be fine enough to stay in suspension in the mortar to the extent required for proper flow, and shall be in accordance with the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

621.3 Composition of Mixture. The Contractor shall submit to the Engineer a mix design with the proportions and source of material, admixtures, dry cubic yard batch weights and actual 28-day compressive test results. The 28-day compressive strength of the mixture shall exceed 50 psi.

621.3.1 Consistency. Flowable backfill will be tested by filling an open-ended 3 inch diameter, 6 inch high cylinder to the top with the mixture and immediately pulling the cylinder straight up. The correct consistency of the mixture shall produce an approximate 8 inch diameter circular-type spread with no segregation. Adjustments to the proportions of fine aggregate or water may be made to achieve proper solid suspension and optimum flowability with approval from the Engineer, except the theoretical yield shall be maintained at one cubic yard for the given batch weights.

621.3.2 Commercial Mixtures. Approved commercial brand mixtures intended specifically for use as flowable backfill may be used, provided the specified strengths are obtained.

621.3.2.1 If approved for use, the material shall be placed in accordance with the manufacturer's recommendations, and a copy of the manufacturer's recommendations shall be furnished to the Engineer.

621.3.2.2 The manufacturer shall submit a request for approval along with appropriate documents to the Engineer for testing and evaluation. Upon approval of the material, the brand name will be placed on a list of qualified commercial brand flowable backfill material.

621.4 Construction Requirements.

621.4.1 The open ends of the area to be backfilled shall be plugged, and the void area filled without the use of a vibrator.
621.4.2 Care shall be taken to prevent the movement of any structure from the designated location or intrusion of flowable backfill into undesirable locations. If such movement or intrusion occurs, the Engineer may require the affected structure to be excavated and replaced to the proper grade at the Contractor’s expense.

621.4.3 If flowable backfill is placed in more than one layer, the base layer shall be thoroughly roughened and all loose and foreign material removed before placing the next layer.

621.4.4 No flowable backfill shall be covered or accepted until a minimum compressive strength of 30 psi has been attained, as demonstrated by failure to deform or crush underfoot when a pressure of approximately 30 psi is applied. If the backfill does not harden to support the required load, the backfill shall be removed and replaced with an acceptable material at the Contractor’s expense.

621.5 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added or deducted from the contract quantity. If flowable backfill is specified, where required, measurement will be made by the computed volume to the nearest 1/10 cubic yard of the voids to be filled, as determined from the dimensional area of the open area and totaled to the nearest cubic yard. If flowable backfill is used as an alternate to compacted backfill specified in the contract or as shown on the plans, measurement will be made as required for the item specified.

621.6 Basis of Payment. If flowable backfill is specified, the accepted quantity will be paid for at the contract unit price. No additional payment will be made if flowable backfill is used as an alternate to compacted backfill.
SECTION 622
PAVEMENT SURFACE TEXTURING AND REMOVAL

622.1 Description. This work shall consist of removing or texturing the surface of existing pavement and bridge decks as shown on the plans. The term “pavement” as used in Sec 622 will be considered reference to the paved portion of the highway within the limits of construction, including bridge decks.

622.2 Construction Requirements.

622.2.1 The pavement surface shall be removed or textured to the depth, width, grade and cross slope shown on the plans or as directed by the Engineer.

622.2.2 Unless specified otherwise in the contract, the Contractor shall accept full ownership of all material generated by removal or texturing operations and shall indemnify the County of responsibility for and pay all costs relating to generation, handling, storage, treatment, transportation, disposal, or any future use of the material.

622.2.3 Depth transitions at the beginning and end of a project, side roads, bridge ends or other locations shown on the plans shall be milled by using equipment and a process approved by the Engineer. The equipment will not be required to have an automatic grade leveling and slope control device or a means of removing and discharging millings from the pavement, unless specified otherwise. Any necessary pavement marking in the transition areas shall be as directed by the Engineer and at the Contractor’s expense.

622.2.3.1 A temporary asphalt wedge transition shall be installed, maintained, and removed at the Contractor’s expense for each vertical lip created from a cold milled depth transition when the Contractor opens the cold milled depth transition to traffic prior to resurfacing. The temporary asphalt wedge shall be, in the opinion of the Engineer, of sufficient length and texture to provide a smooth transition from the existing pavement or bridge surface to the cold milled surface. Temporary asphalt wedges shall be removed prior to the resurfacing.

SECTION 622.10 COLD MILLING EXISTING PAVEMENT FOR REMOVAL OF SURFACE

622.10.1 Description. This work shall consist of coldmilling the existing pavement surface to the depth, profile and cross slope shown on the plans and removing and disposing of the milled material.

622.10.2 Equipment.

622.10.2.1 The equipment for milling and removing the pavement surface shall be capable of removing a thickness of bituminous or concrete material to the specified depth and providing a uniform profile and cross slope.

622.10.2.2 The equipment shall be capable of accurately and automatically establishing profile grades within 1/8 inch of each edge of the machine. The milling equipment shall be regulated by an automatically controlled grade leveling and slope control device. The device shall provide control for producing a uniform surface to the established grade and a cross slope in accordance with the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope as directed by the Engineer.

622.10.2.3 The equipment shall have provisions for controlling dust and other particulate matter created by the cutting action. The equipment shall also have an effective means of removing cuttings from the pavement and discharging them into a hauling unit, all in one operation, as the pavement is milled.

622.10.3 Construction Requirements.
622.10.3.1 Except for cold milling of depth transitions sections and butt joints, all pavement that is cold milled for the purpose of resurfacing shall receive the first lift of resurfacing during the same day or night work shift as the cold milling operation.

622.10.3.2 The milling operations, except in depth transition areas, shall be regulated by an automatically controlled grade leveling and slope control device.

622.10.3.3 The roadway pavement surface shall be removed and planed around and over manholes, utility valves and drainage appurtenances within the limits of the work as directed by the Engineer. Any damage to manholes, utility valves or drainage appurtenances by the removal and planning operation shall be repaired by the Contractor at the Contractor’s expense. After removal of existing material around manholes, utility valves and other appurtenances, the Contractor shall place a temporary wedge around the appurtenance. The temporary wedge shall consist of bituminous or another approved material at a slope that will allow safe transition over the appurtenance by through traffic and of a thickness and design that the material remains intact while under traffic. Bituminous wedges shall be removed prior to resurfacing.

622.10.3.4 The milled surface of each layer shall be substantially free from waves or irregularities. The final milled surface shall not vary from a 10 foot straightedge, applied parallel to the centerline, by more than 1/4 inch. Spalled areas presenting a hazard shall be repaired using an approved bituminous pavement. The texture of the final milled surface shall be a grid surface with discontinuous longitudinal striations.

622.10.3.5 Existing shoulder material shall be removed as necessary to ensure no ponding of water on the driving surface occurs after the milling operation.

622.10.3.6 Care shall be exercised not to damage existing concrete pavement. The concrete pavement surface may be scarified as shown on the plans or approved by the Engineer.

622.10.3.7 Loose material not picked up by the milling machine shall be removed from the roadway or bridge deck surface immediately behind the milling operation, except in areas with earth or stabilized aggregate shoulders. Loose material may be swept to the shoulders as approved by the Engineer.

622.10.3.8 The Contractor shall provide pavement marking as shown on the plans through the limits of the milled surfaces in accordance with Sec 620.

622.10.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement for removal of the existing pavement surface will be computed to the nearest square yard. The correction will be added to or deducted from the contract quantity.

622.10.5 Basis of Payment. The accepted quantity of removal of existing surface will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for removal of shoulder material by milling or other methods as required to provide drainage in accordance with Sec 622.10.3.5, unless shoulders are to be removed as part of the contract. No direct payment will be made for loading, hauling, stockpiling or disposing of milled material, repairing spalled areas, placing and removing temporary wedges, providing temporary pavement marking or performing other items incidental to completion of this work.

SECTION 622.20 COLD MILLING PAVEMENT FOR A DRIVING SURFACE.

622.20.1 Description. This work shall consist of fine-tooth coldmilling to improve the profile, cross slope or texture of an existing pavement surface as shown on the plans or as directed by the Engineer. The finished profile shall provide a smooth riding surface, free from gouges, and shall have a uniform textured appearance.
622.20.1.1 Locations may be field adjusted in length by the Engineer, not to exceed 1/4 mile for any one location and provided the total area for all locations is not changed, without change in payment. All specified locations shall be milled.

622.20.1.2 Contractors shall make their own conclusions concerning the quantity of material to be removed. The actual depths of milling will vary due to rut depths, drainage and profile requirements.

622.20.2 Equipment. Equipment for profiling, texturing and removing the pavement surface shall be in accordance with Sec 622.10, except as modified herein.

622.20.2.1 The minimum drum cutting width shall be 12 feet, unless specified otherwise in the contract.

622.20.2.2 The carbide cutting teeth shall be uniform in diameter, with a uniform length of ± 0.02 inch. In addition, the tooth holder blocks shall be uniform and shall not vary the cutting radius of the mandrel by more than ± 0.02 inch.

622.20.2.3 Removing millings from the pavement and discharging the millings into a hauling unit may be individual operations.

622.20.3 Construction Requirements.

622.20.3.1 Removal of material for rut removal shall be to the approximate depth of the bottom of the wheel rut in the lane being milled. The bottom of the rut shall be textured, but only minimal material removed. Milling shall be done in an approximate lane width, but may start to the right of the centerline in the approximate left wheel path, extending into the shoulder to allow drainage, leaving the existing centerline marking in place.

622.20.3.2 Removal of material for surface texturing shall be done for the full lane width, to the depth needed in order to texture all of the described areas.

622.20.3.3 After the proper combination of mandrel speed and forward speed have been established to produce the required texture, the daily operation shall be uniform and continuous for other than repair or emergency operations. The milling machine shall not be halted to load or unload trucks, or to take on water.

622.20.3.4 The entire surface shall be textured, substantially free from waves or irregularities, and shall not vary from a 10 foot straightedge, applied parallel to the centerline, by more than 1/8 inch. There may be occasional exceptions where the bottom of a wheel path may not be textured in order to maintain an acceptable profile. Spalled areas shall be repaired using an approved bituminous patching material.

622.20.3.5 The texture produced for the finished pavement shall be a uniform surface with longitudinal striations. There shall be a maximum lateral distance of 0.2 inch between adjacent longitudinal striation mark lines. The longitudinal distance from the center of a strike mark to the center of the next successive strike mark in line shall not exceed 5 inches. The longitudinal successive strike marks shall approximate a continuous grooved line. The difference between the high and low of the surface texture shall be approximately 1/16 inch.

622.20.3.6 The pavement surface shall be removed and milled around and over appurtenances, such as manholes, utility valves and drainage features, within the limits of the work as directed by the Engineer. Any damage to appurtenances by the milling and removal operation shall be repaired by the Contractor at the Contractor’s expense. The final milled pavement surface shall be smoothly transitioned at all appurtenances located in the pavement to maintain an acceptable profile.

622.20.3.7 Material adjacent to the lane being milled shall be removed as necessary to provide a smooth transition and to ensure no ponding of water on the driving surface after the milling operation. There will be no pay for
additional milling width beyond lane width as required for drainage. Removal in the traffic lanes shall be with the same equipment, providing the same texture. Removal of shoulder material may be with other milling equipment meeting the Engineer's approval.

622.20.3.8 Loose material not picked up by the milling machine shall be removed from the roadway immediately behind the milling operation. In areas with earth or aggregate shoulders, the loose material may be swept to the shoulders when approved by the Engineer. If required by the Engineer, the finished surface shall be wetted just prior to returning to traffic to reduce traffic visibility problems due to dust.

622.20.3.9 Obliterated edge lines next to a shoulder will not be required to be replaced by the Contractor, unless specified in the contract. Any other pavement marking removed by the Contractor’s operations shall be replaced with temporary pavement marking in accordance with Sec 620, except when permanent pavement marking is specified in the contract. Prior to installation of permanent pavement marking, all joints and cracks shall be cleaned and sealed with hot-poured, elastic type concrete joint sealer in accordance with Sec 1057.

622.20.4 Method of Measurement. The roadway lane width will be assumed for computing milling quantities. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in contract quantity. Where required, measurement for coldmilling of the existing pavement surface will be computed to the nearest square yard. The corrections will be added to or deducted from the contract quantity.

622.20.5 Basis of Payment. The accepted quantity of coldmilling of existing pavement surface will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for loading, hauling, stockpiling or disposing of milled material, repairing spalled areas, temporary pavement marking or other items incidental to completion of the work.

SECTION 622.30 DIAMOND GRINDING OF EXISTING PORTLAND CEMENT CONCRETE PAVEMENT.

622.30.1 Description. This work shall consist of grinding concrete pavement to provide good riding characteristics, a surface texture and proper drainage. The finished surface shall be as shown on the plans or as directed by the Engineer.

622.30.2 Equipment. The equipment shall be of a size that will grind a strip at least 3 feet wide using diamond blades, and shall not cause spalls at cracks, joints or other locations.

622.30.3 Construction Requirements.

622.30.3.1 The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Auxiliary or ramp lane grinding shall transition from the edge of the mainline as required to provide drainage and an acceptable riding surface. Grinding of bridge decks will not be permitted unless specified in the contract.

622.30.3.2 Pavement undersealing or pavement repair, if required, shall be completed prior to any grinding.

622.30.3.3 Grinding shall be accomplished in a manner that eliminates joint or crack faults and provides lateral drainage by maintaining a constant cross slope between grinding extremities in each lane. A maximum tolerance of 1/16 inch will be allowed for adjacent sides of joints and cracks, except that under no circumstances shall the grinding depth exceed 1/4 inch from the top of the original surface. When grinding across faulted joints, a minimum of a 20 foot transition onto the approach side slab shall be used.

622.30.3.4 The cross slope of the pavement shall be as shown on the plans and shall have no depressions or misalignment of slope greater than 1/4 inch in 12 feet when measured with a 12 foot straightedge placed
perpendicular to the centerline. Areas of deviation shall be reground. Straightedge requirements will not apply across longitudinal joints or outside the ground area.

**622.30.3.5** As soon as practical after grinding, the surface will be straightedged longitudinally and all variations exceeding 1/8 inch in 10 feet will be plainly marked. Areas of deviation shall be reground.

**622.30.3.6** Substantially all of the pavement surface shall be textured. Extra depth grinding to eliminate minor depressions in order to provide texturing on 100 percent of the pavement surface will not be required. No unground surface area between passes will be permitted, except as specified otherwise in the contract documents.

**622.30.3.7** The grinding process shall produce a final pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. The line-type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy-type appearance. The peaks of the ridges shall be approximately 1/32 inch higher than the bottoms of the grooves. The grooves shall be evenly spaced. There shall be approximately 50-55 grooves per foot, measured perpendicular to the centerline.

**622.30.3.8** The Contractor shall remove and dispose of all residue from the grinding in a manner and at a location to satisfy environmental regulations. The Contractor shall have the Engineer’s approval for the method of spreading and disposal of the residue prior to beginning any grinding operations.

**622.30.3.8.1** Solid residue shall be removed from the pavement surface before any residue is blown by traffic action or wind.

**622.30.3.8.2** Residue shall not be permitted to encroach on open lanes.

**622.30.3.8.3** The residue shall not enter into gutters or closed drainage systems. Suitable means to restrict the infiltration of the residue into a closed drainage system shall be provided.

**622.30.3.8.4** The Contractor may disperse residue onto unpaved shoulders, adjacent roadside embankments, or median ditch areas of divided highways where the residue runoff can percolate into the soil, unless specified otherwise in the contract. The spread rate shall not generate surface runoff. If surface runoff occurs at a grinding location, the Contractor shall haul the residue to an approved location at the Contractor’s expense.

**622.30.3.8.5** Discharge of any residue runoff shall not flow into adjacent rivers, streams, lakes, ponds or other open bodies of water.

**622.30.3.8.6** Residue shall not be spread within 100 feet of any streams, lakes or other open bodies of water, or within 15 feet of a water filled ditch.

**622.30.3.8.7** The Contractor shall use appropriate equipment and methods so the discharging of the residue does not cause erosion of soil or damage to established vegetation along the roadway. The Contractor shall repair and reseed any areas where the discharge of grinding residue causes damage to roadway slopes or vegetated areas at the Contractor’s expense.

**622.30.3.8.8** If the solids concentration of discharged residue at any particular area is determined to be excessive by the Engineer, the Contractor shall provide equipment and material to flush the areas with water as directed by the Engineer, at the Contractor’s expense.

**622.30.3.8.9** Obliterated edgelines next to a shoulder will not be required to be replaced by the Contractor unless specified in the contract. Any centerline or lane line markings removed by the Contractor’s operations shall be replaced with temporary pavement marking material in accordance with [Sec 620](#), unless permanent pavement
marking material is specified in the contract. Prior to installation of permanent pavement marking material, all joints and cracks shall be cleaned and sealed if specified in the contract.

622.30.3.9 The pavement shall be cleaned prior to opening to traffic as directed by the Engineer.

622.30.4 Smoothness Requirements.

622.30.4.1 Prior to performing any grinding work, but after completion of all pavement repairs, the Contractor shall provide a control International Roughness Index (IRI) per pavement segment, as defined in Sec 610.4.1(b), from the right wheel path of each lane being diamond ground in accordance with TM-59. This control IRI will be used to identify the required smoothness for the project.

622.30.4.1.1 Each segment of the finished ground surface shall be reprofiled in the right wheel path and have a final IRI per segment of 65 percent of the control IRI or 80 inches per mile, whichever is greater.

622.30.4.1.2 Depressed pavement areas due to subsidence or other localized causes and areas where the maximum cut at mid panel or a fault restricts further grinding, will be excluded from testing with the inertial profiler when approved by the Engineer.

622.30.4.1.3 After the initial diamond grinding operation has been profiled, additional correction shall be performed, where determined necessary by the Engineer, to reduce the average segment profile to the specified final profile requirements. The Contractor will not be allowed to make corrective grinding to increase the percent of pay when the final IRI is in accordance with Sec 622.30.4.1.1. On pavement segments where corrections are necessary, additional profiles shall be made to verify that the corrections have produced an average final profile in accordance with Sec 622.30.4.1.1.

622.30.4.1.4 The Contractor shall use the ProVAL software program to compute IRIs in accordance with TM-59. The Contractor shall provide the raw unfiltered profile data file in .ppf format.

622.30.4.2 Inertial profile testing shall not be performed in excluded areas as defined in Sec 610.4.2.2.

622.30.4.2.1 Excluded areas shall be tested with a 10 foot straightedge in accordance with Sec 610.4.3.

622.30.5 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement will be made to the nearest square yard. Measurement will be based upon the full pavement lane width. No deduction will be made for gaps within the pavement lane to avoid striping, raised pavement markers, manholes or other structures.

622.30.6 Basis of Payment. The accepted quantity of ground pavement surface will be paid for at the contract unit price for diamond grinding concrete pavement. Payment will be considered full compensation for all labor, equipment, material and incidentals to complete this work, including hauling and disposal of grinding residue and cleaning the pavement prior to opening to traffic.

622.30.6.1 The contract unit price for diamond grinding will be adjusted based on the final IRI for any segment before corrections, according to the following schedule:

<table>
<thead>
<tr>
<th>IRI, inches per mile</th>
<th>Increase in Contract Unit Price (SY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.0 or less</td>
<td>$0.25</td>
</tr>
<tr>
<td>40.1 to 54.0</td>
<td>$0.15</td>
</tr>
</tbody>
</table>
**SECTION 622.30 DIAMOND GRINDING OF NEW PORTLAND CEMENT CONCRETE PAVEMENT.**

622.30.6.2 At the Contractor’s expense, segments with an IRI not in accordance with Sec 622.30.4.1.1, after the initial grinding, shall be corrected until the IRI is reduced in accordance with Sec 622.30.4.1, unless waived by the Engineer.

### SECTION 622.40 DIAMOND GRINDING OF NEW PORTLAND CEMENT CONCRETE PAVEMENT.

622.40.1 Description. This work shall consist of grinding new Portland cement concrete pavement to provide good riding characteristics and surface texture. The finished surface shall be as shown on the plans.

622.40.2 Equipment. The grinding equipment shall be in accordance with Sec 622.30.2.

622.40.3 Construction Requirements.

622.40.3.1 Paving. When diamond grinding is used as the final texturing for new Portland cement concrete pavement, concrete paving shall be in accordance with Sec 502, except as follows. All joints shall be protected to prevent grinding residue from entering. Joints to be diamond ground shall be cleaned and sealed in accordance with Sec 502 after diamond grinding is completed.

622.40.3.2 Smoothness Requirements.

622.40.3.2.1 No diamond grinding shall be done until the pavement has attained a strength sufficient to be opened to all types of traffic. All diamond grinding shall be completed on any section prior to opening that section to other than construction traffic, unless approved by the Engineer.

622.40.3.2.2 The final pavement surface from the grinding process shall be in accordance with Sec 622.30.3.7. All grooves and adjacent passes shall be parallel to each other and the roadway, with no variation. Adjacent passes shall completely lap with no unground surface between, however, they shall not overlap more than 1 1/2 inches. Adjacent passes shall be within 1/8 inch of the same height as measured with a 3 foot straightedge. No less than 98 percent of the specified surface shall be textured by grinding. There shall be no ridge between lanes. Any remaining ridges on the outside edge next to the shoulder greater than 1/8 inch high shall be feathered out to the satisfaction of the Engineer in a separate operation.

622.40.3.2.3 Any deficiencies in the final surface due to improper Contractor operations or equipment shall be corrected by the Contractor, at the Contractor’s expense.

622.40.3.2.4 The Contractor shall remove and dispose of all residue from grinding operations in accordance with Sec 622.30.3.8.

622.40.4 Basis of Payment. No direct payment for diamond grinding new concrete pavement will be made. Diamond grinding new concrete pavement will be considered as part of the work paid for under the contract unit price for Portland concrete pavement in accordance with Sec 502.
SECTION 623
CONCRETE BONDING COMPOUND, EPOXY MORTAR AND EPOXY POLYMER CONCRETE OVERLAY

SECTION 623.10 CONCRETE BONDING COMPOUND.

623.10.1 Description. This work shall consist of preparing the surface, furnishing and applying the concrete bonding compound to be used to bond plastic concrete mortar to hardened concrete as shown on the plans or as directed by the Engineer.

623.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II Epoxy</td>
<td>1039</td>
</tr>
</tbody>
</table>

623.10.3 Construction Requirements.

623.10.3.1 Surface Preparation. The surface of the hardened concrete to which the plastic concrete mortar is to be bonded shall be surface dry and thoroughly cleaned such that all loose and unsound concrete is removed prior to application of the bonding agent.

623.10.3.2 Application. The bonding agent shall be applied when both the air and surface temperature is within the manufacturer’s written recommendations.

623.10.3.2.1 Components shall be mixed in accordance with manufacturer’s written recommendations. The components may be warmed with indirect heat to a maximum temperature of 100°F to reduce the viscosity. No solvents shall be added to the compound.

623.10.3.2.2 The mixed bonding agent shall be applied in such a manner as to thoroughly work the bonding compound into the hardened concrete surface. The thickness of the application shall be 20 to 25 mils. If the concrete absorbs the bonding agent, additional coats shall be applied until the correct thickness is attained.

623.10.3.2.3 The plastic concrete mortar shall be placed while the bonding agent is still tacky. If there is a delay in placing the plastic concrete mortar and the bonding agent becomes tack free, another coat of bonding agent shall be applied.

623.10.4 Basis of Payment. No direct payment will be made for furnishing material, surface preparation or application.

SECTION 623.20 EPOXY MORTAR.

623.20.1 Description. This work shall consist of preparing the surface, furnishing and applying epoxy mortar as shown on the plans.

623.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type III Epoxy</td>
<td>1039</td>
</tr>
<tr>
<td>Sand for Mortar</td>
<td>1039</td>
</tr>
</tbody>
</table>
623.20.3 Construction Requirements.

623.20.3.1 Surface Preparation. The surfaces to which the epoxy mortar is to be applied shall be free of dust, water or any other material that may affect the adhesion.

623.20.3.2 Application. The epoxy mortar shall be prepared and placed when the weather is dry and the air temperature is in accordance with the manufacturer’s written recommendations.

623.20.3.2.1 The Contractor shall mix only the number of containers of material that can be placed in 20 to 40 minutes.

623.20.3.2.2 Epoxy shall be thoroughly mixed in accordance with the manufacturer’s written recommendations. Mixing shall continue as permitted to ensure uniformity.

623.20.3.2.3 When the epoxy material has been thoroughly mixed, sand shall be added at the manufacturer’s recommended rate while mixing continues. After the proper quantity of sand has been added, mixing shall continue until the mixture is uniform.

623.20.3.2.4 Areas to be patched or leveled shall be thoroughly primed with an application of neat epoxy. After the area is primed, the mortar shall be placed and struck off to grade. The surface shall have a rough finish equal to that of a Portland cement concrete deck.

623.20.3.2.5 The patched or leveled area shall be protected during the curing period to prevent damage. Material shall be cured in accordance with the manufacturer’s written recommendations. Curing acceleration by direct flame application will not be permitted.

623.20.4 Basis of Payment. No direct payment will be made for furnishing material, surface preparation or application.

SECTION 623.30 EPOXY POLYMER CONCRETE OVERLAY.

623.30.1 Description. This work shall consist of furnishing and applying thin polymer concrete overlays in a prime coat, plus two courses on designated bridge structures as shown on the plans or as directed by the Engineer.

623.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Resin for Epoxy Polymer Concrete Overlay</td>
<td>1039</td>
</tr>
<tr>
<td>Aggregate for Epoxy Polymer Concrete Overlay</td>
<td>1039</td>
</tr>
</tbody>
</table>

623.30.3 Construction Requirements.

623.30.3.1 Manufacturer Representation. The overlay manufacturer’s representative shall witness the entire testing phase of each field test. The manufacturer’s representative shall verify that all operations are performed by acceptable practices.

623.30.3.2 Handling and Storage of Material. Handling and storage of material shall be in accordance with the manufacturer’s written recommendations.
623.30.3.3 Field Test. Prior to the start of the overlay operation, a test area of the complete overlay system shall be placed on the bridge deck in a Contractor proposed location that is approved by the Engineer. When multiple bridges are included in a project, a test area will be required on each bridge. The Contractor may utilize one-half of the bridge deck or an area equal to one day’s placement operation, whichever is smaller, as a field test. The degree of cleaning used on the test area shall be the minimum used on the remainder of the structure. The surface for the test overlay shall be prepared in accordance with the test method prescribed in ACI 503R - Appendix A of the ACI Manual of Concrete Practice to establish an approved cleaning practice. The approved cleaning practice shall remove all potentially detrimental material which may interfere with the bonding or curing of the overlay. Concrete shall be sound, with mortar soundly bonded to the coarse aggregate, with clean and open pores to be considered adequate for bond. All areas of asphalt and pavement markings shall be removed. Preparation of the surface shall produce a surface relief equal to International Concrete Repair Institute (ICRI) surface preparation level 6 or 7 or ASTM E 965 pavement macrotexture depth of 0.04 to 0.08 inch.

623.30.3.3.1 Visible moisture on the prepared deck at the time of placing the overlay will not be permitted. Moisture in the deck shall be checked by taping a plastic sheet to the deck for a minimum of 2 hours in accordance with ASTM D4263.

623.30.3.3.2 In addition to the above requirements, the cleaning practice shall provide an adhesion strength test result greater than 250 psi or a failure area into the base concrete that is greater than 50 percent of the test area. After the test area has cured for a minimum of 72 hours, adhesion shall be checked in accordance with ACI 503R. A test result will be the average of three tests on a sample area of the test patch. A minimum of three sample areas per test patch shall be tested. Successful test results will be required from each sample area.

623.30.3.3.3 If the test of a sample area fails to meet the above requirements due to a cohesive failure of the substrate concrete, the adhesive strength of the sample area will be considered acceptable.

623.30.3.3.4 Successful completion of the adhesion strength tests will be required before the full-scale overlay operation is to begin. All cleaning operations shall equal those used for the adhesion strength test areas, in both profile and cleanliness. If changes are made to the established cleaning practice, new adhesion strength testing shall be performed at the Contractor’s expense.

623.30.3.3.5 Test patches shall be installed with the same material, equipment, personnel, timing, sequence of operations and curing period that will be used for the installation of the overlay.

623.30.3.3.6 If the test fails, the Contractor shall remove the material represented by the failed test patches and provide another test patch, at the Contractor’s expense, until satisfactory test results are obtained.

623.30.3.4 Surface Preparation. Before placement of the overlay, the entire deck surface shall be prepared by the cleaning practice established in the field adhesion strength tests in accordance with Sec 623.30.3.3, except that sand blasting will not be permitted. Containment and disposal of material shall be in accordance with Sec 202.2.

623.30.3.4.1 If the Engineer determines that the weather has changed significantly since the application of the field test patch, the Contractor shall verify through adhesion strength tests that the practice is acceptable, at the Contractor’s expense.

623.30.3.4.2 No traffic of any kind shall be permitted on any portion of the deck which has been shot blasted or on the overlay without approval from the Engineer. The time between surface preparation and application of the first course shall not exceed 24 hours.

623.30.3.4.3 All patching and cleaning operations shall be inspected and approved prior to placing the overlay.
623.30.3.4.4 If the deck or intermediate course is contaminated by foreign material or water after initial cleaning, the contamination and any detrimentally affected overlay material shall be removed. Both courses shall be applied prior to opening the area to traffic.

623.30.3.5 Equipment. The Contractor's equipment shall be as recommended by the epoxy manufacturer.

623.30.3.6 Epoxy Mixture. Mixing of epoxy components shall be in accordance with the manufacturer's recommendations, except that the use of a volumetric mixer will be required. When mineral fillers are specified, the mineral fillers shall be inert and non-settling or readily dispersible. Material showing a permanent increase in viscosity or the settling of pigments that cannot be readily dispersed with a paddle shall be replaced at the Contractor's expense. At least 95 percent of the filler shall pass the No. 200 sieve.

623.30.3.7 Application. Application of epoxy shall be performed by the supplier or by a factory trained or licensed applicator with written approval from the manufacturer of the epoxy system.

623.30.3.7.1 The handling and mixing of epoxy shall be in accordance with the manufacturer's written recommendations. The overlay material shall not be placed when weather or surface conditions are such that the material cannot be properly handled, placed and cured within the specified requirements of traffic control, or when rain is forecasted within 24 hours of application.

623.30.3.7.2 The overlay shall consist of a two-course application of epoxy and aggregate. A prime coat shall be used if recommended by the manufacturer. Each of the two courses shall consist of a layer of epoxy covered with a layer of aggregate in sufficient quantity to completely cover the epoxy. The thickness of each course shall be approximately equal. The total thickness of the overlay shall be no less than 1/4 inch.

623.30.3.7.3 The temperature of the bridge deck surface at the time of application shall be less than 90°F and in accordance with the manufacturer’s recommendation.

623.30.3.7.4 Dry aggregate shall be applied in such a manner as to cover the epoxy mixture completely within 5 minutes of application. The dry aggregate shall be placed in a manner such that the level of the epoxy mixture is not disturbed.

623.30.3.7.5 The first course shall be swept to remove loose aggregate prior to the second course application. Sweeping shall be done without removing embedded aggregate. First course applications which do not receive enough aggregate prior to gelling shall be removed and replaced. A second course applied with insufficient aggregate may be left in place, but additional applications shall be placed at the Contractor's expense before opening to traffic.

623.30.3.7.6 The thickness of the overlay shall be verified to be at least 1/4 inch, measured from the deck surface to the top of the resin. The Contractor shall provide a minimum 1/2 inch diameter hole at a rate of at least one hole per 100 feet of traffic lane. Hole placement shall be at locations designated by the Engineer. Thin areas shall be recoated and reverified at the Contractor’s expense.

623.30.3.7.7 When additional applications or recoating are required, the Engineer may require additional adhesion strength tests by the Contractor, at the Contractor’s expense, in accordance with ACI 503R to verify the Contractor's procedure.

623.30.3.7.8 All adhesion strength test areas, thickness test holes or any debonded areas shall be repaired by filling with overlay material before final acceptance.
623.30.7.9 The epoxy concrete overlay shall be cured at least one hour, or until brooming or vacuuming can be performed without tearing or otherwise damaging the surface. No traffic or equipment shall be permitted on the overlay surface during the curing period.

623.30.7.10 After the curing period, all loose aggregate shall be removed by brooming or vacuuming and the next overlay course applied as specified in the contract documents.

623.30.7.11 The polymer mixture shall not be permitted to run into drains.

623.30.7.12 Unless otherwise specified, the epoxy concrete overlay courses shall be applied over the expansion joints and joint seals of the bridge deck. The expansion joints and joint seals shall be provided with bond breaker. Prior to opening to traffic, the overlay shall be removed over each joint by removal of the bond breaker in accordance with the overlay manufacturer’s recommendations.

623.30.7.13 Prior to opening a section to public or construction traffic, the overlay shall be allowed to cure in accordance with the manufacturer’s recommendations. First course applications shall not be opened to traffic.

623.30.7.14 Damaged or debonded areas of an epoxy concrete overlay course shall be removed and repaired prior to acceptance. Repair shall consist of saw-cutting in rectangular sections to the top of the concrete deck surface and replacing the various courses in accordance with this specification at the Contractor’s expense.

623.30.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, the area of polymer concrete overlay will be measured and computed to the nearest square yard. This area will be measured longitudinally from end to end of bridge deck and transversely between the roadway face of curbs, excluding the area of the expansion device, if any. The revision or correction will be computed and added to or deducted from the contract quantity.

623.30.5 Basis of Payment. The accepted quantity of epoxy polymer concrete overlay will be paid for at the contract unit price.

SECTION 623.40 POLYMER CONCRETE.

623.40.1 Description. This work shall consist of furnishing and placing polymer concrete as shown on the plans or as directed by the Engineer.

623.40.2 Manufacturer Representation. The manufacturer’s representative shall be present at the start of surface preparations and polymer concrete installation for at least one day. The Contractor shall furnish the manufacturer’s recommendations to the Engineer as to the acceptability of all aspects of the operation. The Contractor shall contact the manufacturer’s representative at least two weeks prior to installation.

623.40.3 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymer Concrete</td>
<td>1039</td>
</tr>
</tbody>
</table>

623.40.4 Construction Requirements.

623.40.4.1 Equipment. The Contractor's equipment shall be in accordance with the manufacturer’s recommendations.
623.40.4.2 **Surface Preparation.** Portland cement concrete shall be allowed to cure and dry for a minimum of seven dry days prior to installing the polymer concrete. Days with cold, wet or inclement weather which may be a detriment to curing of the Portland cement concrete will not count in this seven day minimum curing and drying time. The concrete surface shall be dry when placing the polymer concrete. The substrate shall be structurally sound and sandblasted to be free of all foreign matter, grease, dirt and laitance for all areas that will be in contact with the polymer concrete. Steel surfaces shall be cleaned in accordance with SSPC-SP 10 surface preparation requirements. Containment and disposal of material shall be in accordance with Sec 202.2. After sandblasting is completed, the joint shall be cleaned of debris by using oil and water free compressed air at a minimum of 90 psi or by vacuuming. These areas shall then be primed in accordance with the manufacturer’s recommendations.

623.40.4.3 **Placement.** The polymer concrete shall be mixed, placed and cured in accordance with the manufacturer’s recommendations and as shown on the plans. Before opening to traffic, the material shall be tack free and fully cured as determined by the Engineer.

623.40.5 **Method of Measurement.** Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, the area of polymer concrete will be measured and computed to the nearest square yard. This area will be measured longitudinally from end to end of bridge deck and transversely between the roadway face of curbs, excluding the area of the expansion device, if any. The revision or correction will be computed and added to or deducted from the contract quantity.

623.40.6 **Basis of Payment.** The accepted quantity of polymer concrete will be paid for at the contract unit price.
SECTION 624
GEOTEXTILE CONSTRUCTION

624.1 Description. This work shall consist of installing geotextile for use in subsurface drainage, in erosion control, as a permeable separator or as otherwise specified.

624.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile</td>
<td>1011</td>
</tr>
</tbody>
</table>

624.3 Construction Requirements. Geotextile shall be placed in accordance with AASHTO M 288 for the appropriate application.

624.4 Method of Measurement. Geotextile used for lining drain trenches, wrapping drain pipe or for control of piping through structural joints and facing panels will not be separately measured. Geotextile used for other purposes will be measured to the nearest square yard of surface area covered without regard to any overlap. Geotextile used for embankment protection as described in Sec 609 and Sec 611 shall be considered incidental and included in the unit price for the particular type of embankment protection.

624.5 Basis of Payment. Geotextile used for lining drain trenches, wrapping drain pipe or for control of piping through structural joints and facing panels will be considered as incidental and will be included in the contract unit price for the drain or structure. The accepted quantity of geotextile used for other purposes will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for securing pins or other incidental items.
SECTION 625.10 SLAB UNDERSEALING.

625.10.1 Description. This work shall consist of stabilizing Portland cement concrete pavement by furnishing, hauling and pumping high density polyurethane or asphalt cement under the concrete slab. This work shall be completed after any required pavement repair and prior to the placement of any new overlay material.

625.10.2 Material.

625.10.2.1 High Density Polyurethane.

625.10.2.1.1 The material shall be a hydrophobic, closed cell, high density polyurethane system with the following physical characteristics and properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, min., per ASTM D 1622</td>
<td>4.0 ± ½lb/ft³</td>
</tr>
<tr>
<td>Compressive Strength, min., per ASTM D 1621</td>
<td>80 psi</td>
</tr>
<tr>
<td>Tensile Strength, min.</td>
<td>90 psi</td>
</tr>
<tr>
<td>Volume Change, max.</td>
<td>+5.0 percent</td>
</tr>
<tr>
<td>Curing Rate</td>
<td>90 percent of compressive strength within 15 minutes after injection</td>
</tr>
</tbody>
</table>

625.10.2.1.2 The material shall be hydrophobic in the material’s component reaction such that the injected product is not significantly compromised by soil moisture or free water under the pavement.

625.10.2.1.3 When requested by the Engineer, pumping units in service shall perform a product density test by injecting a sample of the unit’s polyurethane material into a test cylinder of known volume. The sample’s density shall be in accordance with Sec 625.10.2.1.1.

625.10.2.1.4 When requested by the Engineer, the Contractor, in the presence of the Engineer, shall inject the polyurethane material into a container holding 40 gallons of ambient temperature water at 70°F. The resulting product shall demonstrate consistent, closed cell polyurethane material.

625.10.2.1.5 All stored polyurethane material shall be handled in accordance with the manufacturer’s recommendations.

625.10.2.2 Asphalt Cement.

625.10.2.2.1 Asphalt cement material shall meet ASTM D3141. The Contractor shall provide a supplier certification with each shipment in accordance with Sec 1015.3.1.

625.10.3 Construction Requirements.

625.10.3.1 General.

625.10.3.1.1 Pavement stabilization operations will not be allowed when daytime temperatures are below 35°F or if the subgrade is frozen.
625.10.3.1.2 A hole pattern shall be submitted for approval at least 7 days prior to starting slab stabilization operations. Drilled holes shall be a maximum of 1 1/2 inches in diameter, drilled smooth, vertical and round. Holes drilled with a break out in excess of 1 1/2 inches outside the hole diameter will be unacceptable.

625.10.3.1.3 The Contractor shall provide equipment capable of detecting slab lift to measurements of 0.001 inch. Pavement lifted in excess of 0.125 inch or pavement cracked as a result of the undersealing will be unacceptable.

625.10.3.1.4 Proof of full undersealing, such as material seeping from joints, cracks, or edges; vertical slab movement; or other visual indication, as determined by the Engineer, will be required prior to acceptance. When required, deflection testing shall be performed in accordance with MoDOT Test Method TM 64. No testing shall be performed if the slabs are beginning to lock-up. Tests shall not be performed during Spring thaw conditions or when the subgrade is frozen.

625.10.3.1.5 Undersealing materials shall not enter into gutters or closed drainage systems. Residue shall not be spread within 100 feet of any streams, lakes or other open bodies of water or within 15 feet of a water filled ditch. All removed material shall be disposed of in an environmentally acceptable manner in accordance with all Federal, State, and local regulations.

625.10.3.1.6 All drill tailings, spilled material, and other debris shall be cleaned up at the end of each working day or before the lane is opened to traffic.

625.10.3.1.7 The drill holes shall be filled flush with the pavement surface using a material to match the existing surface.

625.10.3.1.8 The Contractor shall supply certification for the accuracy of the method used to measure the amount of material used on the project.

625.10.3.2 High Density Polyurethane.

625.10.3.2.1 Injection nozzles shall prevent leakage during injection and shall be removed at completion of the injection or driven into the injection hole to a minimum depth of 1-1/4 inches below the pavement surface.

625.10.3.2.2 Any excessive material on the pavement surface shall be removed from the area and the holes shall be sealed with polyurethane material or in accordance with Sec 625.10.3.1.7.

625.10.3.2.3 The pavement shall not be open to traffic until a minimum of 30 minutes after pumping operations have ceased.

625.10.3.3 Asphalt Cement.

625.10.3.3.1 Asphalt cement shall be heated to a temperature between 380°F and 450°F before pumping operations begin.

625.10.3.3.2 Pumping operations shall cease when asphalt cement seeps from cracks and joints. Pumping shall not resume until visible asphalt cement has congealed.

625.10.3.3.3 The Contractor shall provide adequate shielding to ensure passing traffic is not sprayed by asphalt cement.

625.10.3.3.4 The pavement shall not be open to traffic until a minimum of 30 minutes after pumping operations have ceased.
625.10.4 Method of Measurement.

625.10.4.1 High density polyurethane material shall be measured to the nearest pound.

625.10.4.2 Asphalt cement shall be measured to the nearest gallon in accordance with Sec 1015.

625.10.4.3 Measurement of testing for deflection will be per joint, crack or pavement repair patch per traffic lane in which testing is performed. Testing prior to undersealing and testing after undersealing will be measured separately.

625.10.5 Basis of Payment. The accepted quantities of undersealing material and deflection testing quantities will be paid for at the contract unit price. Payment will be considered full compensation for all labor, equipment and material necessary to complete the described work.

SECTION 625.20 SLAB JACKING.

625.20.1 Description. This work shall consist of injecting high density polyurethane or cementitious grout under a sunken section of concrete pavement and raising it back to the correct profile for an acceptable ride and positive drainage.

625.20.2 Material.

625.20.2.1 High density polyurethane used for slab jacking shall meet the requirements of Sec 625.10.2.

625.20.2.2 The material used in grouting shall consist of a mixture of Portland cement, fly ash and water proportioned as specified or as approved by the Engineer. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash</td>
<td>1018</td>
</tr>
<tr>
<td>Cement, Type I, II or III</td>
<td>1019</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

625.20.2.3 Grout shall meet the following minimum requirements:

(a) Flow cone efflux time shall be 10 to 16 seconds, as determined in accordance with ASTM C 939.

(b) The minimum design strength at minimum efflux time shall be 600 psi at seven days, determined in accordance with ASTM C 942, with the exception that storage of compressive specimens after 24 hours shall be placed in a 100 percent humidity cabinet.

625.20.2.4 At least three weeks prior to the beginning of this work, the Contractor shall submit the proposed mixture to the Engineer. The submittal shall include the mix design, source and type of all material test results of the grout showing one-day, three-day and seven-day compressive strengths, efflux time, time of initial and final set by the Gilmore needle in accordance with ASTM C 266 and time delayed to molding specimens after mixing grout. The time delay between mixing and molding will be the maximum holding time permitted in the field. Sufficient quantities of all mixture components to permit laboratory verification of the grout properties listed herein shall accompany the mix design submittal. Approximately 10 pounds of Portland cement and 30 pounds of fly ash shall be furnished.
625.20.3 Construction Requirements. Construction requirements shall be in accordance with Sec 625.10.3.1 and specifically as follows.

625.20.3.1 General.

625.20.3.1.1 The Contractor shall establish a finish target profile using an elevation measuring device or string line. Each profile shall be accepted by the Engineer prior to work being performed at that location.

625.20.3.1.2 Pumping operations shall cease when the slab has achieved the target profile. The Contractor shall provide equipment capable of detecting slab lift to measurements of 0.001 inch. Pavement lifted in excess of 0.125 inch over the accepted profile or pavement cracked as a result of the slab jacking will be unacceptable.

625.20.3.1.3 The Engineer may require the Contractor to verify positive drainage on the lifted slab by flooding the surface area.

625.20.3.2 High Density Polyurethane. Construction requirements shall be in accordance with Sec 625.10.3.2.

625.20.3.3 Cementitious Grout.

625.20.3.3.1 Any admixtures used shall be incorporated in accordance with the manufacturer's recommendations. Admixtures may be added by hand methods. Admixtures shall be measured within a tolerance of plus or minus three percent of the required quantity.

625.20.3.3.2 Personnel, scales and equipment necessary for calibrating the proportioning devices and for verifying the accuracy of proportions shall be furnished by the Contractor and shall be available at all times. All equipment shall be calibrated by the Contractor in the presence of the Engineer, and subject to approval from the Engineer. Verification of the accuracy of the scales and other dispensing methods may be required at any time deemed necessary by the Engineer, but will be performed at least once each day of operation.

625.20.3.3.3 Weight proportioning and volume proportioning equipment, accuracy, calibration and verification shall be in accordance with Sec 501.

625.20.3.3.4 Grout may be re-tempered with water. Prior to re-tempering the grout, the Engineer shall be notified.

625.20.3.3.5 The cement and fly ash for grout shall be measured by weight or volume. The quantity of cement and fly ash to be used shall be calculated from the approved mix design. Batches not containing the proper quantities of material will be unacceptable.

625.20.3.3.6 Filling holes shall be in accordance with Sec 625.10.3.1.7.

625.20.3.3.7 The Contractor may disperse residue onto unpaved shoulders, adjacent roadside embankments or median ditch areas of divided highways where the residue runoff can percolate into the soil, unless specified otherwise in the contract. The spread rate shall not generate surface runoff. If surface runoff occurs at a grinding location, the Contractor shall remove the residue to an approved location at the Contractor's expense.

625.20.3.3.8 Traffic shall not be permitted on the undersealed pavement until three hours after the end of pumping operations, and after all drill holes have been plugged.

625.20.4 Method of Measurement.

625.20.4.1 High density polyurethane material shall be measured to the nearest pound.
625.20.4.2 Portland cement will be measured to the nearest pound.

625.20.4.3 Fly ash will be measured to the nearest pound.

625.20.4.4 Measurement of testing for deflection will be per joint, crack or pavement repair patch per traffic lane in which testing is performed. Testing prior to undersealing and testing after undersealing, will be measured separately.

625.20.5 Basis of Payment. The accepted slab jacking material and deflection testing quantities will be paid for at the contract unit price. Payment will be considered full compensation for all labor, equipment and material necessary to complete the described work.
626.1 Description. This work shall consist of constructing rumble strips as shown on the plans or as directed by the Engineer.

626.2 Construction Requirements. Rumble strips shall be milled into bituminous and concrete pavements to produce a neat and uniform finish. Milled material shall be handled in accordance with Sec 622. Any damage to the pavement or pavement marking resulting from the Contractor’s operations shall be repaired or replaced to the satisfaction of the Engineer by the Contractor, at the Contractor’s expense. On roadways open to traffic, rumble strips shall be in place no later than five days after the final paving operations.

626.3 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, rumble strips will be measured separately for each shoulder and the centerline, which will be measured along the centerline of the travel way, and made to the nearest 1/10 station. The revision or correction will be added to or deducted from the contract quantity.

626.4 Basis of Payment. The accepted quantity of rumble strips will be paid at the contract unit price per 1/10 station. Payment will be considered full compensation for all labor, equipment, and material necessary to complete the described work, including loading, hauling, stockpiling and disposal of milled material; and any other incidental items.
SECTION 627
CONTRACTOR SURVEYING AND STAKING

SECTION 627.10 SURVEYING AND STAKING

627.10.1 Description. This work shall consist of providing the necessary surveying and staking for the successful prosecution of the work.

627.10.2 Staking Requirements. Staking work shall be in accordance with general accepted surveying practices and provisions of the contract. The MoDOT’s current Engineering Policy Guide (EPG), 238.4, may be used as guidance and is available on MoDOT’s web site.

627.10.2.1 The Contractor shall preserve all right of way monuments, benchmarks, control points and reference marks set by the Engineer. If any monumentation is damaged, destroyed or disturbed by the Contractor, the cost of replacement will be at the Contractor’s expense and will be deducted from the payment for the work.

627.10.2.2 All surveying shall be documented by the Contractor in a written form acceptable to the Engineer. During performance of the work, all surveying documents shall be available and supplied to the Engineer upon request, at the Contractor’s expense. All documents shall be labeled with the route, job number, county, Contractor name, survey party supervisor and date.

627.10.2.3 The Engineer will furnish and set control points with known coordinates. The Engineer will furnish all coordinate data to lay out the job and locate benchmarks as shown on the plans. Except as specified herein, the Contractor shall provide all other staking, including but not limited to, centerline stakes, additional lines, connections, ramps, slope stakes, grade stakes, construction benchmarks and reference stakes locating all drainage, and roadway and bridge structures necessary for the successful prosecution of the work, including all staking necessary to facilitate the relocation of utilities. All alignment control established by the Contractor shall be referenced, and a copy of the references shall be furnished to the Engineer.

627.10.2.4 Any surveying or measurements necessary for computing pay quantities will be performed by the Engineer. The Contractor shall notify the Engineer at least two working days prior to disturbing any areas used to calculate pay quantities.

627.10.2.5 All surveying work performed by the Contractor shall be sufficient and accurate to construct the work in accordance with the contract documents. Any delays or additional costs to the project which result from insufficient or inaccurate staking or time lost for corrective action will be considered as a nonexcusable and noncompensable delay.

627.10.2.6 The construction centerline shown on the plans shall be accurately established at fifty foot intervals and the control points of all curves shall be referenced. If it is necessary to introduce an equation in order to match the plan stationing or if a plan equation is changed, such changes will be at the written direction of the Engineer.

627.10.2.7 If design errors are discovered while setting construction stakes, the Contractor shall immediately notify the Engineer. The Engineer will determine the nature of the discrepancy and will make revisions to the plans as necessary. Any restaking required by such revisions shall be performed by the Contractor. Any reimbursement due to the Contractor for additional staking due to design errors will be in accordance with Sec 109.4.3.

627.10.2.8 After the centerline has been established and referenced, centerline elevations shall be taken at all stations, half stations, and any other points required to ensure the computation of accurate quantities. Centerline elevations shall be based on the plan datum. All benchmarks shown on the plans shall be checked.
627.10.2.8.1 In the event a difference of plus or minus 0.01 foot exists in elevation for any benchmark shown on the plans, check levels shall be run and shown in the notes. The elevations shall be corrected to plan elevation at each benchmark where any difference occurs, and shall be noted in the field notes. If a plan benchmark has been disturbed or if correction of the plan elevation is not feasible, a full explanation shall be made in the notes. The Contractor shall furnish to the Engineer a listing of benchmarks prior to beginning construction.

627.10.2.8.2 If original plan cross sections differ from existing conditions by an average deviation in excess of one foot, the Contractor shall immediately notify the Engineer. The Engineer will be responsible for taking cross-sections where deviations are determined to exist.

627.10.2.9 After completing any bridge, box culvert or retaining wall staking, the Contractor shall furnish to the Engineer structural layout plan sheets which show the location of all points that have been staked. At the time of furnishing the marked layout sheets, the Contractor shall meet with the Engineer to review the layout a minimum of two working days before construction begins.

627.10.2.10 Upon completion of the project, the Contractor shall provide to the Engineer all original surveying field notes, layouts and computations in standard bound survey notebooks or in a form acceptable to the Engineer.

627.10.3 Method of Measurement. The work provided in accordance with Sec 105.8 will not be measured for payment, but will be considered a lump sum unit.

627.10.4 Basis of Payment. Contractor furnished surveying and staking will be paid for at the contract lump sum price and will be considered full compensation for the following:

(a) Performing this work.

(b) All material, labor, tools, equipment and incidentals necessary to complete the work.

(c) For all effects, impacts, cumulative impacts, incidental and consequential costs, loss or damage arising from, relating to or produced by error or discrepancies in surveys or staking and plans based on such surveys or staking, and any cost, including time effects, to correct the errors or discrepancies.

627.10.4.1 Payment for surveying and staking will only be made when a pay item is provided in the contract. If no pay item is provided, all costs associated with surveying and staking shall be considered included in the cost of other bid items.

627.10.4.2 Payment for Contractor furnished surveying and staking completed, not to exceed the contract item amount, will be made upon written request by the Contractor. Such a request shall be submitted to the Engineer two business days prior to the progress estimate date.

627.10.4.3 Complete payment will not be made until the Contractor has provided to the Engineer all original surveying field notes, layouts, computations and notebooks.

SECTION 627.20 PROPERTY CORNER SURVEYING

627.20.1 Description. This work shall consist of providing the necessary surveying for the resetting of property corners as directed by the Engineer.

627.20.2 Staking Requirements. The property corners shall be reset by a Land Surveyor registered in the State of Missouri. All surveying and resetting of the property corners shall meet the requirements of the Missouri Department of Natural Resources.
627.20.3 Measurement. Measurement will be per each property corner reset.

627.20.4 Payment. Payment will be per each property corner reset and will be full reimbursement for all surveying, property research and materials required to reset the designated property corner. No payment will be made for the resetting of property corners not specifically required by the County.

SECTION 627.30 “AS-BUILT” DRAWINGS

627.30.1 Definition. This work shall consist of providing “as-built” drawings of the project following completion of the work.

627.30.2 Requirements. The Contractor shall maintain a record set of drawings at the site and mark thereon any changes as the work proceeds. “As-built” drawings shall indicate the vertical and horizontal location of improvements in plan and profile view.

627.30.2.1 The “as-built” drawings shall include the as constructed location and elevation of the roadway centerline, location of the curb or edge of pavement and the location and elevation of all storm and sanitary sewer structures constructed as part of the project.

627.30.2.2 Upon completion of the work, these “as-built” changes shall be transferred, with changes clearly identified, onto drawings which will be furnished to the County. The “as-built” drawings shall be certified by a Land Surveyor or Engineer registered in the State of Missouri. The drawings shall be submitted on paper and in electronic format.

627.30.3 Basis of Payment. The payment for “as-built” drawings shall be on a lump sum basis when specified as a pay item on the bid form.
Division 700

STRUCTURES
SECTION 701
DRILLED SHAFTS

701.1 Description. This work shall consist of constructing cast-in-place reinforced concrete drilled shafts and rock sockets, as required, to serve as a structural foundation. This work shall provide reinforced concrete shafts cast in cylindrically excavated holes extending sufficiently into soil or sound rock to adequately support the structure and all externally applied loads for which the shaft was designed. The drilled shaft foundation, including the rock socket, where required, shall be constructed in accordance with these specifications, as shown on the plans and in accordance with other specifications included in the contract documents. When directed by the Engineer, corrections made by the Contractor will be noncompensable and any effect on time of performance nonexcusable.

701.2 Preconstruction Submittals. At least 30 days prior to drilled shaft construction, the Contractor shall submit to the Engineer for review an installation plan for the construction of drilled shafts. The installation plan shall be of sufficient detail to outline the Contractor’s intended overall construction sequence and methods of excavation for the drilled shafts, including use of slurry, placement of reinforcing steel, details of concrete delivery to the site, an emergency construction joint method, placement of concrete in a continuous pour, including operational procedures for tremie or pump, and methods to prevent and handle delays in concrete batching and delivery to the site. The installation plan shall include details of casings to be used, if applicable, including calculations showing the ability of the casing to withstand anticipated hydraulic and earth pressures, and to withstand stresses due to installation without undue deformation. These details shall include methods for casing handling, splicing, straightening and out-of-round correction. Calculations included in the installation plan shall be signed and sealed by a registered professional Engineer licensed to practice in the State of Missouri.

701.3 Material. All material shall be in accordance with this specification, Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
<tr>
<td>Concrete Admixtures</td>
<td>1054</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Mortars and Grout</td>
<td>1066</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

701.3.1 Concrete. Drilled shafts shall be constructed of Class B-2 concrete, and all material, proportioning, mixing and transporting of concrete shall be in accordance with Sec 501, except as specified herein. An air entrainment admixture shall be used. A high range water-reducing admixture may be used to increase the slump to a maximum of 8 inches. If used, the water-reducing admixture shall be added only after the concrete has reached the job site to reduce the potential for flash setting. The concrete mix for drilled shafts shall be dense, homogeneous, fluid and resistant to segregation, and shall consolidate under self-weight. The concrete mix shall have a set time that ensures that fluidity is maintained throughout the shaft concrete placement and removal of temporary casing, if used. A concrete retarder in accordance with AASHTO M 194, Type B, may be incorporated into the mix to retard set approximately two hours. Concrete for drilled shafts shall have a 28-day minimum compressive strength of 4000 psi. Portland cement shall be Type I or Type II. The maximum water per cement ratio of a concrete mix to be placed under water shall be 0.45.

701.3.2 Casing. Welded or seamless steel permanent casings shall be in accordance with ASTM A 252, Grade 2, unless otherwise specified. The Contractor shall furnish two copies of certification from the fabricator detailing the designated specification with which the furnished casings comply.

701.3.2.1 Shop Drawings. Shop drawings for permanent steel casings shall be prepared in accordance with Sec 1080 and shall be submitted to the Engineer prior to installation of the casings.
701.3.2.2 Condition of Casings. Casings shall be smooth, clean and watertight. For out-of-round tolerance of steel casings before and after installation, the departure of any point on the periphery of the casing from a true circle shall not exceed one inch, measured radially.

701.3.2.3 Extent of Casing Length. Permanent casings, if required, shall be continuous wherever possible or practical. The permanent casing shall terminate at the specified elevation, and the concrete shall be trimmed to within tolerances specified in Sec 701.4.16 prior to acceptance of the completed drilled shaft. Permanent casings shall be extended into rock, as needed, to provide a positive seal and to stabilize the shaft excavation against collapse, excessive deformation, or flow of water. Casings meeting all specified requirements shall be installed from the work platform to the elevations shown on the plans. Where drilled shafts are located in open water areas, casings shall be extended from at least 18 inches above the water elevation and unless otherwise specified in the contract documents, to the specified bottom of casing elevation to protect the shaft concrete from water action during placement and curing of concrete.

701.3.2.4 Use of Teeth or Cutting Edge. The casing may be fabricated with teeth or a cutting edge to facilitate insertion into the rock.

701.3.2.5 Splices. Splicing of permanent casings is not desirable and will only be permitted when approved by the Engineer. If splices are required, the welding process shall be in accordance with the requirements specified herein. The Contractor shall be fully responsible for the adequacy of welds during driving.

701.3.2.6 Welding. Shop welding of casings shall be performed by a fully-automated welding process to develop the full capacity of the shell. All welding shall be in accordance with Sec 1080, except that shop welding of casings will not require radiographic inspection. Inspection will be of a visual nature. If evidence indicating poor welding is found, the Engineer may require radiographing. Field-welded splices of sections of the steel casings shall be made by shielded metal-arc welding procedures performed by a St. Charles County-certified field welder using properly dried low-hydrogen E701 8 electrodes that have been protected from the elements to maintain the dry condition. The welds shall be full penetration, watertight and of x-ray quality in accordance with Sec 1080.

701.3.3 Slurry. Drilling slurry will be defined as mineral slurry, polymer slurry, natural slurry formed during the drilling process, water or other fluids used to maintain stability of the drilled shaft excavation to aid in the drilling process or to maintain the quality of the rock socket. In addition, the terms mineral slurry and polymer slurry, as used herein, will be defined as the final mixed composite of all additives, including manufactured mineral or polymer slurry additives required to produce the acceptable drilling slurry.

701.3.3.1 Slurry Usage. Drilling slurry shall be used if detailed in the approved installation plan, if in accordance with the contract documents or if approved in writing by the Engineer. Drilling slurry may be used at the Contractor’s option if the slurry is not in accordance with the contract documents; however, any slurry shall be approved by the Engineer prior to use. Drilling slurry, when used, will be noncompensable and effect on time of performance due to the use of the slurry will be nonexcusable.

701.3.3.2 General Properties. The material used to make the slurry shall not be detrimental to the concrete or surrounding ground strata. Mineral slurries shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Polymer slurries shall have sufficient viscosity and gel characteristics to transport excavated material to suitable screening systems or settling tanks. The percentage and specific gravity of the material used to make the slurry shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. If approved by the Engineer, the Contractor may use water and on-site soils as a drilling slurry. In that case, the range of acceptable values for density, viscosity and pH, as shown in the following table for bentonite slurry, shall be met, except that maximum density (unit weight) shall not exceed 70 pounds/cubic foot. When water is used as the drilling fluid to construct rock sockets in limestone, dolomite, sandstone or other formations that are not erodible, the
requirements for slurry testing will not apply if the entire fluid column is replaced with fresh water after drilling. To do so, fresh water should be introduced at the top of the casing and existing water used during drilling should be pumped out of the excavation from near the base of the socket until the entire volume of fluid has been replaced.

701.3.3 Preparation. Prior to introduction into the shaft excavation, the manufactured mineral or polymer slurry admixture shall be pre-mixed thoroughly with clean, fresh water and for adequate time in accordance with the slurry admixture manufacturer’s recommendations allotted for hydration. Water used for mixing shall be in accordance with Sec 1070. Slurry tanks of adequate capacity will be required for slurry mixing, circulation, storage and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks without written approval from the Engineer. Adequate desanding equipment will be required as necessary to control slurry properties during the drilled shaft excavation in accordance with the values provided in the table below. Desanding will not be required for signposts or lighting mast foundations unless specified in the contract documents.

701.3.3.4 Control Tests. Control tests using a suitable apparatus shall be performed by the Contractor on the slurry to determine density, viscosity, sand content and pH of freshly mixed slurry, recycled slurry and slurry in the excavation. Tests of slurry samples from within one foot of the bottom and at mid-height of the shaft shall be conducted in each shaft excavation during the excavation process to establish a consistent working pattern. A minimum of four sets of tests shall be conducted during the first eight hours of slurry use on the project. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use, or as otherwise approved by the Engineer. Reports of all tests, signed by an authorized representative of the Contractor, shall be furnished to the Engineer on completion of each drilled shaft. An acceptance range of values for the physical properties will be as shown in the table below.

701.3.3.5 Sampling. When slurry samples are found to be unacceptable, the Contractor shall bring the slurry in the shaft excavation to within specification requirements. Concrete shall not be poured until resampling and testing results produce acceptable values. Prior to placing shaft concrete, the Contractor shall take slurry samples from within one foot of the bottom and at mid-height of the shaft. Any heavily contaminated slurry that has accumulated at the bottom of the shaft shall be removed. Disposal of all slurry shall be done in areas approved by the Engineer. The Contractor shall perform final shaft bottom cleaning after suspended solids have settled from the slurry mix.
### Range of Acceptable Values for Mineral and Polymer Slurries in Fresh Water Without Additives

<table>
<thead>
<tr>
<th>Property</th>
<th>Bentonite</th>
<th>Emulsified Polymer</th>
<th>Dry Polymer</th>
<th>Units</th>
<th>Test Method</th>
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<tr>
<td><strong>Density (Unit Weight)</strong></td>
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<tr>
<td>At Introduction</td>
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<td>&lt;63</td>
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<td>&lt;63</td>
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<td>33 – 43b</td>
<td>50 – 80b</td>
<td>sec/qt</td>
<td>Marsh Funnel</td>
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<td>32 – 60</td>
<td>33 – 43b</td>
<td>50 – 80b</td>
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<td><strong>pH</strong></td>
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<tr>
<td>At Introduction</td>
<td>8 – 10</td>
<td>8 – 11</td>
<td>7 – 11</td>
<td>--</td>
<td>pH Paper or pH Meter</td>
</tr>
<tr>
<td>Prior to Concreting</td>
<td>8 – 10</td>
<td>8 – 11</td>
<td>7 – 11</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td><strong>Sand Content</strong></td>
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<td></td>
<td></td>
<td>Percent by Volume</td>
<td>API Sand Content Kit</td>
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<td>&lt; 1</td>
<td>&lt; 1</td>
<td></td>
<td></td>
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<tr>
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<tr>
<td><strong>Maximum Contact Time</strong>a**</td>
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<td>72</td>
<td>72</td>
<td>Hours</td>
<td></td>
</tr>
</tbody>
</table>

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a Without agitation and sidewall cleaning.
b Higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

### 701.4 Construction.

#### 701.4.1 Protection of Existing Structures. All precautions shall be taken to prevent damage to existing structures and utilities. These measures shall include, but are not limited to, monitoring and controlling the vibrations from the driving of casing or drilling of the shaft, and selecting construction methods and procedures that shall prevent excessive caving of the shaft excavation.

#### 701.4.2 Technique Shafts. When required by the contract documents, the Contractor shall demonstrate the adequacy of methods and equipment used during construction of the first drilled shaft, which shall be an out of position technique shaft, constructed with reinforcement as identified for production shafts on the plans. This technique shaft shall be drilled in the position as directed by the Engineer and drilled to the maximum depth for any production shaft shown on the plans. If at any time the Contractor is unable to demonstrate, to the satisfaction of the Engineer, the adequacy of methods or equipment and alterations required, an additional technique shaft(s) may be required. Technique shafts shall be cut off 3 feet below groundline, buried or otherwise disposed of as specified in the contract documents or as directed by the Engineer. Once approval has been given to construct production shafts, no changes will be permitted in the methods of equipment used to construct the shaft without approval from the Engineer. When a technique shaft is not required, construction of the first production shaft will be used to determine if the methods and equipment used by the Contractor are acceptable. Failure at any time to demonstrate to the Engineer the adequacy of methods or equipment will be cause for the Engineer to require appropriate alterations in equipment or method by the Contractor to eliminate unsatisfactory results.

#### 701.4.3 Construction Sequence. Excavation to footing elevation shall be completed before shaft construction begins, unless otherwise authorized by the Engineer. Any disturbance to the footing area caused by shaft installation shall be repaired by the Contractor prior to pouring the footing. When drilled shafts are to be installed in conjunction with embankment placement, the Contractor shall construct drilled shafts after placement of fills. Drilled shafts constructed prior to the completion of fills shall not be capped until the fills have been placed as near to final grade as possible, leaving only the necessary work room for construction of the caps.
701.4.4 General Equipment and Methods. The Contractor shall perform excavations through whatever material is encountered to the dimensions and elevations shown on the plans. The Contractor’s methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.

701.4.4.1 General Equipment. The Contractor shall provide equipment capable of constructing shafts to a depth equal to the deepest shaft tip elevation shown on the plans plus 15 feet, or as otherwise specified in the contract documents. When a rock socket is identified on the plans at a shaft location, the definition of “shaft tip elevation”, for the purposes of this subsection, shall be taken to refer to the bottom of the rock socket.

701.4.4.2 General Methods. Excavations required for shafts and rock sockets shall be completed in a continuous operation. The Contractor shall be responsible for ensuring the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, the Contractor shall notify the Engineer promptly. Either the dry method, wet method, temporary casing method, permanent casing method if specified, or combinations, as necessary, shall be used to produce sound, durable concrete drilled shafts free of defects. The permanent casing method shall be used only when required by the contract documents. Blasting excavation methods will not be permitted. When a rock socket is required, the Engineer will be the sole judge as to what constitutes the top of sound rock. The Engineer may order in writing additional depths of rock socket below the top of sound rock as considered necessary to improve the foundation. If the top surface of the sound rock is found to be inclined across the width of the shaft, the Contractor shall immediately notify the Engineer. The Contractor shall use an airlift, or other method approved by the Engineer, to clean the bottom of the shaft excavation.

701.4.4.2.1 Dry Construction Method. The dry construction method shall be used only at sites where the groundwater table and site conditions, generally stiff to hard clays or rock above the water table, are suitable to permit construction of the shaft in a relatively dry excavation and where the sides and bottom of the shaft remain stable without any caving, sloughing or swelling and allow visual inspection prior to concrete placement. The dry method shall consist of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation and placing the shaft concrete in a relatively dry excavation. The dry construction method shall be used only when shaft excavations, as demonstrated in a technique shaft or first production shaft, have 12 inches per hour or less of seepage.

701.4.4.2.2 Wet Construction Method. The wet construction method shall be used at sites where a dry excavation cannot be maintained for placement of the shaft concrete. This method shall consist of drilling the shaft excavation below the water table, keeping the shaft filled with water, natural slurry formed during the drilling process, mineral slurry or polymer slurry to contain seepage water or slurry and groundwater movement, and to maintain stability of the hole perimeter until excavation to the final depth and placement of the reinforcing cage and concrete has been completed. This procedure will require placing the shaft concrete with either a tremie or concrete pump beginning at the shaft bottom, and displacing the water or slurry as concrete is placed. Temporary partial depth casings near the ground surface shall be provided to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Where drilled shafts are located in open water areas, shafts shall be constructed by the wet method using casings extending from above the water elevation to the plan casing tip elevation to protect the shaft concrete from water action during placement and curing. The casing shall be installed in a manner that produces a positive seal at the bottom of the casing.

701.4.4.2.3 Temporary Casing Construction Method. The temporary casing construction method shall be used at all sites where the stability of the excavated hole or the effects of groundwater cannot be controlled by other means. In this method, the hole shall be advanced through caving material by the wet method in accordance with Sec 701.4.4.2.2. When a formation is reached that is nearly impervious, a casing shall be placed in the hole and sealed. Drilling may proceed by the dry method to the projected depth. The placement of concrete shall proceed by the dry or wet method, except that the casing shall be withdrawn after the concrete is placed. In the event seepage conditions prevent use of the dry method, excavation shall be completed by the wet method. Before and during casing withdrawal, a 5 foot minimum head of fresh concrete above the bottom of the casing shall be
maintained at such a level that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft. Temporary casings shall be removed while the concrete is still workable and the slump of the concrete is between 4 and 8 inches. Vibratory hammers shall not be used for casing installation or removal within 50 feet of other shafts that have been completed less than 24 hours earlier. The reinforcing cage shall not be damaged or displaced when withdrawing the temporary casing.

701.4.2.4 Permanent Casing Construction Method. The permanent casing construction method shall be used only when required by the contract documents or authorized by the Engineer. The casing shall be continuous between top and bottom elevations shown on the plans. Vibratory hammers shall not be used for casing installation within 50 feet of shafts that have been completed less than 24 hours earlier.

701.4.5 Slurry.

701.4.5.1 Time Limitations. When bentonite slurry is used, the Contractor shall adjust construction operations such that the maximum time that slurry is in contact with the bottom 5 feet of the shaft, the time from the end of drilling to the beginning of concrete placement, does not exceed four hours without agitation. If the four-hour limit is exceeded, the bottom 5 feet of the shaft shall be overreamed prior to performing other operations in the shaft. For rock sockets constructed in shale using polymer slurry, concrete placement shall begin within 72 hours of starting the rock socket excavation to avoid degradation of the shaft sidewall. Before concrete placement begins, foundation inspection, when required, cleaning operations and reinforcing steel placement shall be completed and approved by the Engineer. These operations will be included in the 72-hour time limit. If concrete placement is not begun within the time limit, the Contractor shall take corrective measures to the satisfaction of the Engineer.

701.4.5.2 Level of Slurry. During construction, the level of slurry shall be maintained at a height sufficient to prevent caving of the excavation. If the Engineer determines that the slurry construction method is failing to produce the desired final results, the Contractor shall discontinue operations and propose an alternate method for approval from the Engineer. Correction for a failed slurry construction method will be noncompensable and any effect on time of performance nonexcusable.

701.4.5.3 Slurry Manufacturer’s Representative. When manufactured mineral or polymer slurry additives are to be incorporated into the drilling slurry mix, the Contractor shall provide the technical assistance of a representative of the mineral or polymer slurry additive manufacturer at the site prior to introduction of the slurry into the first shaft where slurry use will be required, and during drilling and completion of a minimum of one shaft to adjust the slurry mix to the specific site conditions.

701.4.5.4 Drilling Fluids for Rock Socket Excavation. For rock sockets excavated in limestone, dolomite, sandstone or other formations that are not erodible and cannot be constructed in the dry, only water shall be used as the drilling fluid, except that when other slurry types are used in drilling through overburden, that slurry shall be removed and replaced with fresh clean water prior to rock socket excavation. For rock sockets excavated in geomaterial that may be eroded by drilling water, such as shales, a polymer slurry will be required prior to beginning rock socket drilling through completion of concreting the rock socket.

701.4.6 Cleaning of Shaft or Casing Sidewalls. Cleaning of the shaft or casing sidewalls shall occur by a method approved by the Engineer as necessary to remove the depth of softening or to remove excessive slurry cake buildup.

701.4.7 General Excavation Considerations. The plans will indicate the top of shaft elevations and the estimated bottom of shaft elevations between which the drilled shaft shall be constructed. Drilled shafts may be extended deeper when the Engineer determines that the foundation material encountered while drilling the shaft excavation is unsuitable or is not the same as anticipated in the design of the drilled shaft. Drilled shafts may be shortened when the Engineer determines the material encountered is better than that anticipated, or based on the results of load tests.
701.4.7.1 Time Restrictions. Drilled shaft excavation shall begin only if the Contractor can complete the excavation, perform foundation inspection and testing, and place the reinforcement and concrete as a continuous operation. No two adjacent shafts shall be excavated at the same time, and shafts shall not be constructed within 24 hours of the completion of an adjacent shaft if the center-to-center spacing is less than 3 shaft diameters.

701.4.7.2 Disposal of Excavated Material. Excavated material removed from the shaft and any drilling fluids used shall be disposed of in accordance with the contract documents, as directed by the Engineer, and in compliance with federal and state laws.

701.4.7.3 Worker Entry Into Shaft Excavation. The Contractor shall not allow workers to enter the shaft excavation for any reason, unless both a suitable casing has been installed and adequate safety equipment and procedures have been provided to workers entering the excavation.

701.4.8 Unexpected Obstructions. Subsurface obstructions at drilled shaft locations shall be removed by the Contractor. The Contractor shall employ special procedures or tools when the hole cannot be advanced using conventional equipment. Blasting will not be permitted. Except as provided in this section, all cost and time effects, direct, indirect and cumulative of subsurface obstruction of whatever nature, will be conclusively deemed fully compensated under the pay items in accordance with the contract. Encountering unexpected obstructions will be considered inherent risks in the nature of this work, both as to type and extent as is variability in material encountered in the work as to effort required to drill through or excavate the material. In the event the Contractor encounters at the site of a drilled shaft location a subsurface or latent physical condition that differs materially from that indicated in the contract documents, the Contractor shall strictly follow the procedure provided for a differing site condition set forth in Sec 104. Any adjustment to the contract amount or time will only be those expressly permitted by the contract documents and only to the extent expressly provided in the contract documents. No contract adjustment will be determined, as to entitlement or amount on any basis other than under the contract as a differing site condition. Specifically, but not by way of limitation, the Contractor agrees that the Contractor will not be entitled to any contract adjustment arising from encountering an unexpected obstruction on the basis that, with respect to the obstruction, the County made: (1) a positive representation; (2) of a material fact; (3) which was false or incorrect; (4) as to which positive representation of material fact the Contractor lacked knowledge that the representation was false or incorrect; (5) upon which positive representation of material fact the Contractor asserts that the Contractor relied; and (6) was damaged as a direct result of the positive representation of material fact.

701.4.9 Lost Tools. Drilling tools lost in the excavation will not be considered obstructions and shall be promptly removed by the Contractor. All work required to remove lost tools or to perform associated corrective work, including but not limited to repair of hole degradation due to removal operations, will be noncompensable and any effect on time of performance nonexcusable.

701.4.10 Excavation Inspection.

701.4.10.1 Inspection Equipment. The Contractor shall maintain at the job at all times, all equipment suitable for use in the shaft inspection.

701.4.10.2 Removal of Excess Sediment and Water. Final shaft depth shall be measured with approved methods after final cleaning by airlift, or other method approved by the Engineer. Unless otherwise stated in the contract documents, a minimum of 50 percent of the base of each shaft shall have less than 1/2 inch of sediment at the time of concrete placement. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1 1/2 inches. For dry excavations, the maximum depth of water shall not exceed 3 inches prior to concrete pour. Shaft cleanliness will be verified by the Engineer for wet or dry shafts.

701.4.10.3 Video Camera Inspection. The primary means of inspecting a shaft excavation, steel casing and the rock socket shall be by video camera lowered into the shaft. The Contractor shall furnish all equipment necessary to
conduct the camera inspection. The Contractor shall operate the camera and supporting equipment under the direction of the Engineer in such a manner as to obtain optimum results from the equipment. The video camera and lighting equipment shall be capable of operating in dry or submerged conditions encountered during the inspection. The excavated shaft shall have the Engineer’s approval prior to proceeding with construction.

701.4.10.3.1 Equipment. Methods and equipment for controlling the camera will be subject to approval from the Engineer and achievement of a satisfactory video record.

701.4.10.3.2 Drawings. The Contractor shall submit layout drawings to the Engineer showing the relative position of all components of the video inspection system, including type and size of barge or other work area. The information submitted shall include a written description of the operating procedure in a step-by-step sequence and shall state the source of power.

701.4.10.3.3 Shaft Inspection. Inspection of a shaft by video camera shall be performed as directed by the Engineer. The excavated shaft, including the rock socket when applicable, shall be thoroughly cleaned of all loose fragments, sediment and turbidity prior to inspection. The camera shall be operated such that optimum clarity of detail can be obtained and all surface areas of the shaft, including the rock socket and the rock socket’s base, can be observed. All scanning of the rock surfaces shall be recorded. After completion of the inspection of a rock socket, the Engineer will direct whether or not drilling of the shaft shall be continued to a greater depth. Recordings shall be furnished to and shall become the property of the Engineer upon completion of the work.

701.4.11 Foundation Inspection. NX size cores will be required for drilled shafts with rock sockets, where NX refers to the nominal diameter of rock core, and the NX core barrel has a 2 1/8 inch inside diameter. At least 15 days prior to drilled shaft construction the Contractor shall drill one NX size core at the center of each rock socket to a depth of 10 feet or twice the diameter of the rock socket, whichever is greater, below the bottom of the rock socket. The Contractor shall use the foundation inspection hole to determine the amount of casing needed and casing ordered prior to foundation inspections holes is at the Contractor’s risk. The Contractor may be directed to extend the rock socket to a lower elevation, resulting from the Engineer’s evaluation of the foundation inspection cores.

701.4.11.1 Log of Excavated Material. The Contractor shall maintain a log of excavated material for each foundation inspection hole, and a rough draft of the logs shall be delivered to the Engineer within 24 hours of completion of the boring. A typed log prepared by a geologist or Engineer along with recommendations for the tip of casing shall be delivered to the Engineer within 5 days. The log shall include the following:

(a) The amount of NX cored per run and the amount recovered. All core loss shall be noted and explained. Clay layers shall be noted and located on the log by depth.

(b) The Rock Quality Designation (RQD) for the NX core. The bedding thickness and degree of weathering shall also be noted.

(c) One unconfined compression test per 5 feet of NX core, unless otherwise specified by the contract documents or directed by the Engineer, shall be run on samples of NX core from the rock socket. The results of these tests shall be delivered to the Engineer. The results of the unconfined compression tests shall be reported in units of kips per square foot (ksf). Any effect on time of performance resulting from delays in delivery of the above test results to the Engineer will be nonexcusable.

(d) Color photographs of the core.

701.4.11.2 Storage and Labeling of Rock Cores. Rock cores shall be stored in structurally sound core boxes and shall be protected from the elements. The core boxes shall be properly labeled to indicate location, depth, beginning elevation, Contractor and date, and shall be delivered to the Engineer.
701.4.12 Reinforcing Steel Cage Fabrication and Placement. The reinforcing steel cage, consisting of the longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, shall be completely assembled as a unit, and shall be placed immediately after the shaft excavation is inspected and accepted, and just prior to shaft concrete placement. Temporary internal cage stiffeners shall be removed as the cage is placed in the shaft such that interference with the placement of concrete does not occur.

701.4.12.1 Reinforcing Ties, Splices and Clearances. All reinforcing steel in the shaft shall be double-wire tied and supported such that the steel remains within the allowable tolerances specified herein during placement of concrete or casing removal. Splices shall be located as shown on the plans and in accordance with plan details. With approval from the Engineer, mechanical bar splices meeting the requirements specified in the contract documents may be used. Mechanical bar splices in adjacent bars shall be staggered not less than 30 inches apart. Welding of reinforcing steel will not be permitted. The reinforcing steel cage shall have sufficient rigidity to prevent racking or permanent deformations during delivery or installation.

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Concrete Cover</th>
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<tbody>
<tr>
<td>Uncased</td>
<td>Casing Remains</td>
</tr>
<tr>
<td>2'-0&quot; or less</td>
<td>3&quot;</td>
</tr>
<tr>
<td>3'-0&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>4'-0&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>5'-0&quot; or larger</td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

701.4.12.2 Spacers. Rolling spacers for reinforcing steel shall be used to minimize disturbance of the shaft sidewalls and to facilitate removal of the casing during concrete placement. Concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient intervals, near the bottom and along the shaft at intervals not exceeding 5 feet, to ensure concentric location of the cage within the shaft excavation. When the vertical steel is greater than one inch in diameter, the maximum spacing may be increased to 10 feet. As a minimum, a set of spacers shall be provided within 2 feet of both the top and bottom of the shaft. In addition, one set of spacers shall be provided at both 2 feet above and below each change in shaft diameter. Non-corrosive spacers shall be provided at a minimum of one spacer per 30 inches of circumference of cage with a minimum of three at each level to maintain the required reinforcement clearances. The spacers shall be of adequate dimension to maintain the specified clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

701.4.12.3 Bottom Supports. Approved non-corrosive bottom supports shall be provided for the reinforcing cage to ensure that the reinforcing is the correct distance above the bottom of shaft. The bottom supports shall not be used to support the weight of the cage. In the event that the shaft has been excavated below the anticipated tip elevation, the reinforcing cage shall be extended at the lower tip end by lap lengths for No. 11 bars or smaller or by use of mechanical connectors. Splices of adjacent bars will not need to be staggered in this situation and all of the reinforcing bars may be spliced at a given location. Reinforcement will not be required for the bottom 12 inches.

701.4.12.4 Durability of Spacers. Concrete spacers and bottom supports shall be constructed of concrete equal in quality and durability to the concrete specified for the shaft. Spacers fabricated from reinforcing steel shall be epoxy coated.

701.4.12.5 Protection of Reinforcing Cage. The reinforcing cage bottom supports shall be positioned such that the reinforcing steel is not allowed to come into contact with the soil or rock and to ensure that the bottom of the cage is maintained at the proper distance above the base as identified in the contract documents or directed by the Engineer.

701.4.12.6 Check of Tolerances for Placement of Reinforcing Cage. The elevation of the top of the reinforcing cage shall be checked before and after the concrete is placed. The reinforcing cage shall be maintained within the specified tolerances, and the Contractor shall make corrections to those tolerances, as required, to the satisfaction
of the Engineer. No additional shafts shall be constructed until the Contractor has modified the reinforcing cage support to obtain the required tolerances.

701.4.13 Concrete Placement.

701.4.13.1 General Considerations. Accumulations of water in casings and excess sediment at the base shall be removed as described herein before the concrete is placed. No concrete shall be placed until all casings, if used, within a 15 foot radius have been installed. Within the 15 foot radius, all driving or vibratory installation methods shall be discontinued until the concrete in the last shaft has set at least five days. Concrete placement shall begin as soon as possible after completion of the excavation, inspection and setting of the reinforcing cage, and shall proceed in a continuous operation from the bottom of the shaft to the plan construction joint or above as specified herein. An unplanned stoppage of work may require an emergency construction joint during the shaft construction.

701.4.13.1.1 Placement of Concrete in the Shaft. Concrete shall be placed for each shaft with the flow of concrete directed down the center of the shaft. Concrete shall be placed by free fall or through a tremie or concrete pump. The free fall placement method will only be permitted in dry holes when approved by the Engineer. The maximum height of free fall placement shall be 5 feet. Concrete placed by free fall shall fall directly to the base without contacting either the reinforcing cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

701.4.13.1.2 Extent of Concrete Placement. Concrete placement shall continue after the shaft is filled until good quality concrete, as determined by the Engineer, is evident at the plan construction joint at the top of the shaft and until a minimum of 18 inches of concrete, measured vertically, has been expelled. Immediately after concrete placement has been completed, all contaminated concrete and deleterious material accumulated above the top of shaft shall be removed to within one foot of plan top of shaft. Any concrete remaining above the top of shaft shall be carefully removed to the plan construction joint after curing and excess casing removal.

701.4.13.1.3 Time Limitations. The elapsed time from the beginning of concrete placement in the shaft to the completion of the placement shall not exceed two hours. All admixtures shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the two-hour placement limit. Prior to concrete placement, the Contractor shall provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets the two-hour requirement. The Contractor may request a longer placement time if a concrete mix is provided that will maintain a slump of 4 inches or greater over the longer placement time in the entire shaft as demonstrated by trial mix and slump loss tests. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures approved for site conditions.

701.4.13.1.4 Adequacy of Concrete Placement Method. Failure to demonstrate the adequacy of concrete placement methods or equipment during construction of any technique or production shafts will be cause for the Engineer to require appropriate alterations in equipment or methods by the Contractor to eliminate unsatisfactory results. Drilled shafts that are completed, but do not meet the concrete placement requirements, will be unacceptable. The Contractor shall correct all unacceptable completed shafts to the satisfaction of the Engineer at the Contractor’s expense.

701.4.13.2 Concrete Placement by Tremie. Tremies used to place concrete shall consist of a tube of sufficient length to discharge concrete at the shaft base elevation. The tremie shall have sufficient weight to rest on the shaft bottom before the start of concrete placement and to prevent curling of the tremie line during placement of the concrete. The tremie shall not contain aluminum parts that may come in contact with the concrete. A tremie shall consist of a watertight tube having an inside diameter of no less than 10 inches and fitted with a hopper at the top. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The tremie wall thickness shall be adequate to prevent crimping or sharp
bends that restrict concrete placement. Tremies used for depositing concrete in a dry drilled shaft excavation shall be supported such that the free fall of the concrete is less than 80 feet at all times.

701.4.13.2.1 Adjustment of Concrete Free Fall or Rate of Concrete Flow. If the free fall concrete causes the shaft excavation to cave or slough, the Contractor shall control the movement of concrete by reducing the free fall of the concrete or the rate of flow of concrete into the excavation. The Contractor shall be responsible for proposing, developing, and after approval from the Engineer, implementing corrective work.

701.4.13.2.2 Tremie Operation. Underwater placement of concrete shall not begin until the tremie is at the shaft base elevation. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall remain immersed as deep as practical in the concrete, but shall be no less than 5 feet at all times. The tremie shall be supported such as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be sealed closed at the start of work to prevent water from entering the tube before the tube is filled with concrete. After placement has started, the level of the concrete in the tremie shall be maintained above the level of slurry or water in the borehole at all times to prevent water or slurry intrusion into the shaft concrete. If water enters the tube after placement is started, the tremie shall be withdrawn, the discharge end resealed, and the placement restarted. The flow of concrete shall be continuous until the work is completed.

701.4.13.2.3 Removal of Tremie Orifice from Concrete. If at any time during the concrete pour, when using the wet construction method, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft will be considered defective. In such a case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall cleaning or overreaming as directed by the Engineer, and repour the shaft. Corrections made by the Contractor will be noncompensable and any effect on time of performance nonexcusable.

701.4.13.3 Concrete Placement by Pump. Concrete pumps and lines may be used for concrete placement by either the wet or dry construction method. All pump lines shall have a minimum diameter of 5 inches and shall be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation. For the wet construction method, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or shall be of a material that does not cause a defect in the shaft if the plug is not removed. The discharge orifice shall remain at least 5 feet below the surface of the fluid concrete. If at any time during the concrete pour the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft will be considered defective. In such a case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall cleaning or overreaming as directed by the Engineer, and repour the shaft. Corrections made by the Contractor will be noncompensable and any effect on time of performance nonexcusable.

701.4.13.4 Drop Chutes. Drop chutes may be used to direct placement of free fall concrete down the center of the shaft excavations where the maximum depth of water does not exceed one inch. The free fall method of placement shall not be used in wet excavations. Drop chutes shall be a smooth tube constructed either as a continuous one-piece unit or as removable sections. Aluminum drop chutes will not be permitted. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement. The drop chute shall be supported such that the free fall of the concrete measured from the bottom of the chute is less than 80 feet at all times.

701.4.14 Construction Joints. Unless otherwise approved by the Engineer, construction joints shall be made only where shown on the plans. All planned reinforcing steel shall extend uninterrupted through joints. Unless otherwise shown on the plans, horizontal joints may be constructed without keys. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and to intentionally
leave the surface in a roughened condition. Shear keys, if required, shall consist of formed depressions in the surface covering approximately one-third of the contact surface.

701.4.15 Concrete Protection and Curing. For at least 48 hours after shaft concrete has been placed, no construction operations that will cause soil movement adjacent to the shaft shall be conducted, except for movement of light construction equipment. Portions of drilled shafts exposed to a body of water shall be protected from the action of water by leaving the forms in place for at least seven days after concrete placement or until the shaft concrete reaches a minimum strength of 2500 psi. After placement, the temporarily exposed surfaces of the shaft concrete shall be cured to prevent loss of water by use of one or more of the approved methods. Curing shall be in accordance with Sec 502.

701.4.16 Construction Tolerances. During excavation of the shaft, the Contractor shall make frequent checks on the plumbness, alignment and dimensions of the shaft. Any deviation exceeding the allowable construction tolerances specified herein shall be corrected with a procedure approved by the Engineer. Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances will not be accepted. Correction methods shall be submitted by the Contractor for the Engineer’s approval. Drilled shaft construction shall not begin until approval has been obtained. When a shaft excavation is completed with unacceptable tolerances, the Contractor shall propose, develop and, after approval from the Engineer, implement corrective work. Redesign drawings and computations submitted by the Contractor shall be signed by a professional Engineer registered to practice in the State of Missouri. The following construction tolerances will apply to drilled shafts unless stated otherwise in the contract documents:

(a) Temporary casing diameters shall provide a final shaft diameter as shown on the plans. When approved by the Engineer, the Contractor may provide a larger casing at the Contractor’s expense.

(b) Shafts shall be constructed such that the center of the top of the shaft is within 3 inches of plan position in the horizontal plane at the plan elevation for the top of the shaft.

(c) The vertical alignment of a vertical shaft excavation shall not vary from the plan alignment by more than 1/4 inch per foot of depth. The alignment of a battered shaft excavation shall not vary by more than 1/2 inch per foot of the distance along the axis of the shaft from the prescribed batter.

(d) After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches above and no more than 3 inches below plan position.

(e) The top elevation of the shaft shall be no more than one inch above or 3 inches below the plan top of shaft elevation.

(f) The bottom of the shaft excavation shall be normal to the axis of the shaft within a tolerance of 3/8 inch per foot of shaft diameter.

701.4.17 Integrity Testing. The completed shaft shall be subjected to the specified testing methods, such as concrete coring or sonic logging testing, to determine the extent of any defects that may be present. Work and material required for testing shall be furnished by the Contractor and will be paid for in accordance with the contract documents. If testing reveals voids or discontinuities in the concrete that, as determined by the Engineer, indicate that the shaft is not structurally adequate, the shaft will be rejected. The Contractor shall then repair, replace or supplement the defective shaft in a method approved by the Engineer. The construction of additional drilled shafts shall be discontinued until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required by the Contractor as a result of shaft defects will be noncompensable and any effect on time of performance nonexcusable.
701.4.17.1 Concrete Coring. At locations where concrete coring is to be provided, as indicated in the contract documents or as directed by the Engineer, the following will apply. Upon completion of placing concrete and after waiting a minimum of 48 hours, the top surface of concrete shall be cleaned of laitance and any unsound concrete, and then one core hole shall be drilled completely through the shaft concrete and the rock socket to approximately one foot below the bottom of the rock socket of each shaft. Provisions for the inspection of the concrete surface shall be in accordance with the applicable requirements described herein. Core holes shall be drilled at locations specified by the Engineer. The holes shall be drilled to recover NX size cores. The core samples recovered shall be labeled as to the location from which the samples were taken. The samples shall be delivered to the Engineer for examination. If the cores indicate defective concrete in the shaft, which in the judgment of the Engineer impairs the strength of the completed shaft, the Contractor shall drill additional cores as directed by the Engineer. If the concrete is found to be defective, the Contractor shall submit to the Engineer in writing a proposal for correction, and those corrective procedures shall be approved by the Engineer before such corrective work is undertaken. The cored holes in non-defective concrete shall be filled with grout such that all voids are filled. All grout used for core holes shall be in accordance with Sec 1066. No direct payment will be made for grout and grouting.

701.4.17.2 Sonic Logging Testing. The Contractor shall perform non-destructive integrity testing on completed drilled shafts and rock sockets using the crosshole sonic logging (CSL) method for concrete drilled shafts. The tests shall be conducted as indicated on the plans or other contract documents, or as directed by the Engineer. Sonic logging measurements and data interpretation shall be performed by a CSL consultant with at least two years of experience in CSL drilled shaft testing. The Contractor shall submit the testing organization experience record to the Engineer, along with a written description of the testing procedures, operation manuals for the testing equipment, and samples of previous test results indicating both sound and defective concrete. The Contractor shall inform the Engineer of scheduled test dates at least seven days prior to CSL testing. The Contractor shall provide reasonable access to the shaft top for performance of the sonic logging testing.

701.4.17.2.1 Installation of Pipes. The Contractor shall furnish and install 2 inch nominal inside diameter steel pipes, ASTM A 53, Standard Weight, for use in sonic testing of each drilled shaft. Pipes shall be installed in each drilled shaft at the locations shown on the plans, as required by the testing agency or as directed by the Engineer. The pipes shall be sufficiently regular and free from defects to permit the free and unobstructed passage of the probes. The pipe shall be installed such that all internal joints are flush. Stiffening devices such as mandrels, tape or similar material to seal the joints shall not be used. Pipe shall be watertight with clean internal and external faces, the latter to ensure a good bond between the concrete and the pipes. The pipes shall be fitted with a screw-on watertight shoe and cap and shall be securely fixed to the interior of the reinforcement cage with a minimum cover of 3 inches from the shaft periphery. The pipes shall be as near to parallel as possible, equally spaced and vertical. Where several sections of pipe are required to reach the full length, joints shall be made watertight. The pipes shall be filled with water and plugged or capped before shaft concrete is poured. The upper end of the pipe shall not be left open after the pour. The pipes shall extend at least 3 feet above the top of the concrete in the shaft to compensate for water displaced by insertion and removal of the transmitter, receiver, and cable. For shafts with a rock socket, the lower end of the pipes shall extend to the bottom of the rock socket. Care shall be taken during the drilled shaft concrete pour to not damage the pipes. If a tremie is used, the tremie shall not be permitted to rest on top of the pipes during the pour. After completion of the sonic logging and final acceptance of the drilled shaft, the Contractor shall fill the access pipes with grout.

701.4.17.2.2 Sonic Logging Equipment. The sonic logging equipment furnished by the CSL consultant shall consist of all necessary supplies, support equipment and power to perform the sonic logging testing requirements as described herein.

701.4.17.2.3 Sonic Logging Test Procedure. The drilled shaft shall be tested between 2 and 40 days after concrete placement. The following procedures shall apply:

(a) Pipes shall be checked to ensure the pipes are free from blockages and are filled with water any addition of water shall be noted and reported.
(b) Levels shall be taken on top of each pipe, each pipe shall be plumbed and the length shall be recorded.

(c) Testing shall be performed between each pair of adjacent pipes around the shaft perimeter and also in pairing combinations between each pipe with all other pipes in the shaft. If concrete coring is performed to confirm the nature of an anomaly identified during CSL testing, a subsequent CSL survey shall be performed using the concrete core hole(s) and the CSL access pipes.

(d) All tests shall be carried out with the probes in the same horizontal plane unless the Engineer directs that defects be further evaluated with the probes on different horizontal planes.

(e) The probes shall be raised simultaneously from the bottom of the pipes ensuring that all slack is taken out of the cables before the analyzer is switched on, and that the distance between transducers remains constant during the course of the test. The speed of ascent shall be less than 12 inches per second. Measurements shall be taken at 3 inch intervals or less. Anomalies indicated by reduced velocity in the drilled shaft concrete and significantly lower energy shall be reported. If anomalies are detected, additional tests with two or more sources per receiver with vertical offsets of greater than or equal to 20 inches may be conducted at the request of the Engineer between the same tubes unless the anomaly is within 20 inches of the bottom of the shaft.

(f) The Contractor shall provide accurate measurements of probe depths on the logs.

701.4.17.2.4 Record of Testing. Preliminary results of the testing shall be provided on site prior to the CSL consultant leaving the site. A detailed CSL report and test data shall be submitted to the Engineer within seven days. The CSL report shall be signed and sealed by a Professional Engineer. The CSL report shall include, but is not limited to, the following: project identification and dates of testing, a table and schematic showing shafts tested with accurate identification of tube coordinates and collar elevation, name of personnel that performed the tests and interpretation and those personnel’s affiliation, equipment used, data logs, interpretation, analysis, and results. The data logs shall include XY plots of FAT, amplitude and velocity versus depth. CSL data shall be processed to provide easy to understand 2D cross-sections between tubes for all tube pair combinations. These plots shall be annotated by the CSL consultant as appropriate to delineate anomalous results. If offset surveys are performed as part of 3D tomography, data plots shall include 3D volumetric images for the entire shaft, color-coded, to indicate velocity variations along the shaft. Locations and geometry of anomalies or unconsolidated zones shall be identified in 3D color images with detailed discussion. The results for CSL and 3D surveys shall be based on the percentage decrease in velocity as correlated to the following Concrete Condition Rating Criteria (CCRC). The velocity datum of good concrete shall be established by averaging the velocities in the good concrete along the drilled shaft. Deviations from the velocity datum shall be used for determining the Concrete Condition Rating.

<table>
<thead>
<tr>
<th>Concrete Condition Rating</th>
<th>Rating Symbol</th>
<th>Velocity Reduction</th>
<th>Indicative Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>G</td>
<td>0 to 10%</td>
<td>Acceptable concrete</td>
</tr>
<tr>
<td>Questionable</td>
<td>Q</td>
<td>10% to 25%</td>
<td>Minor concrete contamination or intrusion. Questionable quality concrete.</td>
</tr>
<tr>
<td>Poor</td>
<td>P/D</td>
<td>&gt; 25%</td>
<td>Defects exist, possible water slurry contamination, soil intrusion, and or poor quality concrete.</td>
</tr>
<tr>
<td>Water</td>
<td>W</td>
<td>V= 4760 to 5005 ft/sec</td>
<td>Water intrusion, or water filled gravel intrusion with few or no fines present.</td>
</tr>
<tr>
<td>No Signal</td>
<td>NS</td>
<td>No signal received</td>
<td>Soil intrusion or other severe defect absorbed the signal, tube debonding if near top.</td>
</tr>
</tbody>
</table>
701.4.17.2.5 **Correction of Unacceptable Results.** The Contractor shall immediately inform the Engineer of any suspected anomalies, honeycombing or poor concrete quality detected by testing. The Contractor and CSL consultant shall duly perform further tests as directed by the Engineer to evaluate the extent of any detected anomalies. Core drilling, or other investigative methods as approved by the Engineer, shall be performed to further investigate the anomaly. If a defect is confirmed, the Contractor shall bear all costs involved with the shaft coring, grouting and remediation. Within 14 days of the completion of testing, the Contractor shall provide a report signed and sealed by a Professional Engineer registered in the State of Missouri providing the results of the additional investigations and recommendations to accept or repair the shaft. The report shall also contain recommendations for modification of construction procedures to prevent defects for subsequent shaft installations. The dates of the completion of drilling, cleaning, steel placement and concrete pour shall also be provided. Construction above the top of shaft shall not be performed until the shaft has been accepted by the Engineer.

701.5 **Drilled Shaft Load Tests.** All load tests, when required by the contract documents, shall be completed and submitted to the Engineer for review and approval before construction of any production drilled shafts. The locations of load test shafts, the maximum loads to be applied, the test equipment to be furnished by the Contractor, and the actual sequence of the load testing shall be as shown on the plans or as specified in the contract documents. After completion of testing, test shafts not used as production shafts shall be cut off at an elevation 3 feet below the finished ground line. The portion of shafts cut off shall be disposed of by the Contractor, at the Contractor’s expense, in a manner approved by the Engineer.

701.6 **Method of Measurement.**

701.6.1 **Drilled Shaft.** Accepted drilled shafts will be measured for payment to the nearest 0.10 linear foot of length along the axis of each shaft complete-in-place. For shafts without a rock socket, measurement will be from the plan top of the shaft elevation to the bottom of the shaft. For shafts with a rock socket, measurement will be from the plan top of the shaft to the top of the rock socket. “Top of the rock socket” will be defined as the upper elevation at which sound rock occurs across the entire width of the shaft, as determined by the Engineer. Reinforcing steel will be measured for payment in accordance with Sec 706.

701.6.2 **Rock Socket.** The accepted rock sockets, if required, will be measured for payment to the nearest 0.10 linear foot of length along the axis of each rock socket in-place from the top of sound rock elevation, as determined by the Engineer and in accordance with Sec 701.6.1, to the bottom of the rock socket as built. In the event that additional rock socket construction is directed by the Engineer, the additional length will be measured to the nearest 0.10 linear foot. Reinforcing steel will be measured for payment in accordance with Sec 706.

701.6.3 **Technique Shafts.** Accepted technique shafts, if required, will be measured for payment to the nearest 0.10 linear foot of length along the axis of each shaft in-place from the plan top of the shaft elevation to the bottom of the rock socket or shaft as built for each size of acceptable technique shaft drilled, including rock socket. Reinforcing steel will be measured for payment in accordance with Sec 706.

701.6.4 **Video Camera Inspection.** Video camera inspection, as required, will be measured for payment per each.

701.6.5 **Foundation Inspection Holes.** Measurement for payment for foundation inspection holes will be to the nearest 0.10 linear foot of length along the axis of each hole by the linear foot. For shafts designed in side friction, measurement will be from the top of the rock socket to the bottom of the foundation inspection hole. For shafts designed in end bearing, measurement will be from the bottom of the rock socket to the bottom of the foundation inspection hole. If the Engineer directs foundation inspection borings more than 10 feet below the anticipated bottom of the rock socket elevation as shown on the plans, measurement for payment for that portion of the boring in excess of 10 feet below anticipated bottom of the rock socket elevation as shown on the plans will be to the nearest 0.10 linear foot of excess.
701.6.6 Concrete Coring. Measurement for payment for concrete cores will be to the nearest 0.10 linear foot of length along the axis of the shaft from the top of concrete to a point as determined by the Engineer, and may extend the entire length of the shaft plus one foot below the bottom of the rock socket.

701.6.7 Sonic Logging Testing. Sonic logging testing of drilled shafts, as required, will be measured for payment per each.

701.6.8 Drilled Shaft Load Tests. Load tests will be measured for payment per each load test performed.

701.7 Basis of Payment.

701.7.1 Drilled Shaft. Payment will be considered full compensation for all steel casing required, costs of drilling, excavation, slurry, cleaning, an acceptable method of inspection as required, furnishing and placing concrete, grouting and incidental work and material required by the contract documents. Payment for any drilled shaft installed and accepted will be at the contract unit price per linear foot for the diameter of the drilled shafts specified, irrespective of the character of the material actually encountered during excavation. No additional compensation will be made for concrete required to fill an oversized casing or for oversized excavation. If the method of construction requires that drilled shaft casing be seated into the sound rock such that the bottom of the casing is below the determined top of sound rock elevation, payment for excavation below the top of the sound rock layer (top of the rock socket) will be included in the payment for the rock socket. If sound rock is encountered within the excavation at which point a rock auger, core barrel or other rock-removing specialty tool must be used by the Contractor before the top of the sound rock elevation to be used as “top of the rock socket” is confirmed by the Engineer, that work will be paid for as rock socket excavation. Payment for reinforcing steel will be in accordance with Sec 706.

701.7.2 Rock Socket. Payment will be considered full compensation for drilling, excavation, slurry, cleaning, dewatering, an acceptable method of inspection as required, furnishing and placing concrete, and incidental work and material according to the contract documents. For payment purposes the length of any rock socket installed and accepted shall be paid for at the contract unit price per linear foot for the diameter of the rock socket specified, irrespective of the character of the material actually encountered during excavation. In the event that the Engineer orders additional rock socket construction, payment for the additional length will be at the rate of 150 percent of the contract unit price per linear foot of rock socket up to a maximum additional length of 8 feet. Any work necessary to extend the length of the rock socket more than the additional 8 feet will be paid for as changes in the work in accordance with Sec 104.3. Payment at the adjusted rate will be considered full compensation for the additional excavation into rock, all additional concrete, except reinforcing steel, including any and all splices, and all incidentals necessary to complete the work down to the elevation designated by the Engineer. Reinforcing steel will be paid for in accordance with Sec 706.

701.7.3 Technique Shafts. Payment for technique shafts will be in accordance with the contract unit prices for the appropriate drilled shaft and rock socket diameters. Payment will be considered full compensation for any steel casing required, all costs of drilling, excavation, an acceptable method of inspection as required, furnishing and placing concrete, grouting and incidental work, and material necessary to satisfactorily construct the technique shafts according to the contract documents. Reinforcing steel will be paid for in accordance with Sec 706.

701.7.4 Unexpected Obstructions. Contract adjustment, in time or amount, resulting from encountering any obstructions in the work covered by Sec 701 will be made only if the obstruction constitutes a differing site condition, as defined by the contract. Contract adjustments will be determined only under the terms of the contract for adjustments in time or compensation due to encountering a differing site condition. Contract adjustments will be allowed only to the extent, in type and amount of contract adjustment, that such adjustment is expressly allowed for or permitted by the contract documents, specifically:

(1) Sec 109.4 through Sec 109.4.3 for cost adjustment; and
(2) See 108.14 to determine any adjustment in contract time.

701.7.5 Video Camera Inspection. Payment for one complete video camera inspection of each shaft, including the rock socket when applicable, will be paid at the contract unit price. Any additional video camera inspections required by the Engineer due to extending the rock socket to a greater depth will be paid for at the contract unit price for video camera inspection. Payment for video camera inspection will be considered full compensation for moving in equipment, flushing turbid water from the shaft, conducting the actual scanning as specified, furnishing video recording, removing equipment, and all tools, labor and any incidentals necessary to complete the work.

701.7.6 Foundation Inspection Holes. Payment for foundation inspection holes will be at the contract unit price and will be considered full compensation for drilling or coring the holes, extracting and packaging the samples or cores, laboratory testing, delivering the samples or cores to the specified St. Charles County location and for all other expenses necessary to complete the work. If the Engineer directs foundation inspection borings more than 10 feet or twice the diameter of the rock socket, whichever is greater, below the anticipated bottom of rock socket elevation as shown on the plans, payment for that portion of the boring in excess of 10 feet or twice the diameter of the rock socket, whichever is greater, below the anticipated bottom of the rock socket elevation as shown on the plans will be at the rate of 150 percent of the contract price per linear foot of excess.

701.7.7 Concrete Coring. Payment for concrete coring will be considered full compensation for all material, labor, tools, equipment, grouting and incidentals necessary to complete the work. The number of feet of cored holes may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation. When concrete coring has not been setup as a contract item and is eligible for payment, payment for concrete coring will be made per foot at the fixed contract unit price specified in Sec 109.

701.7.8 Sonic Logging Testing. Payment for sonic logging testing of drilled shafts as required by the Engineer will be made at the contract unit price per each for sonic logging testing. No payment will be made for supplementary sonic logging testing to evaluate defects. Payment for sonic logging testing will be considered full compensation for providing all equipment, access pipes, conducting the actual probing measurements as specified, furnishing reports, removing equipment, and all tools, labor and any incidentals necessary to complete the work. The number of sonic logging inspections may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation.

701.7.9 Drilled Shaft Load Tests. Payment will be at the contract unit price and will be considered full compensation for all costs related to the performance of the load tests as specified by the contract documents.

701.7.10 Welding Inspection. If evidence of poor welding is found, radiographing or other non-destructive testing of welds required by the Engineer will be noncompensable and any effect on time of performance nonexcusable.
SECTION 702
LOAD-BEARING PILES

702.1 Description. This work shall consist of furnishing and driving concrete and steel load-bearing piles to the minimum nominal axial compressive resistance and penetration required, at the location shown on the plans.

702.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section/ Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
<tr>
<td>Cast-In-Place Pile Shells (Thick Shell Type) Welded or Seamless Steel Pipe</td>
<td>ASTM A 252 Grade 3</td>
</tr>
<tr>
<td>Closure Plates</td>
<td>AASHTO M 270, Grade 50</td>
</tr>
<tr>
<td>Structural Steel Pile</td>
<td>AASHTO M 270, Grade 50S</td>
</tr>
<tr>
<td>Fluted Pipe</td>
<td>SAE-1010 or SAE-1015</td>
</tr>
<tr>
<td>Forged Steel Tips or Noses</td>
<td>SAE-1020</td>
</tr>
<tr>
<td>Pile Point Reinforcement</td>
<td>ASTM A 27, Grade 65-35</td>
</tr>
<tr>
<td></td>
<td>or ASTM A 148, Grade 90-60</td>
</tr>
<tr>
<td>Galvanizing</td>
<td>1081, ASTM A 123</td>
</tr>
<tr>
<td>Field Galvanizing and Galvanizing Repair</td>
<td>ASTM A 780*</td>
</tr>
</tbody>
</table>

*Zinc rich paints will not be allowed.

702.2.1 Cast-In-Place (CIP) Concrete Piles. Cast-in-place concrete piles shall consist of Class B-1 concrete cast in pre-driven steel shells. The steel shells shall be in accordance with the shape, size and minimum shell thickness shown on the plans, or to an approved equivalent section. All material, proportioning, air-entraining, mixing, slump and transporting of concrete shall be in accordance with Sec 501. Steel shells shall be free from water, soil and other deleterious matter when concrete is cast in the shells.

702.2.2 Structural Steel (HP) Piles. Structural steel piles shall be of the size, weight and structural shape shown on the plans. Piles shall not have a camber or sweep in excess of 1/8 inch multiplied by the length of pile in feet divided by five. Structural steel piles shall be stored such that damage to the piling does not occur.

702.2.3 Pile Point Reinforcement. Pile point reinforcement shall be furnished and installed on load-bearing piles at locations shown on the plans. Pile point reinforcement for steel piles shall be furnished and installed in accordance with Sec 1080, except as modified herein.

702.2.4 Pile Length. The Contractor shall be fully responsible for the lengths the Contractor furnishes for driving to obtain the specified minimum nominal axial compressive resistance and penetration. The pile lengths shown on the plans shall be considered approximate lengths.

702.2.5 Probe Piles. Probe piles shall be of the same material and size as the permanent piles. Probe piles shall be of such length as to permit driving the tips to an elevation 10 feet below that indicated by plan lengths. Probe piles used as permanent piles in place shall conform to Sec 702.4.1.

702.2.6 Certification. For structural steel piles and shells for cast-in-place piles, the Contractor shall furnish two copies of a certification from the pile manufacturer or fabricator setting out the designated specification with which the material furnished complies.

702.3 Equipment.
702.3.1 Driving Equipment. Piles shall be driven with power-driven hammers, or by a combination of power-driven hammer and water jets. Power-driven hammers will be defined as hammers operated by steam, air or diesel power. For determining the energy per blow of diesel power hammers without a fully enclosed ram, the manufacturer's energy rating for the hammer will apply and may be assumed equal to the ram weight times the stroke. If the Contractor desires to check a diesel power hammer against an approved steam hammer on a specified type of pile at a particular site, the Contractor may do so at the Contractor’s expense, and the checked rating of the diesel-powered hammer will be used in determination of pile nominal axial compressive resistances at that site. Diesel hammers that have a fully enclosed ram shall be equipped with a gauge and accompanying charts which evaluate the equivalent manufacturer’s rated energy being produced under any driving condition.

702.3.2 Leads. Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and leads shall be held in position by guys or stiffener braces to ensure support to the pile during driving. Inclined leads shall be used for the driving of battered piles.

702.3.3 Followers. Followers may be used in driving piles only if approved in writing by the Engineer. If a follower is used, one pile of every group of ten shall be driven without a follower to determine the available nominal axial compressive resistance of the group.

702.3.4 Water Jets. Water jets used to aid in driving piles shall be sufficient in number to deliver a volume and pressure of water at the jet nozzles that will freely erode the material adjacent to the pile. The use of water jets shall be discontinued before the final penetration is reached, and piles shall be driven to secure a final penetration of no less than 2 feet if the nature of the soil permits.

702.3.5 Hammer Energy. The Contractor is responsible for determining the hammer energy required to successfully drive the pile to the minimum tip elevation and to reach the minimum nominal axial compressive resistance specified on the plans. When specified in the contract documents, the Contractor shall perform a drivability analysis to select an appropriate hammer size to ensure the pile can be driven without overstressing the pile and to prevent refusal of the pile prior to reaching the minimum tip elevation. The Contractor shall plan pile driving activities and submit hammer size and hammer energy requirements to the Engineer for approval before driving.

702.4 Construction Requirements.

702.4.1 Probe Piles. The Contractor shall furnish and drive probe piles at locations specified. Where required, probe piles shall be driven to refusal or to a capacity 50 percent greater than that shown on the plans. In all cases, probe piles shall be driven to at least the minimum tip elevation shown on the plans for permanent piles. If no minimum tip elevation is shown on the plans, piles shall have a tip elevation at least 10 feet below the bottom of the supported footing or 10 feet below the natural ground line, whichever is lower, unless specifically authorized otherwise by the Engineer. Probe piles shall be driven with the same type of equipment as will be used for driving the permanent piles. Before driving probe piles, the excavation shall be completed to an elevation no more than 2 feet above the proposed grade at the point where a probe pile is to be driven. Probe piles not driven in a permanent location shall be cut off, or pulled and backfilled as approved by the Engineer.

702.4.2 Load-Bearing Piles. Load-bearing piles shall not be driven until after the excavation for the footing has been substantially completed. The heads of piles shall be protected against damage during driving. The procedure incident to the driving of piles shall not subject piles to excessive and undue abuse. Steel shells and structural steel piles shall hold the original form without distortion after being driven and after adjacent piles have been driven. Any load-bearing pile broken or damaged by reason of internal defects, by improper driving, or driven outside of the pile’s proper location, shall be removed and replaced, or a second adjacent pile may be driven if this can be done without detriment to the structure, as determined by the Engineer.
702.4.3 **Preboring.** Where piles are to be driven through more than 5 feet of compacted embankment that has been in place for less than five years, holes shall be prebored entirely through the embankment to the lowest elevation of the natural ground line adjacent to the embankment, or as shown on the plans. The holes shall have a diameter no less than that of the pile. After the pile is placed in the hole and before driving begins, the space remaining around the pile shall be filled with sand or other approved material before and maintained full during the driving of the pile.

702.4.3.1 Other locations where preboring for piles will be required will be shown on the plans. At such locations, holes shall be prebored to the elevation specified prior to pile placement. The holes shall have a diameter no less than that of the pile and shall be large enough to avoid damage to the pile being driven through the hole in hard material. The size of the hole shall be approved by the Engineer before preboring is started. Pilot holes of lesser diameter than the pile shall not extend below the pile tip. For holes not prebored into hard rock, the hole shall be filled with sand or other approved materials prior to or after placement of the pile. For holes prebored into hard rock, the hole shall be filled with sand or other approved materials prior to placement of the pile. At all locations, the hole shall be maintained full with sand or other approved material during the driving of the pile. The pile shall then be driven in accordance with Sec 702.4.11.

702.4.4 **Pile Placement Tolerances.** Final position of piles shall be no more than 1/4 inch per foot from the vertical or from the batter line shown on the plans. The maximum variation of the head of the pile from the position shown on the plans shall be no more than 2 inches, except that piles in footings entirely below the finished ground line may not vary more than 6 inches. All piles forced upward by the driving of adjacent piles or by any other cause shall be redriven to the required minimum nominal axial compressive resistance and penetration.

702.4.5 **Pile Point Reinforcement.** Each point shall be manufactured in one piece of cast steel. Pile points furnished for cast-in-place concrete piles shall be attached to the pile as shown on the plans. Pile points for structural steel piles shall be furnished with the minimum point web and flange thickness at the location of attachment to the pile equal to the thickness of that portion of the pile being attached thereto multiplied by the factor (t) shown below with additional requirements as described herein.

<table>
<thead>
<tr>
<th>Material</th>
<th>(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A 27 Grade 65-35</td>
<td>2.0</td>
</tr>
<tr>
<td>ASTM A 148 Grade 90-60</td>
<td>1.6</td>
</tr>
</tbody>
</table>

702.4.5.1 The point shall extend onto the pile a minimum of 1/2 inch for both faces of the web and for the end one-fourth of the inside face of each flange.

702.4.5.2 The web portion of the point shall protrude a minimum of 0.2 times the flange width below the pile with the flange portion of the pile point transitioning to a protrusion depth of no less than the pile point flange thickness at the extreme ends.

702.4.5.3 The point shall be attached to the pile with a full penetration weld along each flange. Weld backing shall be furnished for the total width of each flange.

702.4.5.4 The point extension onto the web of the pile may be omitted if alternating 1 1/2 inch x 1/4 inch fillet welds are placed on each side of the web.

702.4.5.5 Welding of the point to the pile shall be by a St. Charles County-certified welder. Properly dried low hydrogen electrodes of the E70XX series shall be used with adequate protection from the elements in accordance with Sec 1080. The Contractor shall be fully responsible for the adequacy of welds during driving.
702.4.6 Splices. Full length piles shall be driven wherever possible and practical. If extensions and splices are permitted or required by the Engineer, all welding, including splicing of steel shells and structural steel piles, and support or reinforcing angles welded to steel piles, shall be in accordance with Sec 1080 and performed by a St. Charles County-certified field welder using properly dried low-hydrogen E7018 electrodes that have been protected from the elements to maintain the dry condition. Steel shells for cast-in-place concrete piles shall be spliced as shown on the plans. Structural steel piles shall be spliced with a butt joint as shown on the plans. The Contractor may furnish lengths of steel shells that incorporate no more than one splice per pile or structural steel piles that incorporate no more than one splice per pile for lengths up to and including 40 feet. No more than two splices will be permitted in each structural steel pile furnished for lengths exceeding 40 feet. In preparation of piles prior to driving, the use of individual sections less than 8 feet long will not be permitted. Additional field splices necessary to extend structural steel piles or steel shells to reach adequate bearing material shall be limited to one per pile, unless authorized by the Engineer.

702.4.7 Cut-Offs. The tops of all piles shall be cut off square at cut-off elevations.

702.4.8 Protective Coatings.

702.4.8.1 Bitumen and Paint. Before the coatings are applied, steel shall be thoroughly cleaned. A commercially available bituminous coating, as approved by the Engineer, shall be applied heavily to steel shells and structural steel piles in end bents for a length of 3 feet below the bottom of the concrete cap. All exposed steel piles shall have a bituminous coating 3 feet below and one foot above the finished ground line. Unless otherwise specified in the contract documents, all other exposed surfaces of steel shells and structural steel piles, including bracing, shall be coated with one 6-mil thickness of an approved gray epoxy mastic in accordance with the epoxy mastic manufacturer’s recommendations. Protective coatings will not be required below the normal low water line or for galvanized piles and bracing.

702.4.8.2 Galvanizing. Steel shells for cast-in-place piles, structural steel piles, and structural steel bracing shall be galvanized as shown on the plans and in accordance with this specification. All pile below the pile concrete encasement shall be galvanized down to an elevation as shown on the plans. At the Contractor’s option, the entire pile length may be galvanized. Repairs to the galvanized coating and field galvanizing shall be in accordance with this specification. Repairs and field galvanizing will not be required where the pile will be encased in concrete or below the limits specified herein. Galvanizing material shall be omitted or removed one inch clear of weld locations. The method used to omit or remove the galvanizing material shall be masking, grinding or other methods as approved by the Engineer. If a weld location falls within an area where galvanizing is required, clean the weld area making sure to remove all welding slag. Then field galvanize the weld area in accordance with this specification.

702.4.8.3 Bitumen and paint protective coatings will not be required for galvanized piles and bracing.

702.4.9 Time Restrictions. Concrete footings shall not be placed on cast-in-place piles until at least 12 hours after the last pile in the footing has been cast. No piling shall be driven within a radius of 20 feet of concrete that has not attained a minimum compressive strength of 1,500 psi. Compressive strength will be determined by tests performed in accordance with approved methods.

702.4.10 FHWA-modified Gates Dynamic Pile Formula. The following formula shall be used to determine the nominal axial compressive resistance, \( P \), of piles when other methods of determination are not specified in the contract documents:

\[
P = 1.75E^{0.5} \log_{10}(10N) - 100
\]

\( P \) = Nominal Axial Compressive Resistance measured during pile driving in kips
E = Developed hammer energy in foot-pounds (Joules). This is the kinetic energy in the ram at impact for a given blow and may be assumed equal to the ram weight times the stroke.

N = Number of hammer blows for 1.0 inch of pile permanent set in blows/inch.

702.4.10.1 The above formulas will be applicable only if:

(a) The hammer has an unrestricted fall.

(b) The pile head is not broomed, crushed or splintered.

(c) There is no appreciable bounce of the hammer after striking the pile.

(d) The penetration is at a uniform or uniformly decreasing rate.

702.4.10.2 For piles driven to a batter, the nominal axial compressive resistance, P, in the equations provided in Sec 702.4.10 shall be divided by the pile batter factor, B, in order to calculate the value of N, the number of hammer blows for 1.0 inch of pile permanent set.

\[ B = 0.1 \left( 10^{-m} \right) \left( 1 + m^2 \right) \]

\[ m = \text{the tangent of the angle of batter to a vertical line} \]

702.4.11 Minimum and Maximum Limits of Pile Driving. Piles shall be driven to at least the minimum tip elevation indicated on the plans. If no minimum tip elevation is shown on the plans, piles shall have a tip elevation at least 10 feet below the bottom of the supported footing or 10 feet below the natural ground line, whichever is lower, unless specifically authorized otherwise by the Engineer. Piles shall be driven to attain a nominal axial compressive resistance determined in accordance with Sec 702.4.10 and no less than that shown on the plans as the minimum nominal axial compressive resistance.

702.4.11.1 Pile Driving to Hard Rock. Prior to driving structural steel piles, the Contractor shall review the boring logs to determine the depth at which rock may be anticipated. The Contractor shall be attentive to the physical conditions associated with pile refusal on hard rock. When indication of hard rock occurs, in no case shall the pile be driven more than 3 blows when the hammer is operating at maximum rated energy and the penetration per blow is equivalent to or less than 10 blows per 0.5 inch. Driving shall cease immediately to avoid damage to the pile and to reduce the risk of injury.

702.5 Method of Measurement.

702.5.1 Probe Piles. Probe piles will be measured to the nearest linear foot of pile authorized and driven. For galvanized pile, no separate measurement will be made for the part of the pile that is not galvanized.

702.5.2 Load-Bearing Piles. Piles in place will be the actual length of all piles, except probe piles, measured to the nearest foot for that portion of each pile that remains permanently in the structure. For galvanized pile, no separate measurement will be made for the part of the pile that is not galvanized.

702.5.3 Preboring. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement of prebored holes required under the provisions of Sec 702.4.3 will be made to the nearest linear foot of each hole specified or directed by the Engineer. The revision or correction will be computed and added to or deducted from the contract quantity.
702.5.4 Pile Point Reinforcement. Pile point reinforcement will be measured per each.

702.6 Basis of Payment.

702.6.1 Probe Piles. Probe piles will be paid for at the contract unit price. Probe piles, if driven and used as permanent piles in place, will be paid for as probe piles, and not as load-bearing piles in place.

702.6.2 Load-Bearing Pile. The accepted quantity of load-bearing pile in place will be paid for at the contract unit price for each of the items included in the contract. No direct payment will be made for incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

702.6.3 Pile Cut-Offs. No direct payment will be made for pile cut-offs.

702.6.4 Preboring. Preboring will be paid for at the contract unit price. No direct payment will be made for backfilling.

702.6.5 Pile Point Reinforcement. Pile point reinforcement, where specified, will be paid for at the contract unit price per each.

702.6.6 Splices. Splices may be required to extend a structural steel or steel shell pile to reach the minimum nominal axial compressive resistance. Any splices authorized to achieve the minimum nominal axial compressive resistance will be paid for as an additional 8 feet of pile in place at the contract unit price.

702.6.7 Protective Coatings. No direct payment will be made for coating exposed surfaces of steel shells and structural steel piles. Galvanized bracing in place will be paid for at the contract unit price for miscellaneous fabricated structural steel. Payment for coating the structural steel piles as described herein, and all material, excavation, labor, tools, equipment and incidentals necessary to complete the protective coating items will be considered completely covered under the contract unit price for other items.
SECTION 703
CONCRETE MASONRY CONSTRUCTION

703.1 Description. This work shall consist of constructing culverts, bridges and other concrete structures as shown on the plans or as directed by the Engineer.

703.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing Pads for Structures</td>
<td>1038</td>
</tr>
<tr>
<td>Concrete Sealer</td>
<td>1053</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Precast Concrete Box Culverts</td>
<td>1049</td>
</tr>
</tbody>
</table>

703.2.1 Concrete Requirements. All material, proportioning, air-entraining, mixing, slump and transporting of Portland cement concrete shall be in accordance with Sec 501.

703.2.2 Material Source Changes. Changes in sources of cement and aggregate will be permitted only with written approval from the Engineer. Aggregate of essentially the same characteristics, except as noted in Sec 1005, and cements resulting in concrete of the same color, shall be used in any individual unit of the structure. The superstructure will be considered an individual unit of the structure unless otherwise shown on the plans.

703.3 Construction Requirements.

703.3.1 Falsework. Falsework for concrete masonry construction shall be adequate to support and hold the forms true to lines, camber and grades shown on the plans. If requested by the Engineer, the Contractor shall submit detailed plans for falsework, including the supporting design computations. The Engineer's acceptance of the plans will not relieve the Contractor of the responsibility for obtaining satisfactory results. The falsework shall be constructed in general accordance with the submitted plans. Falsework and forms for single and multispans concrete frames and for continuous concrete slab and girder-type bridges shall be provided for the full length of each continuous or monolithic unit and for the full width of the structure before starting concrete placement in that unit. The use of shims or blocking shall be held to a minimum. Jacks shall be placed at approved locations to secure and maintain the required camber. Means shall be provided by the Contractor for accurately determining settlement of the falsework while the falsework is being loaded. The Contractor shall correct for any settlement of forms or falsework during the concrete placing process.

703.3.2 Forms. Forms for concrete shall be built true to the lines and grades specified, and shall be mortar-tight and of sound material adequate to prevent distortion during the placing and curing of concrete. All concrete shall be formed unless otherwise specified. A concrete pad of approved thickness may be used as a form for the unexposed bottom of end bent beams on piles. If required by the Engineer, formwork plans shall be submitted by the Contractor before formwork is started. If during or after placing the concrete the forms sag or bulge, the affected concrete shall be removed, the forms realigned and new concrete placed. Construction camber to accommodate shrinkage or settlement impairing the strength of the structure by the reduction of depth will not be permitted. The forms shall be designed for following minimum criteria: a fluid pressure of 150 pounds per cubic foot, and for a live load of 50 pounds per square foot on horizontal surfaces and 30 pounds per square foot on vertical surfaces for impact and vibration.

703.3.2.1 Face lumber of forms for exposed surfaces of concrete shall have a smooth dressed surface free of loose knots, knotholes and other defects. The spacing of supports and the thickness of face lumber shall be adequate to prevent distortion due to the pressure of the concrete. Form material shall be placed with horizontal joints.
Triangular moulding, smooth on three sides and having a 3/4 inch width on each of the two form sides, shall be used to bevel all exposed edges of the structure, except where special bevels are shown on the plans.

703.3.2.2 Forms reused shall be in good condition. Form lumber which is unsatisfactory in any respect shall not be used.

703.3.2.3 Design and construction of forms shall permit the removal of the forms without damage to the concrete. Coffer dam braces or struts that will extend through any exposed concrete section will not be permitted. Forms under copings and around offsets may be given a draft of no more than one inch per foot to permit removal without damage to the concrete. For narrow walls where access to the bottoms of the forms is not otherwise obtainable, an opening shall be provided to allow chips, dirt, sawdust or other foreign material to be removed immediately prior to placing concrete.

703.3.2.3.1 Deck Forming Hardware. Material utilized in supporting or securing falsework or forms for bridge decks must be constructed as to be held in place independently of the shear connectors or deck reinforcing steel. Any deck supporting hardware to remain embedded in the deck or haunch area must be so constructed as to allow for removal to a depth of 1 inch for patching. Also, all hardware that remains in the concrete shall be epoxy coated or galvanized. Where blocking or wedges are required to secure or support forms or brackets, they must form an integral part of the unit and must be securely attached to the form or bracket.

703.3.2.4 Form lining will be permitted, and will be required for exposed curved surfaces. Liners other than plywood may be used with approval from the Engineer.

703.3.2.5 Fiber tubes for column forms above the ground line shall have a finish free of gaps or overlaps in the inside ply and shall be coated inside with a waterproofing material that will not stick or bond to, or discolor the concrete surface of the column. Fiber tubes for column forms from 6 inches below the finished ground line down may show seams, shall be waterproofed and need not be removed.

703.3.2.6 If wood forms are to be used in combination with metal forms, form details shall be submitted for approval if requested by the Engineer. Steel panels, or panels with metal frames and wood that leaves permanent impressions or ridges shall not be used, except for concrete box culvert-type structures and other non-exposed areas.

703.3.2.7 The inside of all forms shall be oiled, except for forms having composition linings. The oil used shall be a light, clear paraffin-based oil or other approved material that will not discolor or damage the exposed concrete surface. The coating shall be applied before placing reinforcing steel.

703.3.2.8 Ties, spreaders and all metal appliances used inside of forms to hold the forms in correct alignment and location shall be constructed such that after removal of the forms, the metal may be removed to a depth of at least one inch below the surface of the concrete. Metal tie rods used inside the forms where concrete will have an exposed surface shall be of a type that will not produce a cavity at the surface of the concrete greater than 1 1/2 inches in diameter. Bolts and rods used as ties shall not be removed by pulling the bolts and rods through the concrete. Wire ties and pipe spreaders will not be permitted, and metal or wood spreaders, which are separate from form ties, shall be removed as concrete is being placed. A bolt-through method of supporting forms for massive substructure units may be used with approval from the Engineer. No form ties shall be embedded in concrete above the roadway surface on bridges, except that coil ties and threaded rods may be permitted through the vertical face of the base and vertically through the top of barrier curbs. Coil ties, and all metal to be embedded in barrier curbs shall be epoxy-coated or galvanized.

703.3.2.9 Cavities produced by the removal of metal tie rods shall be filled with mortar composed of approximately one-part Portland cement to two parts sand or a non-shrinking, non-staining type of mortar. After the cavities are filled, the finished surface shall be left smooth, even and uniform in color and texture with minimal evidence of
shrinkage. White cement may be added to the mortar if necessary to obtain the required color. Tie rod cavities in surfaces against which backfill is to be placed shall be filled with mortar or an approved plastic compound in accordance with Sec 1057. Patching of tie rod cavities in the interior surfaces of box girders will not be required. At the time the wall forms are removed, in addition to filling the tie holes, all fins and irregular projections are to be removed, all surface voids filled, the exposed faces rubbed to a surface which is smooth, even, and uniform in color and texture, and immediately thereafter cured as directed.

703.3.2.10 Tubes for Voids

703.3.2.10.1 Fiber tubes for voids shall be properly designed for the use indicated. The outside surface shall be waterproof. Distortion of the tubes shall be prevented. The ends shall be covered with suitably designed mortar tight caps. If material used for capping tubes expands when moist, preformed joint filler 5/16 inch thick shall be used around the perimeter of the caps to prevent distortion, or another method approved by the Engineer.

703.3.2.10.2 Steel tubes for voids shall be properly designed for the use indicated. Excessive distortion shall be prevented in handling, storage and placing. The diameter of the tube shall be as shown on the plans with a tolerance of plus zero and minus 3/4 inch. The ends of tubes shall be covered with suitably designed mortar tight metal end caps. Excessive rusting of tubes will be reason for rejection.

703.3.2.10.3 Tubes for producing voids in concrete slab superstructures shall be accurately located in positions shown on the plans and shall be positively anchored to the joists carrying the floor forms. Anchors and ties shall be designed to leave a minimum of supporting material exposed in the bottom of the finished slab of the completed structure. Details of proposed anchorage and ties for the tubes shall be submitted for approval before work is started on the bridge superstructure. One 3/4 inch diameter weephole shall be provided near each end of each tube. Weepholes shall be placed in straight lines parallel to beams, and shall extend through the forms and be kept open at all times. Tubes shall be protected from moisture and heat until concrete is placed. Distortion of tubes after placing of concrete shall not increase the tubes' vertical axis by more than 1/2 inch.

703.3.2.10.4 Falsework and form removal from under any structural concrete unit shall not be started until the concrete has attained at least the required compressive strength shown. The falsework support of all concrete spans of a continuous or monolithic series shall be first released from the center of all spans, and shall proceed simultaneously from all span centers each way toward adjacent bents. Release shall be in such a manner as to permit the concrete to gradually and uniformly take stresses due to the self-weight of the concrete. Compressive strength will be determined by tests conducted in accordance with AASHTO T 22.

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703.3.2.10.5 Except in accordance with Sec 703.3.6, forms for vertical surfaces of bridge superstructures shall be removed as soon as the concrete is self-supporting to permit prompt patching of tie holes.

703.3.2.10.6 Girders and beams shall not be set on bent cap until the concrete in the bent cap has attained at least the required compressive strength shown in Sec 703.3.2.10.4.

703.3.3 Placing Concrete. Placing concrete in any unit of a structure shall not begin until preparations for placing and finishing are satisfactory to the Engineer. Concrete shall be placed in the form in layers as near final position as practical with minimum handling. Each placement shall be completed in a continuous operation with no interruption in excess of 45 minutes between the placing of contiguous portions of concrete. Where a finishing machine is to be used, the machine shall be moved over the area to be finished immediately prior to placing
Concrete in any bridge deck pour to facilitate checking reinforcement cover and slab thickness. This checking shall be done in the presence of the Engineer and with the screeds in the finishing position. Placing of concrete for bridge decks shall proceed uniformly for the full width of the placement. Once begun, placing of concrete in the superstructure of a continuous or monolithic series of spans shall proceed as rapidly as good construction practice will permit until all concrete in that series is placed. Vibrators having a minimum frequency of 4,500 impulses per minute shall be used to thoroughly consolidate the concrete in the forms and around the reinforcing steel. Sufficient vibrators shall be on hand to ensure continuous placement of the concrete without delay. The vibrators shall not be used for moving concrete nor shall vibrators penetrate or disturb previously placed layers of concrete after initial set. Vibration shall not cause segregation of the material. Reinforcing steel protruding through transverse or longitudinal headers shall not be disturbed until the concrete is at least 24 hours old.

703.3.1 Where placing operations involve dropping the concrete more than 5 feet, the concrete shall be deposited as approved by the Engineer to avoid segregation and contamination. Where concrete is placed in the interior of pneumatic caissons, the concrete may be deposited through air locks or other approved devices, and the requirement of dropping the mixture no more than 5 feet may be waived.

703.3.2 Concrete shall be worked under and around the reinforcing steel without displacing the steel. Forms and reinforcing steel above concrete being placed, and placing equipment shall be kept clean and free from coatings of hardened concrete. Water used for flushing the equipment shall be discharged clear of the concrete and forms.

703.3.3 Concrete shall be placed around the tubes forming voids in slab spans using methods to prevent the displacement of the tubes. For tubes having an inside diameter greater than 14 inches, the concrete shall be placed in three layers. The first layer shall extend from the floor forms up to a plane 1/4-tube diameter above the bottom of the tubes and the second layer to 3/4-tube diameter. For tubes 14 inches or smaller, the concrete shall be placed in two layers, with the lower layer extending to the middle of the tube. Each layer shall be vibrated and allowed to settle after placing, before the next succeeding layer is placed. The succeeding layer shall be deposited while the concrete in the layer below is still plastic enough to permit intermixing the two layers by use of a vibrator.

703.3.4 The sequence of placement of concrete for roadway slabs on a continuous series of spans will be shown on the plans, along with the minimum rates of placement required for the basic sequence and for combinations thereof. The basic sequence of placement shall be observed unless it can be demonstrated that the Contractor can place and satisfactorily finish combined placements at the required rate. If the Contractor wishes to alter the placing sequence or to combine units, the Contractor shall submit a written request subject to approval from the Engineer.

703.3.5 Concrete for substructure units shall be placed in the dry unless otherwise approved by the Engineer. If the supporting material at plan elevation of the bottom of a pile footing is not sufficiently stable to support the concrete, the material shall be stabilized, or the bottom of the footing shall be formed to adequately support the concrete. The stabilizing of material or forming under pile footings will be at the Contractor’s expense.

703.3.6 Depositing concrete under water will be permitted when provided for in the contract or upon written permission of the Engineer. The concrete shall be placed by means of a tremie or a bottom dump bucket. The tremie shall consist of a tube having a diameter of not less than 10 inches and shall be equipped with a hopper of suitable capacity. The bottom dump bucket shall have a capacity of not less than ⅓ cubic yard. The concrete shall be placed in its final position in still water and shall not be vibrated or disturbed after being deposited. Concrete placed under water and for seal courses shall be seal concrete in accordance with Sec 501. No additional compensation for seal concrete will be given unless previously stipulated in the contract.

703.3.7 Conveying, placing and pumping equipment shall have adequate capacity, be suitable for the intended work and shall be operated to produce a continuous stream of uniform concrete. Equipment shall be arranged to prevent transmission of vibration to freshly placed concrete. The system through which the concrete is pumped shall be manufactured such that no aluminum parts will come into contact with the concrete.
703.3.8 At the completion of concrete placement, the last concrete in the pipeline shall not be used.

703.3.9 Concrete used for filling cavities or crevices as directed by the Engineer and as required in Sec 206 shall be Class B concrete. This concrete shall be unformed mass concrete placed separately from and prior to the placing of footing concrete.

703.3.10 When a closure pour is specified on the bridge plans, or is necessary for other requirements, the closure pour between slabs poured independently shall be expansive Class B-2 concrete. Unpolished aluminum powder shall be added to the Class B-2 concrete as recommended by the powder manufacturer or as approved by the Engineer for controlled expansion. A shrinkage compensating cement may be substituted for the unpolished aluminum powder and cement. If a shrinkage compensating cement is substituted, the type and amount shall be approved by the Engineer.

703.3.10.1 Prior to placing the closure pour, the Contractor shall release the falsework to allow the initial deflection in the slab extension. The Contractor shall obtain approval from the Engineer prior to placing the closure pour.

703.3.10.2 The slab area to be in contact with the closure pour shall be sandblasted to remove all foreign matter and shall be cleaned to remove all dirt and loose material. Containment and disposal of material shall be in accordance with Sec 202.2. After the slab area has been cleaned and any damaged epoxy coating on the reinforcing bars repaired, an epoxy-bonding compound shall be applied to the slab area to be in contact with the closure pour. The concrete bonding compound and application shall be in accordance with Sec 623.

703.3.10.3 Immediately following application and before the concrete bonding compound has set, the closure pour shall be placed.

703.3.4 Joints in Concrete Masonry. Construction and expansion joints in concrete masonry shall be located where shown on the plans, except that in case of an unforeseen contingency, an emergency construction joint may be permitted.

703.3.4.1 Surfaces of construction joints shall be roughened or scored unless shear keys are shown on the plans. The face edges of all joints shall be carefully finished, and feathered edges shall be avoided. When the placing of concrete is temporarily discontinued, the concrete shall be cleaned of laitance and other objectionable material after becoming firm enough to retain form, and shall be thoroughly wetted before placing new concrete. Contraction joints in floor slabs of truss bridges may be sawed. Waterstops and flashings as shown on the plans shall be continuous if practical. If splices are shown on the plans or permitted by the Engineer, they shall be watertight.

703.3.4.2 Preformed (grey) sponge rubber expansion joint material shall be of the dimensions shown on the plans. Splices shall be held to a practical minimum and shall be made by lacing with copper wire or soft-drawn galvanized steel wire. All joint material shall be securely stitched to one face of the concrete with No. 10 gage copper wire or No. 12 gage soft-drawn galvanized steel wire. Unless joint sealing is specified, the sponge rubber material shall be left exposed for the material’s full length with clean and true edges.

703.3.4.3 Geotextile filter cloth, three feet wide double in thickness, meeting the requirements of Sec 1011.3.4, shall be centered on transverse joints in top slab and sidewalls for both cast-in-place and precast box culverts.

703.3.5 Concrete Finishes. Riding surfaces shall be finished true to the alignment, grade, cross section and camber shown on the plans. These surfaces shall be finished by use of an approved mechanical finishing machine. On skewed structures the finishing machine shall be adjusted to finish the surface approximately parallel to the skew if the angle of skew exceeds 45 degrees, or if the angle of the skew exceeds 30 degrees and the placement width
divided by the span length equals or exceeds 0.8. Vibratory screeds shall not be used, including those that are a part of the proposed finishing machine.

703.3.5.1 Machine finishing shall be with an approved self-propelled mechanical finishing machine. The Engineer may waive the use of a finishing machine on isolated irregular shaped areas of the bridge surface. The finishing machine shall travel on adjustable rails or guides set to proper grade, and supported outside the limits of the finished riding surface. Where a longitudinal joint is shown on the plans, the finishing machine rails or guides shall be placed as close as practical to the longitudinal joint. The rails shall be supported to limit the full operating load deflection between supports to 1/8 inch or less. The rails shall be placed parallel with the centerline of roadway or the longitudinal axis of the area to be finished. Where supports are located such that fresh concrete must be placed around the supports, the rails or guides shall be furnished in sections of 10 feet or less and placed above the concrete surface. The sections and supports shall be removed and the holes filled with concrete immediately after the final straightedging. The finishing machine shall make sufficient passes to obtain the specified cross section and surface finish. The final pass of the machine shall be of the maximum practical length, and shall be coordinated with the rate of placement. Finishing machine loads will not be permitted on concrete that has not reached a compressive strength of 3200 psi.

703.3.5.2 Where hand finishing of riding surfaces is permitted, the surface shall be struck off to the design section by a rigid metal shod template. The template shall be supported on rails or guides that can be adjusted to produce the design section and slab thickness. The rails or guides shall be supported above or outside the concrete surface. The surface behind the template shall be finished with a longitudinal float. The longitudinal float shall have a rigid metal shod smoothing surface which is a true plane no less than 10 feet long and 8 inches wide. The float shall be operated from movable bridges with a combined longitudinal and transverse motion. Each transverse pass shall overlap the previously floated area by approximately one-half the length of the float.

703.3.5.3 Sufficient work bridges shall be provided to complete the work in an orderly and continuous manner. Work bridges shall be supported outside the limits of concrete placement.

703.3.5.4 Straightedging. The riding surface shall be checked with a 10 foot straightedge immediately after the final finishing operation. The straightedge shall be pulled lightly across the surface from one edge of the finished area to the other without interruption. Reaching from outer edges to the center of the finished area will not be permitted. Each transverse pass shall overlap the previously straightedged portion by approximately one-half the length of the straightedge. The straightedge shall not be used to cut or move concrete from its finished position. Any irregularities, bumps or improperly finished areas shall be refinished and the surface again checked by repeating the straightedging operation.

703.3.5.5 Roadway Finish Texture. The roadway surface, except within 12 inches of the inside face of the curb, shall be textured as soon as the condition of the concrete will permit. The roadway finishing shall otherwise be in accordance with Sec 502.4. Hand-operated devices producing a satisfactory texture will be permitted. At the Contractor’s option, a finned float with a single row of fins may be used. The grooves produced by the finned float shall be approximately 1/8 inch wide at 5/8 to 3/4 inch centers and shall be approximately 1/8 inch deep. This operation shall be performed at such a time and in such a manner that the desired texture will be achieved while minimizing displacement of the layer aggregate particles.

703.3.5.6 Surface Test. As soon as curing has been completed, the riding surface will be thoroughly straightedged by the Engineer, and all variations exceeding 1/8 inch in 10 feet will be plainly marked. Areas more than 1/8 inch high shall be removed by an approved device consisting of multiple cutting edges leaving a grooved surface finish comparable to that produced by the broom. The use of a bush hammer or other impact device will not be permitted.

703.3.5.7 Unless an armored joint is shown on the plans, construction and expansion joints in the roadway surface shall be carefully edged and left free of all mortar and concrete. If shown on the plans, these joints shall be sealed.
with joint sealing material. Joints shall be dry and cleaned immediately before the joints are sealed. Required joint sealing shall be done prior to surface sealing the bridge deck.

703.3.5.8 Surface finish for concrete masonry units, other than those specified in Sec 703.3.5, shall begin immediately following removal of the forms. Fins and irregular projections shall be removed. Form tie cavities, holes, honeycomb spots in other than exposed surfaces, and other defects shall be thoroughly cleaned, saturated with water and carefully pointed with a mortar in accordance with Sec 703.3.2.9. Repaired surfaces shall be satisfactorily cured.

703.3.5.9 Bridge seats shall be finished to a smooth even surface. Where lead plates or fabric pads are used to seat steel bearing plates, the area under the lead plates or fabric pads shall be finished to within 1/8 inch above plan elevation and shall be dressed to a uniform, level bearing with a Carborundum brick or power grinder after the concrete has set sufficiently to fix the larger particles of sand. The deviation of the bearing seat from a true level surface shall not exceed 1/16 inch. Where elastomeric bearing pads are used, the finishing of 1/8 inch above plan elevation and grinding of the bridge seat area will not be required. Wells for anchor bolts shall be completely filled with an expansive-type mortar in accordance with Sec 1066 after the steel has been erected and adjusted. In lieu of wells, anchor bolt holes may be drilled in accordance with Sec 712. Keyways, anchor bolt wells, holes and other depressions that might collect water and freeze shall be sealed.

703.3.6 Curing Concrete.

703.3.6.1 Bridge Decks. Curing compound for bridge decks shall be Type 1-D liquid membrane-forming curing compound in accordance with Sec 1055 Bridge Curing Compounds, except that if diamond grinding is specified, either Type 1-D or Type 2 liquid membrane-forming curing compound in accordance with Sec 1055 may be used for the surfaces to be textured by diamond grinding. Wet curing is required and shall be performed in accordance with Sec 703.3.6.1.4.

703.3.6.1.1 Application Rate. The material shall be approved by the Engineer prior to use and shall be applied at the manufacturer’s recommended rate, but at a rate of no less than one gallon per 150 square feet.

703.3.6.1.2 Conventional Texturing. When conventional texturing is specified, fresh concrete shall be sprayed immediately with a curing compound following texturing as specified in Sec 703.3.5.5. The application of the curing compound shall progress such that no more than 10 linear feet of the textured concrete surface is exposed without curing compound at any time.

703.3.6.1.3 Diamond Grinding. When diamond grinding is specified in lieu of conventional deck texturing, fresh concrete shall be sprayed immediately after surface floating to smooth surface with curing compound as specified in Sec 703.3.6.1.

703.3.6.1.4 Wet Curing. The Contractor shall submit to the Engineer a plan to monitor the free moisture and maintain continuous free moisture for the 7 day period. The concrete shall be covered with clean mats as soon as the curing compound has dried sufficiently to prevent adhesion, and the concrete surface will support the curing mat without marring or distorting the finish, but no more than 90 minutes after the concrete is floated or textured. If the concrete mix contains more than 15 percent fly ash or slag or combination thereof and remains plastic after 90 minutes, coverage with mats may be delayed, as directed by the Engineer, until the surface will support the curing mat without marring or distorting the finish. The mats shall be sufficiently wet at the time of placement to prevent moisture absorption from the finished surface. The Contractor shall control the run-off so as not to cause a traffic hazard or soil erosion. The continuous wet cure shall be maintained a minimum of seven days and until the concrete has attained a minimum compressive strength of 3,000 psi.

703.3.6.1.5 Opening to Construction Activities. Light material and equipment weighing less than 1,000 pounds may be carried onto the bridge deck after the deck concrete has been in place at least 24 hours, provided curing is not
interfered with and the surface texture is not damaged. Vehicles, material and equipment needed for construction activities and weighing less than 4,000 pounds shall not be moved onto any span until after the last placed deck concrete has attained a compressive strength of at least 3,200 psi. Loads in excess of the above shall not be moved onto the bridge deck until the deck concrete has reached the compressive strength specified on the plans. Placement of barrier walls on bridge decks shall not begin until the 7 day wet cure is complete and the deck has reached the minimum compressive strength shown on the plans.

703.3.6.1.6 Open To Traffic. Structures shall not be opened to any public vehicular traffic until at least 14 days after the last placement of deck concrete and until such time that the concrete has attained the compressive strength specified on the plans.

703.3.6.2 Concrete Masonry Not to be Sealed. Curing of exposed concrete masonry surfaces not to be sealed shall be initiated after finishing operations are completed and as soon as marring of the concrete will not occur by application of the curing process. The surface of exposed concrete shall be covered and cured in accordance with one of the following methods. Concrete adjacent to construction joints shall be wet cured, and other locations shall be either wet cured or cured by application of Type 1-D liquid membrane-forming curing compound in accordance with Sec 1055. Curing mats for curing exposed surfaces shall be kept wet for 72 hours. The mats shall remain in place until the mats are dry, or if not dry, at least 24 hours after the wet curing period. Concrete shall not be left exposed for more than 30 minutes between stages of curing and during the curing period.

703.3.6.2.1 Damp Proofed. Surfaces to be damp proofed shall not be cured with liquid membrane-forming compound.

703.3.6.2.2 Footings. Footings may be cured by submersion with approval from the Engineer.

703.3.6.2.3 Precast Members. Steam curing or curing by complete submersion in water will be permitted for precast members. If steam curing is applied, the jets shall not impinge directly on the concrete or on the forms, free circulation around the units shall be maintained, the steam shall be thoroughly saturated at all times, and the temperature around the concrete shall be raised no more than 40°F per hour and shall not exceed 160°F at any time. After the steam curing period, the temperature inside the chamber shall be reduced at a rate of no more than 40°F per hour until the temperature has reached about 20°F above the temperature of the air to which the concrete will be exposed.

703.3.6.3 Concrete Masonry to be Sealed. Curing of exposed concrete masonry surfaces to be sealed shall be initiated after finishing operations are completed and as soon as marring of the concrete will not occur by application of the curing process.

703.3.6.3.1 Curing. Concrete curing shall be performed in accordance with Sec 703.3.6.1, except for curbs, parapets, medians and bridge barriers.

703.3.6.3.2 Curbs, Parapets, Medians and Bridge Barrier.

703.3.6.3.2.1 Curing. Curing compounds for sealed concrete masonry shall be Type 1-D liquid membrane-forming curing compound in accordance with Sec 1055 Bridge Curing Compounds. Wet curing will not be required for curbs, parapets, medians and bridge barriers.

703.3.6.3.2.2 Application Rate. The material shall be approved by the Engineer prior to use and shall be applied at the manufacturer’s recommended rate, but no less than 150 square feet per gallon.

703.3.6.3.2.3 Application Time. The application of the curing compound shall progress such that no more than 10 linear feet of the textured concrete surface is exposed without curing compound at any time.
703.3.6.3.2.4 Open to Traffic. Structures shall not be opened to any public vehicular traffic adjacent to curbs, parapets, medians and bridge barrier until such time that the concrete has attained the compressive strength specified on the plans. The requirement for reaching compressive strength prior to adjacent traffic will be waived for curb blockouts placed on existing curbs.

703.3.7 Bridge Deck Surface Texturing. For conventional texturing, the roadway surface shall be textured in accordance with Sec 703.3.5.5 prior to the application of the curing compound.

703.3.7.1 When diamond grinding is specified, following the curing period and the attainment of design strength, the deck surface shall be diamond ground in accordance with the following.

703.3.7.1.1 The bridge deck shall be diamond ground in accordance with Sec 622.30, except traffic control and closure for grinding operations shall be as specified by other portions of the contract documents, except as noted herein. Grinding may proceed after design strengths are attained and shall be completed prior to opening to any traffic other than construction traffic.

703.3.7.1.2 Bumps and high areas shall be removed prior to the start of final grinding operations in accordance with Sec 703.3.5.6. Typically, 1/8 inch, and no more than 1/4 inch shall be removed from the plan profile of the deck. The final surface shall be textured to the satisfaction of the Engineer.

703.3.7.1.3 The surface of the approach slabs and deck shall be ground simultaneously in a longitudinal manner to a distance 2 feet from the bridge barrier.

703.3.8 Surface Sealing for Concrete. Bridge decks shall be sealed with one application of an approved penetrating concrete sealer in accordance with Sec 1053. The penetrating concrete sealer shall also be applied to the top surface of the concrete bridge approach slabs, top and roadway faces of sidewalks, curbs, parapets, medians and barrier. The surfaces of deck patching shall not be sealed unless the surface of the rest of the deck is being sealed. The surface of a Latex Modified Concrete overlay shall not be sealed. The surface of all other concrete overlays shall be sealed.

703.3.8.1 Equipment. Application equipment shall be as recommended by the manufacturer except as mentioned below. A low pressure, high volume method of application shall be used that will not atomize the silane. Hand pump sprayer shall not be used. The spray equipment, tanks, hoses, brooms, rollers, coaters, squeegees, etc. shall be free of foreign matter, oil residue and water prior to applying the treatment.

703.3.8.2 Cleaning and Surface Preparation. Surfaces which are to be treated shall meet the approved product's requirements for surface condition. Sealing shall not be done until all concrete construction or repair has been completed and cured to the requirements of the manufacturer. The Contractor shall furnish the Engineer with written instructions for the surface preparation requirements.

703.3.8.2.1 Sealing shall be done after the bridge deck has been textured or diamond ground.

703.3.8.2.2 At a minimum, the surface shall be thoroughly cleaned to remove dust, dirt, oil, wax, curing components, efflorescence, laitance, coatings and other foreign materials. The manufacturer or manufacturer’s representative shall approve the use of chemicals and other cleaning compounds to facilitate the removal of these foreign materials before use. The treatment shall be applied within 48 hours following surface preparation.

703.3.8.2.3 Cleaning equipment shall be fitted with suitable traps, filters, drip pans and other devices to prevent oil and other foreign material from being deposited on the surface.

703.3.8.3 Test Application. Prior to final application, the Contractor shall treat a measured test coverage area on horizontal and vertical surfaces of the different components of the structure to be treated for the purpose of
demonstrating the desired physical and visual effect on an application or of obtaining a visual illustration of the absorption necessary to achieve the specified coverage rate. In the latter case, the applicator shall use at least ½ gallon (1.9 liter) of treatment following the manufacturer’s recommended method of application for the total of the test surfaces. Horizontal test surfaces shall be located on the deck and on the curb or sidewalk, and vertical test surfaces shall be located on a parapet or safety barrier curb so that the different textures are displayed.

703.3.8.4 Application. The sealer shall be applied by thoroughly saturating the concrete surfaces so that one gallon of material shall not be spread over more than 200 square feet.

703.3.8.4.1 The concrete surface temperature shall be between 35°F and rising and 100°F and falling.

703.3.8.4.2 At a minimum, the wet cure must be complete and the moisture content of the concrete must be at or below 8 percent as measured by a moisture meter.

703.3.8.4.3 Allow concrete to dry a minimum of 48 hours after any measurable precipitation.

703.3.8.4.4 The treatment shall be spread from puddles to dry areas.

703.3.8.4.5 If the applicator is unable to complete the entire application continuously, the location where the application was stopped shall be noted and clearly marked.

703.3.8.5 Protection of Adjoining Surfaces and the Public.

703.3.8.5.1 When applying the sealer, the Contractor shall protect adjoining surfaces of the structure that are not to be sealed. The Contractor shall also make provision to protect the public from overspray.

703.3.8.5.2 Asphalt and mastic type surfaces shall be protected from spillage and overspray. Any asphalt pavement damaged by the sealer will result in removal and replacement at the Contractor’s expense. Joint sealants, traffic paints and asphalt overlays may be applied to the treated surfaces 48 hours after the treatment has been applied. Adjoining and nearby surfaces of aluminum or glass shall be covered where there is possibility of the treatment being deposited on the surfaces. Plants and vegetation shall be protected from overspray by covering with drop cloths. Precautions shall be followed as indicated on the manufacturer's product and material safety data sheet.

703.3.8.6 Opening to Traffic. Traffic may be allowed on a deck when the material is tack free.

703.3.9 Hot Weather Concreting. The Contractor shall schedule placing and finishing of bridge deck concrete during hours in which the ambient temperature will be lower than 85°F. The mixed concrete when placed in the deck forms shall have a temperature no higher than 85°F, however, if the Contractor starts the concrete placement at least 30 minutes after sundown and covers the concrete with wet burlap when it will not mar the surface, but before morning solar radiation dries the surface and implements, to the extent possible, precautionary measures for hot weather concreting recommended in ACI 305R ‘Hot Weather Concreting’, then the concrete temperature can be increased to 90°F.

703.3.10 Cold Weather Concreting. Concrete work shall proceed on all structures, except bridge superstructures, whether or not heating will be required, unless it can be definitely established that the overall progress of the project will not be affected. Placing of concrete in the superstructure of a continuous or monolithic series of spans once begun shall be continued within the provisions of cold weather concreting procedures until all the concrete in that series is placed. Concrete placed in cold weather shall be protected from freezing during the curing period. Concrete shall not be placed on frozen ground, or against steel or concrete surfaces with temperatures lower than 35°F. Concrete shall not be placed where the ambient temperature is below 35°F without prior approval from the Engineer. Concrete in bridge superstructures shall not be placed where the ambient temperature is below 40°F without prior approval from the Engineer.
703.3.10.1 The aggregate, the water, or both, shall be heated during the season when the atmospheric temperature may drop below 40°F. Aggregate shall not be heated higher than 150°F. The temperature of the aggregate and water combined shall not be higher than 100°F when the cement is added. Any method of heating during the mixing of concrete may be used, provided the heating apparatus will heat the mass uniformly and avoid hot spots that will burn the material. The temperature of the concrete at the time of placing in the forms shall be no lower than 45°F for concrete in footings, massive piers and abutments, or less than 60°F for all other concrete.

703.3.10.2 When the ambient temperature is below 40°F, with the approval from the Engineer, curing of superstructure concrete, substructure units above ground surface, retaining walls and box culverts of more than 15 square feet opening shall be accomplished by methods that will prevent concrete from freezing. The minimum compressive strength required for form removal and ending protection from freezing shall be in accordance with Sec. 703.3.2.10.4. The Contractor shall furnish temperature monitoring equipment and accessories that demonstrate to the Engineer that concrete has been protected from freezing, with payment for such equipment and accessories included in the contract unit price for concrete. Exposed surfaces of the concrete shall be kept moist during the curing process. Substructure concrete below ground surface may be protected by submersion provided the temperature of the water is maintained between 40°F and 80°F for seven days.

703.3.10.3 Concrete headwalls for pipe culverts, drop inlets and box culverts of 15 square feet or less openings, may be placed without air temperature limitations, but the Contractor shall be responsible for proper protection from freezing during placing and curing of the concrete.

703.3.11 Extending and Widening Structures. Extending and widening of existing concrete structures shall be in accordance with the details shown on the plans. A continuous groove at least one inch deep shall be sawed in the faces of the existing concrete as a guide for the line of break to prevent spalling. Surfaces of existing concrete that are to come in contact with new concrete shall be thoroughly cleaned, saturated with water and painted with an epoxy mortar of paint consistency or other approved products. The new concrete shall be placed immediately after the cement grout has been applied. If new concrete is to be placed against the natural finish of existing concrete work, the surface shall be roughened by bush hammering or other approved methods before being cleaned and treated. Before applying a new concrete riding surface, any existing bituminous surfacing shall be removed, and the exposed concrete surface shall be roughened by bush hammering or other approved methods before being cleaned and treated. Work incidental to joining new concrete to existing concrete will be at the Contractor’s expense.

703.3.12 Bedding. The bedding shall be minimum of 12 inches thick below the Cast-In-Place Reinforced Concrete Box Culverts. The bedding material shall be a select granular backfill per Sec 1010.

703.4 Method of Measurement. Final measurement will not be made unless changes from contract plans are authorized by the Engineer during construction, or appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. Where required, quantities for concrete masonry will be computed from dimensions shown on the plans, or as revised in writing by the Engineer because of changes to the contract plans or due to appreciable errors, and will be computed to the nearest 1/10 cubic yard for each structure. No deduction will be made for the space occupied by reinforcing steel, conduit or piles. Deductions will be made for the space occupied by the tubes in voided slabs.

703.4.1 Measurement of concrete quantities in seal courses will be made for the actual quantity placed, except that this quantity will be limited to that included within vertical planes 18 inches outside the neat lines of the footings, and to the maximum depth shown on the plans or as authorized by the Engineer.

703.4.1.1 Class B Concrete used for Cast-in-Place (C.I.P.) Reinforced Concrete Box Culvert structures shall not be quantified as a pay item. Payment for C.I.P. Box Culverts will be made at the unit bid price per lump sum. Lump sum price shall include all concrete, reinforcing steel, formwork, headwalls, wingwalls, toewalls, pipe connections, excavation, bedding, finishing grading and all other items incidental to completion of the box culvert structure. No
direct payment will be made for incidentals necessary to complete the work unless specifically provided as a pay item in the contract.

703.4.1.2 Class B Concrete used for Cast-In-Place walls shall be computed to the nearest 1/10 cubic yard. Final measurement of the completed cast-in-place wall will not deviate from the contract quantity except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. Cubic yard unit price for concrete shall include all concrete, reinforcing steel, formwork, excavation, bedding, finishing grading, form liners and all other items incidental to completion of the cast-in-place wall. No direct payment will be made for incidentals necessary to complete the work unless specifically provided as a pay item in the contract.

703.4.2 Measurement of concrete quantities used to fill cavities or crevices will be made for the accepted quantity placed below the authorized elevation of the structure footing.

703.4.3 Final measurement for diamond grinding will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from contract quantity.

703.5 Basis of Payment. The accepted quantity of concrete masonry, complete in place, will be paid for at the contract unit price for each of the pay items included in the contract.

703.5.1 The accepted quantity of concrete used to fill cavities or crevices below final authorized bottom elevation of the footing structure will be paid for based on the accepted quantity per cubic yard at the fixed unit price specified in Sec 109.

703.5.2 No direct payment will be made for incidental items necessary to complete the work unless specifically provided as a pay item in the contract documents. No direct payment will be made for concrete required to fill overbreak where footings or walls are cast against vertical faces of rock or shale excavation.

703.5.3 Payment for diamond grinding will be made per square yard of surface.

703.5.4 No direct payment will be made for furnishing and applying the surface sealer and all incidental work. Payment shall be considered completely covered by the contract unit price for other items.

703.5.5 Payment for the work necessary to complete a closure pour, including all material, labor, tools, equipment and incidentals, will be made and considered completely covered under the contract unit price for the applicable pay item for the slab.

703.5.6 Payment for Cast-In-Place Reinforced Concrete Box Culverts will be made at the unit bid price provided in the contract documents. No direct payment will be made for concrete, reinforcing steel, formwork, headwalls, wingwalls, toewalls, pipe connections, excavation, bedding, finish grading, and all other items incidental to completion of the box culvert structure, unless specifically provided as a pay item in the contract. Replacement of unsuitable material below the 12 inch bedding will be paid in accordance with Sec 206.

703.5.7 Payment for Cast-In-Place walls will be made at the unit bid price per cubic yard of concrete as provided in the contract documents. No direct payment will be made for reinforcing steel, formwork, excavation, bedding, finish grading, form liners and all other items incidental to completion of the cast-in-place wall, unless specifically provided as a pay item in the contract, as these will be considered incidental to the concrete placement.
SECTION 704
CONCRETE MASONRY REPAIR

704.1 Description. This work shall consist of removing deteriorated concrete, preparing the repair site, forming where required, placing and finishing new concrete or qualified special mortar, applying epoxy and applying concrete crack filler in the required areas.

704.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows. The qualified special mortar shall be from the qualified rapid set concrete patching material listing available from MoDOT’s web site.

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
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<tr>
<td>Concrete Bonding Compound and Epoxy Mortar</td>
<td>623</td>
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<tr>
<td>Gradation E Coarse Aggregate</td>
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<tr>
<td>Type III Cement</td>
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<tr>
<td>Type III Epoxy &amp; Epoxy Polymer Concrete Overlay</td>
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<td>Concrete Crack Filler</td>
<td>1053</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

704.3 Types of Repair.

704.3.1 Repairing Concrete Deck (Half-Soling). This work shall consist of partial removal and replacement of bridge deck concrete in the required areas.

704.3.2 Deck Repair with Void Tube Replacement. This work shall consist of partial removal and replacement of bridge deck concrete and removal and replacement of the deteriorated void tube in the required areas.

704.3.3 Full Depth Repair. This work shall consist of complete removal and replacement of the bridge deck concrete in the required areas and for voided slabs, the removal and replacement of the deteriorated void tube in the required areas.

704.3.4 Modified Deck Repair. This work shall consist of the removal and replacement of visibly loose or spalled bridge deck concrete and placement of concrete in the areas where the reinforcing steel is exposed. The repair concrete for these areas shall be Class B-1.

704.3.5 Superstructure Repair (Unformed). This work shall consist of repairing the deteriorated concrete on the bottom of the bridge deck in the required areas with a qualified special mortar.

704.3.6 Slab Edge Repair. This work shall consist of repairing the edge of the bridge deck by removing deteriorated concrete and patching the required areas with a qualified special mortar. All repairs made within 4 inches of the edge of the bridge deck, regardless of the repair thickness, will be considered slab edge repair. Portions of the bridge deck areas requiring repair that extend more than 4 inches from the edge of the bridge deck shall be repaired as superstructure repair (unformed) or full depth repair.

704.3.7 Substructure Repair (Formed). This work shall consist of formed substructure repair. The required areas shall be patched with Class B-1 concrete. Coarse aggregate shall be Gradation E in accordance with Sec 1005. The extent of a single formed repair area for measurement shall be the contiguous concrete surfaces that meet at a formed edge.
704.3.8 Substructure Repair (Unformed). This work shall consist of unformed substructure repair. The required areas shall be patched with a qualified special mortar.

704.3.9 Epoxy Sealing. This work shall consist of applying an epoxy material to the concrete in the required areas.

704.3.10 Concrete Crack Filler. This work shall consist of applying a concrete crack filler to the concrete in the required areas.

704.4 Construction Requirements.

704.4.1 Removal Requirements. The type of repair and areas to be repaired will be outlined by the Engineer. All loose, deteriorated and unsound concrete in the required repair areas shall be removed by conventional hand/mechanical, hydro demolition or other approved equipment to a depth as specified herein and as directed by the Engineer. Slight deck imperfections surrounded by sound concrete shall be cleaned of all dirt, loose material and deteriorated concrete. If reinforcing steel is not exposed, deck repair work will not be required.

704.4.1.1 Bridge Decks to be Covered with Asphalt or Concrete Wearing Surface. The existing bridge deck shall be scarified for the concrete wearing surface as specified in the contract documents. Slight bridge deck imperfections of 0.5 inch or less in depth below the prepared deck surface that are surrounded by sound concrete, and the reinforcing steel is not exposed, shall not be half-soled. These areas shall be cleaned by hand tools, sand or hydro blasting to remove all dirt, loose material and deteriorated concrete before the application of the asphalt or concrete wearing surface. Asphalt or concrete for these areas shall be placed monolithic with the wearing surface in accordance with Sec 401 or the contract documents.

704.4.1.2 Bridge Decks to be covered with Epoxy Polymer Concrete Overlay. Preparing and cleaning the existing bridge deck shall be in accordance with Sec 623.

704.4.1.3 Conventional Hand/Mechanical Equipment. Conventional hand/mechanical equipment consisting of jackhammers no heavier than the 35-pound class shall be used for concrete removal. For bridge decks rated 5 or below, the jackhammers shall not be heavier than the 65-pound class. Chipping hammers from the 15-pound class shall be used to remove concrete from beneath any reinforcing bars, where required. The bits shall be sharp in order to reduce pounding. Jackhammers shall be operated to minimize damage to the sound concrete around the patch area. Other methods that would be less damaging to the concrete and reinforcement may be used with approval from the Engineer.

704.4.1.4 Patch Repair Hydro Demolition Equipment. The hydro demolition equipment shall be capable of removing concrete to the specified depth and shall be capable of removing rust and concrete particles from exposed reinforcing bars. All water used in hydro demolition shall be potable in accordance with Sec 1070. Stream or lake water will not be permitted. The Contractor shall take necessary precautions during hydro demolition to prevent damage to the remaining structure and adjacent property as a result of runoff. Slab drains receiving runoff from the Contractor’s operation shall be temporarily plugged. The discharge water shall not be released from the site until the broken concrete, aggregate and other settleable solids have been removed through filtration, sediment basins or other approved methods. The Contractor shall control dust and run-off in accordance with applicable governmental regulations. Environmental protection shall be in accordance with Sec 107. Hydro demolition shall not impede or interfere with maintaining traffic. Heavy equipment, such as vacuum trucks for removal of concrete debris, will not be permitted to place wheel loads on the deck areas where deteriorated concrete has been removed.

704.4.1.5 Concrete Removal. A boundary perimeter with one inch vertical sides shall be established outside the deteriorated area. The deteriorated concrete shall be removed as required to provide good sound concrete on which new concrete can be placed and satisfactorily bonded to the reinforcing bars. The areas of repair shall be made approximately rectangular with the sides generally perpendicular to the surface being repaired. These areas shall be carefully removed such that reinforcement is not disturbed or damaged. For full depth repair, a saw cut
outside the deteriorated area shall also be made on the bottom of the bridge deck, except on voided slab, solid slab and box girder bridges without entry access. Other acceptable methods for saw cutting the bottom of the deck may be used with approval from the Engineer. No more than one-fourth of the column perimeter shall be removed at any one time, and no more than one-eighth of the column perimeter if the repair is completed under live load. Once the one-quarter or one-eighth limit has been reached, the column shall be repaired before any further column removal is done.

704.4.1.6 Reinforcing Bar Exposed. All exposed reinforcing bars shall be thoroughly cleaned by sand or hydro blasting to the satisfaction of the Engineer.

704.4.1.6.1 Superstructure and Substructure Repair. The concrete within the boundary area for superstructure repair (unformed), substructure repair (formed) and substructure repair (unformed) shall be removed a minimum of one inch beyond the inside edge of any exposed reinforcing bars, including the main reinforcement.

704.4.1.6.2 Deck Repairs. The minimum depth of repair for repairing concrete deck (half-soling) or modified deck repair shall expose the upper layer of the top mat of reinforcing steel. When the bond between existing concrete and a reinforcing bar has been destroyed, or more than half the diameter of a reinforcing bar is exposed, the concrete adjacent to the reinforcing bar shall be removed to a depth that will permit the concrete to bond to the entire periphery of the bar. A minimum of one inch clearance shall be maintained.

704.4.1.6.3 If a reinforcing bar is exposed during slab edge repair, the concrete adjacent to the bar shall be removed to a depth that will permit a qualified special mortar to bond to the entire periphery of the bar. A minimum of one inch clearance shall be maintained.

704.4.1.7 Reinforcement Repair. Particular care shall be taken not to disturb or damage reinforcing bars. All exposed reinforcing bars shall be thoroughly cleaned by sand or hydro blasting. Cut or broken bars or bars with 25 percent or more cross-sectional area lost shall be spliced 24 diameters on each side of the damage with new bars of the same size in accordance with Sec 706. Damaged existing epoxy coated reinforcement shall be repaired in accordance with Sec 710.

704.4.1.8 Material Disposal. All material removed shall be disposed of in accordance with Sec 202.

704.4.2 Preparation of the Repair Area.

704.4.2.1 Patch Preparation Requirements. After removal of deteriorated concrete, the area to be repaired shall be sand or hydro blasted to remove all foreign matter, dirt, free standing water and loose material. Containment and disposal of material shall be in accordance with Sec 202.2. The hydro demolition process will not require sand or additional hydro blasting unless the bonding surface of the repair area becomes contaminated or unsatisfactory prior to placement of new concrete. The area to come in contact with new concrete shall be cleaned as stated above, saturated with water and painted with a concrete bonding compound or an epoxy mortar prior to the placement of new concrete. A concrete bonding compound shall be used for all structures with the following exception. An epoxy mortar shall be used on box girder, voided and solid slab structures and on structures where a cathodic protection system is to be installed.

704.4.2.2 Epoxy Sealing Preparation. The area to be sealed shall be cleaned by sand blasting. Containment and disposal of material shall be in accordance with Sec 202.2. Prior to sealing the concrete, all loose particles and foreign matter shall be removed using oil-free and water-free compressed air or a vacuum of at least 90 psi.

704.4.2.3 Concrete Crack Filler Preparation. The area to fill the cracks shall be cleaned by pressure washing with at least 2500 psi, 3 days minimum prior to the crack filler application and 2 days after any measurable precipitation.
704.4.3 Applying Epoxy. The area to be sealed shall be sealed with a qualified Type III epoxy or epoxy material for epoxy polymer concrete overlay. Sealing shall be completed before the application of any overlay. The cleaning, sealing and epoxy application shall proceed only as approved by the Engineer, in accordance with the manufacturer’s written recommendations. The epoxy application and rate of coverage shall be in accordance with manufacturer’s recommendations, with a maximum coverage of 100 square feet per gallon.

704.4.3.1 Applying Concrete Crack Filler. The area to fill the cracks shall be filled with a low viscosity polymer crack filler. The concrete crack filler application and rate of coverage shall be in accordance with the manufacturer’s recommendations, with a maximum coverage of 100 square feet per gallon. The broadcasting of dry blasting sand shall be applied only as approved by the Engineer, in accordance with the manufacturer’s written recommendations with a maximum coverage of 1 to 2 lbs/sq.yd. starting approximately 10 minutes after crack filling operation has started.

704.4.4 Placement of New Concrete.

704.4.4.1 Concrete Placement Requirements. Concrete shall be placed before the concrete bonding compound or epoxy mortar has begun to set. Deck repair concrete shall be placed in the repair area to match the top of the original deck surface. For bridges to be covered with concrete wearing surface, deck repair concrete shall be placed in the repair area up to the bottom of the proposed concrete wearing surface. The finished repair area shall have a light broom texture for bonding of the deck seal, except bridges to be covered with concrete wearing surface shall have a rough surface for bonding of the concrete wearing surface. All joints shall be formed to match any existing joint pattern.

704.4.4.2 Concrete Requirements. Concrete for concrete deck repair shall be Class B-2, except that solid slab, voided slab and box girder structures shall be the same class as the existing deck concrete and as specified in Sec 704.3.4 and Sec 704.4.4.3. The repair area shall not be opened to any traffic until the concrete has reached a compressive strength of 3,200 psi. Type III cement may be used to accelerate the set. The coarse aggregate shall be Gradation E in accordance with Sec 1005. Accelerating additives containing chlorides will not be permitted.

704.4.4.3 Bridge Decks with Cathodic Protection System. Concrete for repairing the concrete deck shall be Class B-1. The repair area shall not be opened to any traffic until the concrete has reached a compressive strength of 3200 psi. Type III cement may be used to accelerate the set. The coarse aggregate shall be Gradation E in accordance with Sec 1005. Accelerating additives containing chlorides will not be permitted. All half-sole repairs made on the deck shall be Class B-1 concrete that has a maximum chloride ion content of 5 pounds per cubic yard. All full depth repairs made on the deck shall be chloride-free Class B-1 concrete from the bottom of the deck to within one inch of the lowest rebar of the top layer of reinforcing steel. The remainder of the repair shall be Class B-1 concrete with a maximum chloride ion content of 5 pounds per cubic yard.

704.4.4.4 Curing. The repaired areas shall be cured in accordance with Sec 703. The cleaning and application of the epoxy polymer concrete overlay to the deck shall proceed only as approved by the Engineer in accordance with the manufacturer’s written recommendations.

704.5 Method of Measurement. The extent of repair may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation. Final measurement will not be made for preparation of the existing deck. No duplication of measurement will be made for full depth repair, repairing concrete deck (half soling), deck repair with void tube replacement, slab edge repair, superstructure repair (unformed) or modified deck repair. No duplication of measurement will be made for substructure repair, unformed and formed.

704.5.1 Repairing concrete deck (half-soling), deck repair with void tube replacement, full depth repair, modified deck repair, superstructure repair (unformed) and substructure repair (formed and unformed) will be measured to the nearest square foot.
704.5.2 Slab edge repair will be measured to the nearest linear foot.

704.5.3 No measurement will be made for epoxy sealing.

704.5.4 Measurement of reinforcing steel replaced due to excess section loss will be made to the nearest 10 pounds.

704.5.5 Filling concrete cracks will be measured to the nearest square foot.

704.6 Basis of Payment. Accepted quantities of concrete masonry repairs will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for epoxy sealing. Payment for accepted quantities of reinforcing steel replaced due to excess section loss will be paid for at the fixed contract unit price specified in Sec 109.16. No payment will be made for replacement of reinforcing steel cut or broken by the Contractor.
705.1 Description. This work shall consist of furnishing and placing prestressed concrete members, complete in place, in the superstructure of bridges. This work shall cover both prestressed and post-tensioned members.

705.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prestressed Concrete Members for Bridges</td>
<td>1029</td>
</tr>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
<td>1036</td>
</tr>
</tbody>
</table>

705.3 Equipment. Prestressing equipment shall be in accordance with Sec 1029.

705.4 Construction Requirements.

705.4.1 Post-Tensioned Members. Post-tensioned members shall be in accordance with Sec 1029.

705.4.2 Erection. Erection of the structure shall be in accordance with the working drawings. Camber of beams, measured as the differential between adjacent beams in the final location, shall be no more than 1/8 inch per 10 feet of span, and in no case greater than 1 inch. The butt joints between precast panels shall be caulked to prevent excessive grout leakage between panels.

705.5 Method of Measurement. Measurement of prestressed concrete members, complete in place, in the finished structure will be based on contract plan quantities. Final measurement will not be made, prestressed concrete members will be computed to the nearest linear foot for each structure and each type of prestressed concrete member.

705.6 Basis of Payment. Accepted prestressed concrete members will be paid for at the contract unit price for each of the pay items included in the contract.
SECTION 706
REINFORCING STEEL FOR CONCRETE STRUCTURES

706.1 Description. This work shall consist of furnishing and placing reinforcing steel of the designated shape, size and grade as shown on the plans.

706.2 Material.

706.2.1 All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
</tbody>
</table>

706.2.2 Reinforcing steel shall be accurately cut and bent to the dimensions and shapes shown on the plans. Cutting and bending tolerances for reinforcing steel shall be in accordance with the Concrete Reinforcing Steel Institute’s Manual of Standard Practice. Flame-cutting of uncoated reinforcing steel will be permitted.

706.3 Construction Requirements.

706.3.1 Reinforcing steel shall be protected from damage at all times. When placed in the work and before concrete is placed, reinforcing steel shall be free from dirt, oil, paint, grease, loose mill scale, thick rust, any dried mortar and other foreign substances. A thin layer of powdery rust may remain. All reinforcing steel required for superstructure concrete, such as slabs, girders and beams and top slabs of culverts with more than a 4 foot span, shall be held securely in correct position with approved metal or plastic bar supports and ties. Reinforcing bars shall be positively secured against displacement. For bridge decks and top slabs of culverts, bars in the top mat shall be tied at all intersections except where spacing is less than or equal to 12 inches in each direction, in which case alternate intersections shall be tied. At other locations, the bars shall be firmly tied at alternate crossings or closer. The steel shall be tied in the correct position with proper clearance maintained between the forms and the reinforcement. The Contractor shall construct the unit as shown on the plans. Measurements to reinforcing steel will be made to the centerline of bar, except where the clear distance from face of concrete is shown on the plans.

706.3.2 Bars shall not be spliced, except as shown on the plans or as directed by the Engineer.

706.3.3 Mechanical bar splice systems, as shown on the plans, shall be capable of developing 125 percent of the specified yield strength of the bar being spliced and shall be installed in accordance with the manufacturer’s recommendations and as modified herein.

706.3.3.1 The Contractor shall furnish to the Engineer a manufacturer’s certification stating that the mechanical bar splice systems are in accordance with this specification. The certification shall include or have attached specific results of tests showing yield and ultimate tensile load capacities.

706.3.3.2 The splicing system may attach directly to the bars being coupled or may be of a type that provides reinforcing bars of like size that lap with the bars being joined. A threaded-type splice system will be required where clearance considerations require the splicing device to be placed flush to the face of the construction joint for the initial concrete placement.

706.3.3.3 Regardless of the type of splicing system that will be used, the total bar lengths for bars indicated in the bill of reinforcing steel are determined based on the end of the bars being located flush to the face of the construction joint. No additional payment will be made for any additional bar lengths required for the mechanical bar splices. Reinforcing bar lengths shown in the bill of reinforcing steel may require modification to accommodate
the specific mechanical bar splice system that will be used. The Contractor shall determine the actual reinforcing bar lengths to accommodate the manufacturer's recommendations for installation of the mechanical bar splices.

706.3.3.4 For mechanical bar splice systems that require laps with the reinforcement, the minimum lap length in inches on each side of the joint shall be as shown in the tables below provided that the actual cover to the nearest concrete surface or actual bar spacing is no less than minimums shown.

### Minimum Lap Lengths

<table>
<thead>
<tr>
<th>Location 1</th>
<th>Location 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Horizontal and Inclined Bars with more than 12 inches of fresh concrete cast below bars</td>
<td>- Vertical Bars - Horizontal and Inclined Bars with 12 inches or less of fresh concrete cast below bars</td>
</tr>
<tr>
<td>f'c = 3 ksi</td>
<td>f'c = 4 ksi</td>
</tr>
<tr>
<td>Bar Size</td>
<td>Plain</td>
</tr>
<tr>
<td>-----------</td>
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</tr>
<tr>
<td>4</td>
<td>29</td>
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<td>10</td>
<td>72</td>
</tr>
<tr>
<td>11</td>
<td>80</td>
</tr>
</tbody>
</table>

Values are LRFD Class B splices based on the following modification factors:

\[
\lambda_{rl} = 1.3 \text{ (Location 1), } \lambda_{rl} = 1.0 \text{ (Location 2), } \lambda_{cf} = 1.0 \text{ (Plain), } \lambda_{cf} = 1.5 \text{ (Epoxy), } \\
\lambda_{rc} = 0.4 \text{ (Minimum reinforcement confinement factor)}
\]

706.3.3.4.1 For reinforcement with cover or spacing less than required minimums shown in the table provided in Sec 706.3.3.4, the required minimum lap length in the table shall be multiplied by the reinforcement confinement adjustment ratio, B.

\[
B = \frac{d_b}{0.4c_b}, \text{ if } B > 2.5, \text{ then } B = 2.5
\]

Where:

- \(d_b\) = diameter of bar (inches)
- \(c_b\) = the smaller of the distance from center of bar to the nearest concrete surface and one half the center-to-center spacing of the bars (inches)

706.3.3.4.2 Mechanical bar splice systems that require laps with the reinforcement shall not be used for voided slab and solid slab bridges. Systems that require laps shall be Grade 60 deformed bars in accordance with Sec 1036. Epoxy-coated bars shall have epoxy-coated mechanical bar splices.

706.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, measurement of reinforcing steel will be made to the nearest 10 pounds for each structure. The weight will be the plan weight of uncoated bars, and will not include mechanical bar splice systems, clips, wire, supports, spacers or other fastening
devices for holding the reinforcement in place. Allowances will not be made for an overrun in scale weights of bars. The revision or correction will be computed and added to or deducted from the contract quantity. Mechanical bar splice systems will be measured per each.

706.4.1 Reinforcing Steel used for Cast-in-Place (C.I.P.) Reinforced Concrete Box Culvert structures shall not be quantified as a pay item. Payment for C.I.P. Box Culverts will be made at the unit bid price per lump sum. Lump sum price shall include all concrete, reinforcing steel, formwork, headwalls, wingwalls, toewalls, pipe connections, excavation, bedding, finishing grading and all other items incidental to completion of the box culvert structure. No direct payment will be made for incidentals necessary to complete the work unless specifically provided as a pay item in the contract.

706.5 Basis of Payment. The accepted quantity of reinforcing steel, complete in place, will be paid for at the contract unit bid price. No additional payments will be made for test samples required under provisions of the contract. No direct payment will be made for reinforcing steel bar supports, cost to be included in the reinforcing steel contract unit price. If no unit bid price for reinforcing steel is listed in the contract, payment for reinforcing steel shall be considered incidental to other bid items.
SECTION 710  
EPOXY COATED REINFORCING STEEL

**710.1 Description.** This work shall consist of furnishing and placing epoxy-coated reinforcing steel of the shape, size and grade shown on the plans, and in accordance with Sec 706, except as modified herein.

**710.2 Material.**

**710.2.1** All material shall be in accordance with Division 1000 Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Coated Reinforcing Steel</td>
<td>1036</td>
</tr>
</tbody>
</table>

**710.2.2** Epoxy coated reinforcing steel shall not be flame-cut.

**710.3 Construction Requirements.**

**710.3.1 Handling.** All systems for handling epoxy-coated bars shall have padded contact areas. If, in the judgment of the Engineer, the coating is damaged to the extent that the coating can no longer provide the intended protection and cannot be satisfactorily patched, the material shall be returned to the coating applicator for repair or shall be replaced.

**710.3.2 Placement.**

**710.3.2.1** Epoxy-coated bars shall be held securely in the correct position with approved metal bar supports coated with plastic or epoxy or on plastic bar supports, and shall be held in place by use of plastic-coated tie wires or molded, plastic clips. When placing epoxy-coated bars, the bars shall be prevented from coming into contact with other steel items such as drains and shear connectors.

**710.3.2.2** The Contractor shall prevent damage to the epoxy coating when placing and vibrating concrete. In order to prevent damaging the coated bars, the vibrator head shall be covered with a sheet of rubber, and shall be equipped with a rubber tip with a maximum diameter of 2 1/2 inches. Another resilient material may be substituted for rubber as approved by the Engineer.

**710.3.2.3** After the reinforcing bars are secured to approved bar supports, a final visual inspection will be made, and all uncoated or damaged areas shall be coated or repaired in accordance with Sec 710.3.3 as directed by the Engineer.

**710.3.3 Repairing Bars.** All damaged areas of epoxy coating shall be patched with the material specified in Sec 1036, and in accordance with the manufacturer’s recommendations. All sheared or cut ends of bars, end areas left bare during the coating process, and any areas where the entire coating is removed shall be patched. All repairs shall be completed as soon as practical, and in the case of bare end areas and sheared ends, before visible oxidation of the surface occurs.

**710.3.4 Mechanical Bar Splices.** Requirements for mechanical bar splice systems shown on the plans shall be in accordance with Sec 706. Epoxy coated mechanical bar splices shall be used with epoxy-coated reinforcing steel, and if the epoxy coating is damaged, shall be repaired in accordance with Sec 710.3.3 as directed by the Engineer.

**710.4 Method of Measurement.** Measurement of epoxy-coated reinforcing steel will be made for plan weight of uncoated bars in accordance with Sec 706.4.
10.5 Basis of Payment.

10.5.1 The accepted quantity of epoxy-coated reinforcing steel, including any approved mechanical bar splice systems, complete in place, will be paid for at the contract unit price.

10.5.2 Repair of damaged epoxy coating will be at the Contractor’s expense.
SECTION 711

PROTECTIVE COATINGS FOR EXPOSED CONCRETE SURFACES

711.1 Description. This work shall consist of the surface preparation and application of protective coatings for sealing and protecting exposed concrete elements. The locations and elevations of the protective coatings shall be as shown on the bridge plans. The work involving temporary coating on weathering steel bridges shall also include the removal of the temporary coating.

711.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective Coating Material</td>
<td>1059</td>
</tr>
</tbody>
</table>

711.3 Construction Requirements.

711.3.1 Protective Coating - Concrete Bents and Piers (Urethane). This protective coating shall consist of a modified urethane or polyurethane elastomer. New concrete shall cure a minimum of 28 days prior to application of the protective coating. The coating shall be applied to dry surfaces. The surface preparation and application shall be in accordance with the manufacturer's recommendations. The surface preparation shall include removal of all loose or delaminated concrete, as well as any other contaminants or latent materials. The coating shall be applied to obtain a minimum dry film thickness of 40 mils. Any unevenly applied film that causes ponding of water shall be given additional coats as directed by the Engineer.

711.3.2 Protective Coating - Concrete Bents and Piers (Epoxy). This protective coating shall consist of a two-component, modified polyamide converted epoxy, clear or gray in color. New concrete shall cure a minimum of 28 days prior to application of the protective coating. The coating shall be applied to dry surfaces. The surface preparation and application shall be in accordance with the manufacturer's recommendations. The surface preparation shall include removal of all loose or delaminated concrete, as well as any other contaminants or latent materials. The coating shall be applied to obtain a minimum dry film thickness of 6 mils.

711.3.3 Concrete and Masonry Protection System. This protective coating shall consist of a clear penetrating siloxane or silane-based sealer. The surface preparation and application shall be in accordance with the manufacturer's recommendations. Field approval of the proposed material will be in accordance with Sec 1059.

711.3.4 Sacrificial Graffiti Protection System. This system shall consist of a clear coating that can be removed with a hot water wash. The surface preparation and application shall be in accordance with the manufacturer's recommendations. Field approval of the proposed material will be in accordance with Sec 1059.

711.3.5 Temporary Coating - Concrete Bents and Piers (Weathering Steel). This protective coating shall consist of a clear temporary coating applied to the concrete substructure for protection against staining from weathering steel girders during initial weathering. The surface preparation and application shall be in accordance with the manufacturer's recommendations. The concrete substructure shall be cured a minimum of 14 days prior to application, unless otherwise specified by the manufacturer. The coating shall be applied to the concrete substructure before the erection of structural steel. The temporary coating shall be removed by the Contractor after construction of the deck and curbs is complete, or as directed by the Engineer.

711.4 Basis of Payment. The accepted quantity of protective coatings for exposed concrete surfaces will be paid for at the contract lump sum price.
SECTION 712
STRUCTURAL STEEL CONSTRUCTION

712.1 Description. This work shall consist of the field construction of bridges and structures made of structural steel and miscellaneous metals.

712.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Connectors</td>
<td>1037</td>
</tr>
<tr>
<td>Paint for Structural Steel</td>
<td>1045</td>
</tr>
<tr>
<td>Structural Steel Fabrication</td>
<td>1080</td>
</tr>
<tr>
<td>Coating of Structural Steel</td>
<td>1081</td>
</tr>
</tbody>
</table>

712.3 Handling, Transporting, Storing and Erecting. Fabricated material shall be properly braced and supported at all times to prevent damage from torsional, vertical and lateral deflections. Members or shipped material showing possible damage during handling, transporting, storing or erecting will be subjected to nondestructive tests as directed by the Engineer. The costs of these tests will be at the Contractor’s expense. Fabricated structural steel shall be stored on suitable supports. Trough sections shall be stored in a manner to provide drainage. Any material that has become bent shall be straightened before being assembled or shall be replaced, if necessary. Material intended for use in the finished structure shall not be used by the Contractor for erection or temporary purposes unless such use is provided for in the contract, or with written approval from the Engineer.

712.4 Falsework. Staging and falsework necessary for the erection of the structure shall be furnished and placed and, upon completion of the erection, removed by the Contractor. If required, plans for falsework shall be submitted to the Engineer before starting the work, but the Engineer’s acceptance of the plans will not relieve the Contractor of the responsibility for obtaining satisfactory results.

712.5 Erection. Erection of all parts of the structure shall be in accordance with the erection diagram or working drawings. Surfaces to be in permanent contact shall have all burrs and loose scale removed. Before erection, machine finished surfaces shall be cleaned of the protective coating, other than the primer permitted by the contract, and contact surfaces shall be given a heavy coat of graphite and oil. Connections match marked in the shop shall be erected in accordance with those match marks. Interchange or reversal of match-marked connections will not be permitted. Any damage or distortion of members will not be permitted.

712.5.1 Fit-up and Drifting. Truss spans, plate girders and continuous I-beams shall be supported to maintain required camber during erection. High-strength bolted field splices and primary connections, except for trusses and structures carrying live load erection stresses, shall have no less than one-half of the holes filled with a combination of fitting-up bolts and cylindrical drift pins. No more than 50 percent of this combination shall be fitting-up bolts. Splices and primary connections carrying erection traffic during erection or truss connections shall have no less than three-fourths of the holes filled with drift pins and bolts with no more than 50 percent of being fitting-up bolts. The specified ratio of pins to bolts shall apply to each element of the splice, for example, top flange, web and bottom flange of girders. Fitting up bolts shall be the same diameter as the high-strength bolts. High strength bolts may be used for fitting-up bolts, and may be left in place, as long as they are not damaged during erection. High strength bolts will be considered damaged and shall be replaced if they are tensioned past snug tight, used to draw two members together, driven into place with a hammer, or have any deformation of the threads. Drift pins shall be sized to provide a driving, tight fit that maintains structure geometry during erection. Reaming of the holes to aid in drifting the connections will not be permitted. Fitting up bolts shall be placed uniformly to draw the entire splice tight. All fitting-up bolts and drift pins shall be properly installed before beginning high strength bolt installation. Holes that do not match shall be reamed only with approval from the Engineer. Drifting that would distort the metal will not be permitted.
712.5.2 Bearings. The lead plates or preformed rubber and fabric pads shall be approximately 1/8 inch thick and 1/2 inch greater in length and width than the bottom bearing plates under which the plates are to be placed. Lead plates shall weigh approximately 8 psf. Preformed rubber and fabric pads shall be in accordance with Sec 1038. Shop drawings will not be required for lead plates or preformed rubber and fabric pads. Lead plates or preformed rubber and fabric pads will be considered incidental to bearings, and payment will be considered as covered under the contract unit price for bearings.

712.5.3 Anchor Bolts. Anchor bolt wells for superstructures shall be formed in the substructure units in accordance with the details shown on the plans utilizing removable forming material which shall not be left in place. Where permitted or required, the anchor bolt wells may be omitted, and in lieu thereof, holes drilled into the substructure without cutting any reinforcements. The anchor bolt holes shall be drilled in the exact location shown, to the required depth and perpendicular to the plane of the bridge seat. The drilled holes shall be at least 1 inch larger than the bolt diameter. When the anchor bolts are set in wells or holes, the wells or holes shall be clean and dry prior to grouting with an expansive mortar in accordance with Sec 1066. Excess mortar forced out of the holes shall be removed. The location of anchor bolts in relation to the center of slotted holes provided in movable plates and shoes shall be varied to compensate for the movement of spans due temperatures above or below 60°F. Nuts on anchor bolts through moving parts of expansion bearings shall be adjusted to provide ample clearance for free movement of the span.

712.5.4 Grouting. Grouting under bearing plates and castings to build the bearing plates and castings to the proper grade will not be permitted. Steel shims the full size of the plate of the bearing device may be used for this purpose. Shims shall be placed between the bottom of the stringers and the top of bearing plates, if practical, and shall be straightened to a plane surface.

712.6 Field Welding. All field welding shall be performed in accordance with Sec 1080.

712.6.1 Certification. All field welders shall be certified to weld on all steel products incorporated in St. Charles County projects.

712.6.2 Testing. Field welders shall be certified by a test facility with an established accredited American Welding Society (AWS) Certified Welder Program as defined in the current AWS Standard QC 4. Welders shall be certified per the current QC 7 Standard for AWS Certified Welders. The code of acceptance shall be AWS Bridge Welding Code D1.5 and qualifications range shall include the processes, positions, filler and base metal type as the work requires. Certification maintenance per applicable AWS Code of Acceptance shall be the responsibility of the certification holder. A copy of the current welder’s certification from the AWS test facility shall be delivered to the Engineer. The Engineer may require recertification if there is specific reason to question the welder’s ability.

712.6.3 Welding Procedures. Welding procedures shall be submitted for review prior to welding, at the Engineer’s request. The Engineer may verify the quality of a certified welder at any time.

712.7 High-Strength Bolt Installation.

712.7.1 Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed one in 20 with respect to a plane normal to the bolt axis. All bolted parts, including underhead bearing areas and joint surfaces within the grip of the bolt, shall fit solidly together when assembled in the snug tight condition, and shall not be separated by gaskets or any other interposed compressible material. When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale, dirt, burrs, other foreign material and other defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil and paint, except in accordance with Sec 1081.3.9, lacquer, rust inhibitor and galvanizing. All bolts, nuts and washers shall be free of rust, burrs, dirt, other foreign material and other defects that would prevent proper tensioning. All nuts for coated high-strength bolts shall be properly lubricated with a visible water-soluble
lubricant. All nuts for uncoated high-strength bolts shall be properly lubricated with a water-soluble lubricant that is oily to the touch.

712.7.2 Snug Tightness of Connections. Regardless of the method of final tightening used to install the fasteners, the joint and all fasteners shall first be brought to the snug tight condition. Snug tight will be defined as the tightness where all faying surfaces of the joint are in firm contact as attained by a few impacts of an impact wrench or the full effort of a person using an ordinary spud wrench. Following the initial snug tightening of the fitting-up bolts, the remaining holes shall be filled with high strength bolts and tightened to a snug tight condition. All final bolts completing the connection shall be high strength and required nominal diameter. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges. Bolts shall be retightened in a similar manner as necessary until all bolts are simultaneously snug tight, and the section is fully compacted with the bolted parts of the joint in full contact. For Type 3 and Type 1 bolts that will be field coated, if a connection is not completely tightened within five days of snug tightening, the Contractor shall remove five percent or five bolts (whichever is less) of a given connection and conduct rotational capacity testing in accordance with Sec 1080 to verify nut lubrication. For bolted field splices, the amount of bolts specified for bolt removal shall apply to each element of the splice (top flange, web and bottom flange). If the rotational capacity test is unacceptable, all bolts shall be removed, inspected, relubricated and then may be reinstalled. For galvanized bolts, the above condition shall be met as well as the threads of the bolts and nuts shall be inspected for galling prior to final tensioning. Any bolts or nuts with threads that are galled shall be removed and replaced.

712.7.3 Bolt Tension. Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension shown below for the size and grade of fastener used. Threaded bolts shall be tightened by methods described in Sec 712.7.5, Sec 712.7.6, or Sec 712.7.7. If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. On non-parallel abutting surfaces where bevel washers will not be required, the nut shall be torqued against the non-sloping surface. Nuts shall be placed on the inside face of exterior girders, the top of girder flanges or in other situations the least exposed position, except if inaccessible for turning, on a sloping surface or otherwise approved by the Engineer. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds. Bolts or nuts, once tensioned and subsequently loosened (turned), shall not be used as permanent bolts or nuts. Bolt tension calibration devices shall be calibrated and certified as to accuracy by a private testing lab within one year before usage, or at any time the tensioning process indicates that the calibration is in error.

<table>
<thead>
<tr>
<th>Bolt Size. (in.)</th>
<th>Minimum Bolt Tension (lb x 1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A 325</td>
</tr>
<tr>
<td></td>
<td>A 490</td>
</tr>
<tr>
<td>1/2</td>
<td>12</td>
</tr>
<tr>
<td>5/8</td>
<td>19</td>
</tr>
<tr>
<td>3/4</td>
<td>28</td>
</tr>
<tr>
<td>7/8</td>
<td>39</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>1 1/8</td>
<td>56</td>
</tr>
<tr>
<td>1 1/4</td>
<td>71</td>
</tr>
<tr>
<td>1 3/8</td>
<td>85</td>
</tr>
<tr>
<td>1 1/2</td>
<td>103</td>
</tr>
</tbody>
</table>

712.7.4 Washers. All fasteners shall have a hardened washer under the nut or bolt head, whichever is turned in tightening. All fasteners over all oversized or slotted holes shall also have a hardened washer under the nonturned element. Where an outer face of the bolted parts has a slope of more than one in 20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.
712.7.5 Calibrated Wrench Method. When calibrated wrenches are used to provide the bolt tension specified in Sec 712.7.3, the wrench setting shall be such as to induce a bolt tension 5 to 10 percent in excess of the specified value. Wrenches shall be calibrated at least once each working day by tightening in a device capable of indicating actual bolt tension no less than three typical bolts of each diameter from the bolts to be installed. Power wrenches shall be adjusted to stall or cut out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the selected tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. After the joint has been brought to a snug tight condition, all bolts in the joint shall be tightened by progressing systematically from the most rigid part of the joint to the free edges. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the selected tension. During tightening, there shall be no rotation of the part not turned by the wrench.

712.7.6 Turn-of-Nut Method. When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a snug tight condition as defined in Sec 712.7.2 to ensure that the parts of the joint are brought into full contact with each other. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable nut rotation specified below, with tightening progressing systematically from the most rigid part of the joint to the free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

<table>
<thead>
<tr>
<th>Nut Rotation from Snug Tight Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposition of Outer Faces of Bolted Parts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bolt length measured from underside of head to extreme end of point</th>
<th>Bolt faces normal to bolt axis</th>
<th>One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)</th>
<th>Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 4 diameters</td>
<td>1/3 turn</td>
<td>1/2 turn</td>
<td>2/3 turn</td>
</tr>
<tr>
<td>Over 4 diameters but not exceeding 8 diameters</td>
<td>1/2 turn</td>
<td>2/3 turn</td>
<td>5/6 turn</td>
</tr>
<tr>
<td>Over 8 diameters but not exceeding 12 diameters</td>
<td>2/3 turn</td>
<td>5/6 turn</td>
<td>1 turn</td>
</tr>
</tbody>
</table>

Nut rotation shall be relative to bolts, regardless of the element (nut or bolt) being turned. For bolts installed by one-half of a turn and less, the tolerance will be ± 30 degrees. For bolts installed by two-thirds of a turn and more, the tolerance will be ± 45 degrees.

712.7.7 Load Indicating Bolt Method. Tightening by this method will be permitted, provided it can be demonstrated by the following procedure that the bolt has been tightened, at a minimum, to the bolt tension indicated in Sec 712.7.3. Three bolts of a representative length and of the same grade, diameter and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. There shall be a washer under the part turned in tightening each bolt. Each bolt specified shall be tightened in the calibration device until the spline drive has sheared off. When this method is used to provide the bolt tension, all bolts in the joint shall be tightened in stages to prevent or minimize slackening of the installed bolts. The first stage shall be to tighten all bolts to a snug tight condition at which point all of the faying surfaces of the joint shall be firmly in contact. The final stage of tightening to full tension shall be accomplished by progressing systematically from the most rigid part of the joint to the free edges.
712.7.8 Bolt Length. When snug tight, the beginning of the bolt threads shall be even with or project slightly beyond the nut. When properly tensioned, the bolt projections beyond the nut shall be as such to prevent the nut from engaging the thread runout.

712.7.9 Bolt Tension Calibration Device. A Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device will be required at each job site during erection. Periodic testing, at least once each working day when the calibrated wrench method is used, shall be performed to assure compliance with the installation test procedures required for the tightening method used, and to perform pre-installation job site rotational capacity testing. Bolts too short for the Skidmore-Wilhelm Calibrator may be tested using direct tension indicators (DTI). The DTI shall be calibrated in the Skidmore-Wilhelm Calibrator using longer bolts. Bolt tension calibration devices shall be calibrated and certified as to accuracy by a private testing laboratory within one year before usage or at any time the accuracy is questionable.

712.7.10 Rotational-Capacity Testing. The rotational-capacity test shall be performed on each rotational capacity lot prior to the start of bolt installation. Hardened steel washers shall be part of the test, regardless if washers will not be required as part of the installation procedure. Bolt, nut, and washer when required, combinations as installed shall be only from the established and tested rotational-capacity lot.

712.7.11 Weathered Bolts. Weathered or rusted bolts or nuts not in accordance with Sec 712.7.1, Sec 712.7.3, and Sec 712.7.10 shall be cleaned and relubricated prior to installation. Recleaned or relubricated bolt, nut and washer assemblies shall be retested in accordance with Sec 712.7.10 prior to installation.

712.7.12 Inspection. The Engineer will observe the installation and tightening of bolt assemblies to determine that the selected tightening procedure is properly used, and will determine that all bolt assemblies are tightened. The following verification inspection will be used:

(a) Either the Engineer, or the Contractor in the presence of the Engineer, will use an inspecting torque wrench and bolt tension calibration device furnished by the Contractor.

(b) Five bolt assemblies of a representative length, and of the same grade, diameter and condition as those under inspection will be placed individually in a calibration device capable of indicating bolt tension. There will be a washer under the part turned in tightening each bolt. Each bolt specified will be tightened in the device by any convenient means to the minimum tension specified in Sec 712.7.3. The inspecting torque wrench then will be applied to the tightened bolt, and the torque necessary to turn the nut or head 5 degrees, approximately one inch at 12 inch radius, in the tightening direction will be determined. Of the five values obtained, the highest and the lowest values will be disregarded, with the average of the remaining three being taken as the job inspecting torque to be used in the manner specified in Sec 712.7.12. The inspecting torque will be re-established at intervals of no more than 30 calendar days or at any time appreciable changes are encountered.

(c) Bolts represented by the sample prescribed in Sec 712.7.12 that have been tightened in the structure will be inspected by applying, in the tightening direction, the inspecting wrench and the wrench’s job inspecting torque to 10 percent of the bolts, but no less than two bolts, selected at random in each connection. If no nut or bolt head is turned by this application of the job inspecting torque, the connection will be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection. All bolts whose nut or head was turned by the job inspecting torque shall be tightened and re-inspected.

(d) Calibrated wrench tightening will be verified during actual installation in the assembled steel work. The wrench adjustment selected by the calibration shall not produce a bolt or nut rotation from snug tight greater than permitted in Sec 712.7.6.

712.8 Field Coating. Field coating of structural steel shall be in accordance with Sec 1081.
712.9 Steel Bar Dams. Steel bar dams placed at expansion devices on existing bridges to serve as headers for surfacing material shall be installed in a manner that will not interfere with the movement of the expansion devices.

712.10 Method of Measurement.

712.10.1 Steel and Iron. Payment for structural steel and wrought iron weights will be based on contract plan quantities. The theoretical weight of the various sections will be used to compute the contract plan quantities of the material incorporated in the completed structure. No allowance will be made for overrun in scale weights or for erection bolts, excess field bolts or similar items, or the weight of any coating, galvanizing or weld material.

712.10.2 Bolts. The weight of steel bolts for steel-to-steel connections will be included in the contract plan quantities for fabricated structural steel on the basis of following weights per 100 bolts:

<table>
<thead>
<tr>
<th>Bolt Size (in.)</th>
<th>Weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>40</td>
</tr>
<tr>
<td>3/4</td>
<td>65</td>
</tr>
<tr>
<td>7/8</td>
<td>95</td>
</tr>
<tr>
<td>1</td>
<td>135</td>
</tr>
</tbody>
</table>

*These specified weights will be considered to cover the head, nut, any required washers and only that part of the bolt extending outside the grip of steel.

712.10.3 Connection to Concrete or Timber. The weight of bolts connecting steel to concrete or timber will be included for payment as fabricated structural steel, and the full weight of the bolts will be computed.

712.10.4 Castings. Castings will be computed on the basis of the theoretical weight of the material in the completed structure, and no allowance will be made for overrun in scale weights or for the weight of any coating material, galvanizing material or other protective coatings.

712.10.5 Accuracy of Weights. Weights of structural steel, wrought iron and castings will be computed to the nearest 10 pounds of the total weight of each class of material in the completed structure.

712.10.6 Coatings. For recoating or overcoating, the contract documents will indicate the estimated number of tons to be coated for informational purposes.

712.10.6.1 Weight Measurement. If the contract specifies a unit of measurement of coating steel structures in tons, the weight of the steel to be cleaned and coated will be based on plan quantities to the nearest 1/10-ton. The weight will not vary with the number of coats applied.

712.10.6.2 Surface Area Measurement. If the contract specifies a unit of measurement of coating steel structures in square feet, the area of the girders or stringers to have surface preparation performed or to be coated will be computed to the nearest 100 square feet. The bearings, diaphragms, stiffeners and all other miscellaneous steel within the limits of surface preparation or of the field coatings will not have the area computed and will be considered completely covered by the area computations of the girders or stringers. The area will not vary with the number of coats applied. Final measurement will not be made.

712.10.6.3 Lump Sum Measurement. Measurement will not be made when the contract specifies units of measurement per lump sum.
712.10.7 Bar Dams. A steel bar dam shall consist of the complete assembly on both sides of the expansion joint and will be considered a unit.

712.10.8 Shear Connectors. The weight of shear connectors will be based on the theoretical weight and will be included for payment in the weight of material to which the connectors are attached.

712.11 Basis of Payment.

712.11.1 Fabricated Steel. Payment for fabricated structural steel, fabricated wrought iron, steel castings and gray iron castings will be based on the contract plan quantities. Any change in the contract plan quantities based on approved change orders will be paid for at the contract unit price. Payment for the shop prime coat, including inaccessible areas, will be included in the cost of fabricated structural steel, and no direct payment will be made. No direct payment will be made for coating bolted field connections, touch-up, galvanizing, applying protective coating to machined surfaces or for cleaning coatings and rust streaks from finished concrete.

712.11.2 Hardware. Bolts for attaching timber members to any part of a structure will be classified as hardware and no direct payment will be made.

712.11.3 Coatings. Payment for surface preparation and applying field coatings to the structural steel, if specified as a contract item, will be based on the contract plan quantities. Any change in the contract plan quantities, based on approved change orders, will be paid for at the contract unit price. If no contract item is specified for surface preparation or applying field coatings, no direct payment will be made. Payment for the shop applied coatings, including inaccessible areas, will be considered completely covered by the cost of the fabricated structural steel. No direct payment will be made for the surface preparation or applying field coatings to the bearings, diaphragms, stiffeners and all other miscellaneous steel within the limits of surface preparation or of the field coatings. No direct payment will be made for stencils, paint and painting specified in Sec 1081. No direct payment will be made for field touch-ups or repairs specified in Sec 1081.

712.11.4 Bar Dams. The accepted number of steel bar dams will be paid for at the contract unit price.
713.1 Description. This work shall consist of furnishing and erecting steel thrie beam guardrail, including beams, posts and all appurtenances, as shown on the plans or as directed by the Engineer.

713.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guardrail Materials</td>
<td>1040</td>
</tr>
</tbody>
</table>

713.3 Construction Requirements. Anchor bolts for posts shall be set with suitable templates in position and securely fixed to prevent displacement during concreting operations. The areas upon which the bases of the posts are to bear shall be dressed smooth to a true plane. Posts shall be aligned by the use of shims such that the post deviates no more than 1/2 inch from true alignment after final adjustment.

713.4 Method of Measurement. Final measurement of the completed thrie beam for bridge guardrail will not be made except for authorized changes during construction or if appreciable errors are found in the contract quantity. Where required, measurement of thrie beam for bridge guardrail will be made to the nearest linear foot for each structure, measured along the face of the thrie beam and from center to center of end posts. The revision or correction will be computed and added to or deducted from the contract quantity.

713.5 Basis of Payment. The accepted quantity of thrie beam for bridge guardrail, complete in place, will be paid for at the contract unit price for each of the pay items included in the contract.
SECTION 715
VERTICAL DRAIN AT END BENTS

715.1 Description. This work shall consist of furnishing and installing a vertical drain system consisting of drain core, geotextile fabric, perforated and unperforated drain pipe, couplers and a rodent screen as shown on the plans or as directed by the Engineer.

715.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile</td>
<td>1011</td>
</tr>
<tr>
<td>Geocomposite Drainage Material</td>
<td>1012</td>
</tr>
<tr>
<td>Miscellaneous Drainage Material</td>
<td>1013</td>
</tr>
<tr>
<td>Corrugated Metallic-Coated Steel Pipe Underdrain</td>
<td>1022</td>
</tr>
</tbody>
</table>

715.3 Construction Requirements.

715.3.1 The Contractor shall install the vertical drain system in accordance with the manufacturer’s recommendations.

715.3.2 If the core of the drain is not perforated, modifications shall be made to the core to provide adequate drainage into the drain pipe as approved by the Engineer.

715.3.3 Vertical and horizontal joints shall be constructed to form an uninterrupted drain face after compaction is completed. All joints shall have an overlap of geotextile to prevent any intrusion of fill material into the drain. Horizontal joints shall be designed to drain downward. Any cracks or openings in the drain adjacent to the fill will be cause for rejection of the drain, and the drain shall be replaced by the Contractor, at the Contractor’s expense.

715.3.4 The backfill material shall be placed and compacted in accordance with Sec 206. The backfill shall be placed in such a manner as to prevent damage to the vertical drain system. The backfill material shall be as approved by the Engineer.

715.4 Method of Measurement. The work provided herein will not be measured for payment, but will be considered completely paid for as a system, per each.

715.5 Basis of Payment. The accepted vertical drain system, complete in place, will be paid for at the contract unit price for vertical drain at end bents, per each. No direct payment will be made for excavation, backfilling, compaction, drain pipe or other material and work.
SECTION 716
NEOPRENE BEARINGS

SECTION 716.10 PLAIN AND LAMINATED NEOPRENE BEARING PADS.

716.10.1 Description. This work shall consist of furnishing and installing complete factory-produced plain or laminated neoprene bearing pads as shown on the plans or as directed by the Engineer.

716.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomeric Bearing Pads</td>
<td>1038</td>
</tr>
</tbody>
</table>

716.10.3 Construction Requirements. The neoprene pads shall be bonded to the bearing seat with an epoxy adhesive, in accordance with the bearing manufacturer’s recommendations for bonding neoprene to concrete to prevent sliding.

716.10.4 Method of Measurement. Measurement will be made per each. The plain neoprene bearing pad, complete in place, shall include the plain neoprene bearing pad and any incidental materials needed to complete the work. The laminated neoprene bearing pad, complete in place, shall include the laminated neoprene bearing pad and any incidental material needed to complete the work.

716.10.5 Basis of Payment. The accepted quantity of plain neoprene bearing pads will be paid for at the contract unit price.

SECTION 716.20 LAMINATED NEOPRENE BEARING PAD ASSEMBLY.

716.20.1 Description. This item shall include furnishing and installing complete factory produced bearings as shown on the plans or as directed by the Engineer.

716.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomeric Bearing Pads</td>
<td>1038</td>
</tr>
</tbody>
</table>

716.20.3 Construction Requirements. All sole plates shall be furnished with the bearings as a complete unit and directly welded to the girder or stringer as shown on the plans. The neoprene pads shall be bonded to the bearing seat with an epoxy adhesive in accordance with the bearing manufacturer’s recommendations for bonding neoprene to concrete to prevent sliding.

716.20.4 Method of Measurement. Measurement will be made per each. The laminated neoprene bearing pad assembly, complete in place, shall include the steel sole plate, laminated neoprene bearing pad, anchor bolts, heavy hexagon nuts, coating and any incidental material needed to complete the work.

716.20.5 Basis of Payment. The accepted quantity of laminated neoprene bearing pad assemblies will be paid for at the contract unit price.

SECTION 716.30 TYPE “N” POLYTETRAFLUROETHYLENE (PTFE) BEARINGS.
716.30.1 Description. This work shall consist of furnishing and installing complete factory produced Type “N” PTFE bearings as shown on the plans or as directed by the Engineer.

716.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type “N” PTFE Bearings</td>
<td>1038</td>
</tr>
</tbody>
</table>

716.30.3 Construction Requirements. All sole plates shall be furnished with the bearings as a complete unit and directly welded to the girder or stringer as shown on the plans. At the time of installation, the stainless-steel sliding face of the upper element and the PTFE sliding face of the lower element shall have the surface finish specified and shall be free of all dust, dirt, moisture or any other foreign matter. The neoprene pads shall be bonded to the bearing seat with an epoxy adhesive in accordance with the bearing manufacturer’s recommendations for bonding neoprene to concrete to prevent sliding. The top and bottom plates shall be properly aligned before gluing pads.

716.30.4 Method of Measurement. Measurement will be made per each. The type “N” PTFE bearing, complete in place, shall include the steel sole plate, stainless steel plates, PTFE face on the stainless-steel plates, laminated neoprene bearing pad, anchor bolts, heavy hexagon nuts, coating and any incidental material needed to complete the work.

716.30.5 Basis of Payment. The accepted quantity of type “N” PTFE bearings will be paid for at the contract unit price.
SECTION 717 FLEXIBLE JOINT SYSTEMS

SECTION 717.10 PREFORMED COMPRESSION SEAL.

717.10.1 Description. This work shall consist of furnishing and installing a preformed compression seal for joints as shown on the plans or as directed by the Engineer. Structural steel for the joints shall be furnished and installed as shown on the plans.

717.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preformed Compression Seals</td>
<td>1073</td>
</tr>
</tbody>
</table>

717.10.3 Construction Requirements.

717.10.3.1 Shop Drawings. Shop drawings for structural steel for expansion joint systems shall be prepared in accordance with Sec 1080. The dimensions of the seal shall be shown on the shop drawings for the armored joint. Shop drawings will not be required when the seal is placed against concrete or existing steel armor.

717.10.3.2 Installation. The preformed compression seal shall be installed in joints in one continuous piece without field splices. Factory splicing will be permitted for joints in excess of 53 feet. The area of steel armor to come in contact with preformed compression seal lubricant adhesive shall be sand blasted prior to installing the seal. Sand blasting will be considered acceptable when the steel surfaces have been cleaned to an SSPC-SP10 degree of cleanliness. Containment and disposal of material shall be in accordance with Sec 202.2. The lubricant adhesive shall be applied in a continuous film to the sides of the seal and to the joint surfaces just prior to placing the seal in the joint. The seal shall be installed with an installation tool recommended by the manufacturer, in a manner that prevents the seal from being damaged and from being in tension. Twisting, curling and nicking the seal will be prohibited. Lubricant adhesive on top of the installed seal shall be removed before drying. Unless the installation tool is capable of installing the seal without elongation prior to placement, the seal shall be pre-cut to the exact length for the joint plus ends as shown in the contract documents. The precut seal shall be installed and measured for stretch. The seal shall be removed and reinstalled if the seal stretch length exceeds five percent of the pre-cut length.

717.10.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where significant errors are found in the contract quantity. Where required, the preformed compression seal will be measured to the nearest linear foot based on measurement from roadway face of curb to roadway face of curb along the centerline of the joint. The revision or correction will be computed and added to or deducted from the contract quantity. No measurement will be made of portions of the joint that extend past the roadway face of curbs.

717.10.5. Basis of Payment. Preformed compression seals, including all material, coating, equipment, labor, fabrication, installation and any other incidental work necessary to complete this work, will be paid for at the contract unit price.

SECTION 717.20 STRIP SEAL.

717.20.1 Description. This work shall consist of furnishing and installing a watertight strip seal for joints as shown on the plans or as directed by the Engineer. The structural steel for the joints shall be furnished and installed as shown on the plans.
**717.20.2 Material.** All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip Seal</td>
<td>1073</td>
</tr>
</tbody>
</table>

**717.20.3 Construction Requirements.**

**717.20.3.1 Shop Drawings.** Shop drawings for structural steel for expansion joint systems shall be prepared in accordance with Sec 1080. The drawings shall show in detail the type, size, location of anchors, and sequence of installation. The dimensions of the seal shall be shown on the shop drawings for the armored joint. The cavity in the steel armor (also known as an extrusion) shall be of a dimensional tolerance that prevents the lug of the strip seal gland from slipping loose. The upper lip of the extrusion shall extend over the bottom lip to avoid pinching the gland when the expansion joint system is in a closed position. Shop drawings will not be required when the seal is placed in existing steel extrusions.

**717.20.3.2 Installation.** The area of steel armor to come in contact with strip seal lubricant adhesive shall be sand blasted prior to installing the seal. Sand blasting will be considered acceptable when the steel surfaces have been cleaned to an SSPC-SP10 degree of cleanliness. Containment and disposal of material shall be in accordance with Sec 202.2. The strip seal shall be made watertight with a lubricant adhesive for bonding the neoprene gland to the steel extrusion as recommended by the manufacturer. The Contractor shall obtain the services of a qualified technical representative, approved by the manufacturer of the expansion system and acceptable to the Engineer, to assist during the installation. The installation shall not occur without the technical representative being present.

**717.20.4 Method of Measurement.** Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, the strip seal will be measured to the nearest linear foot, based on measurement from the roadway face of curb to roadway face of curb along the centerline of the joint. The revision or correction will be computed and added to or deducted from the contract quantity. Portions of the joint that extend past the roadway face of curbs will not be measured for payment.

**717.20.5. Basis of Payment.** Strip seals, including all material, coating, equipment, labor, fabrication, installation, technical assistance, and any other incidental work necessary to complete this work, will be paid for at the contract unit price.

**SECTION 717.30 SILICONE EXPANSION JOINT SEALANT.**

**717.30.1 Description.** This work shall consist of furnishing and installing the backer rod and silicone expansion joint sealant for joints as shown on the plans or as directed by the Engineer. Structural steel for the joints shall be furnished and installed as shown on the plans.

**717.30.2 Material.** All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone Expansion Joint Sealant</td>
<td>1057</td>
</tr>
</tbody>
</table>

**717.30.3 Construction Requirements.** The Contractor shall furnish to the Engineer the manufacturer's written product information, installation procedures and instructional information at least two weeks prior to installation. The Contractor shall obtain the services of a qualified technical representative approved by the manufacturer of...
the expansion system and acceptable to the Engineer, to assist during the installation. The Contractor, the technical representative and the Engineer shall meet to review and clarify installation procedures and requirements prior to starting the work. The start of surface preparations and sealant installation shall not occur without the technical representative being present. The technical representative shall be present for at least one day at the start of surface preparations and sealant installation.

717.30.3.1 Shop Drawings. Shop drawings for structural steel for expansion joint systems shall be prepared in accordance with Sec 1080. The dimensions of the seal shall be shown on the drawings for the armored joint. Shop drawings will not be required when the sealant is placed against concrete or existing steel armor.

717.30.3.2 Surface Preparation. The concrete or steel surface shall be prepared for priming and sealant placement. New Portland cement concrete shall be fully cured and allowed to dry a minimum of seven days. The joint shall be cleaned of all gravel, loose material and other contaminate before sand blasting. Areas that will be in contact with the sealant shall be sand blasted with a clean, hard aggregate that will leave little to no dust residue. Sand blasted concrete surfaces will be considered acceptable when areas that will be in contact with the sealant have a roughened surface with clean, exposed aggregate. The surface shall be free of foreign matter or plastic residue. Sand blasted steel surfaces will be considered acceptable when the steel surfaces have been cleaned to an SSPC-SP10 degree of cleanliness. Containment and disposal of material shall be in accordance with Sec 202.2. After sand blasting is completed, the joint shall be cleaned of debris using oil-free and water-free compressed air or a vacuum, either being at least 90 psi.

717.30.3.3 Priming. Priming shall immediately follow sand blasting and cleaning and will only be permitted to proceed when the air and substrate temperatures are at least 40°F and rising. Sand blasting, priming and sealing shall be performed on the same day. The entire sand blasted surface shall be primed. Application and drying times for primers shall be in accordance with the manufacturer’s recommendations. All leftover primer shall be properly disposed.

717.30.3.4 Joint Installation. The backer rod shall be installed as specified on the plans and in accordance with the manufacturer’s recommendations. All voids in the installed backer rod shall be filled to prevent sealant leakage.

717.30.3.5 Sealant Placement. The sealant thickness and recess depth shall be as shown in the contract documents and shall be measured during installation at approximately 2 foot intervals. Adjustments to correct sealant thickness to within ± 1/8 inch tolerance shall be made before the sealant begins to set. Sealant placement will only be permitted when the air and substrate temperatures are above 40°F, below 90°F and 5°F above the dew point. The joint surfaces shall be kept clean and dry during sealing. The joint shall remain clean and dry during the sealing operation. Sealing shall be performed using a pneumatic gun in accordance with the manufacturer’s recommendations. End of seal treatment at vertical faces of curbs, sidewalks or parapets shall be as recommended by the manufacturer and as shown in the contract documents. Sealant placed incorrectly shall be removed and replaced at the Contractor’s expense.

717.30.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, the silicone expansion joint sealant will be measured to the nearest linear foot based on measurement from the roadway face of curb to roadway face of curb along the centerline of the joint. The revision or correction will be computed and added to or deducted from the contract quantity. Portions of the joint that extend past the roadway face of curbs will not be measured for payment.

717.30.5 Basis of Payment. Silicone expansion joint sealant, including all materials, coating, equipment, labor, fabrication, installation, technical assistance and any other incidental work necessary to complete this work, will be paid for at the contract unit price.

SECTION 717.40 SILICONE JOINT SEALANT FOR SAW CUT AND FORMED JOINTS.
717.40.1 Description. This work shall consist of sealing the saw cut and formed joints as shown in the contract documents.

717.40.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone Joint Sealant for Saw Cut and Formed Joints</td>
<td>1057</td>
</tr>
</tbody>
</table>

717.40.3 Construction Requirements.

717.40.3.1 Saw Cut Joints. Joints shall be sawed as shown on the plans as soon as the concrete has hardened sufficiently to permit sawing of a neat straight joint with minimal raveling, and before uncontrolled shrinkage cracking occurs. All joints shall be sawed to the required dimension and cleaned by sand blasting, wire brushing or other methods approved by the Engineer in accordance with the manufacturer’s recommendations. Joint interfaces shall be fully cured and dry, or free of moisture at the time of installation. All loose particles shall be removed by oil-free and water-free compressed air or a vacuum of at least 90 psi before the application of the backer rod and sealant.

717.40.3.2 Formed Joints. Any joints 0.25 inch or greater shall be cleaned and packed with backer rod and silicone joint sealant. Any joints less than 0.25 inch shall be cleaned and caulked with silicone joint sealant as shown on the plans. All joint interfaces shall be cleaned by grinding, saw cutting, sand blasting, wire brushing or other methods approved by the Engineer in accordance with the manufacturer’s recommendations. New Portland cement concrete shall be fully cured and allowed to dry a minimum of seven days. The joint interfaces shall be free of moisture at the time of installation. All loose particles shall be removed by oil-free and water-free compressed air or vacuum of at least 90 psi before the application of the backer rod and sealant.

717.40.3.3 Joint Backer Rod. The backer rod shall be used in the joint slot to ensure the sealant adheres to the sidewalls or interface of the joint. All joint areas requiring a backer rod shall be packed with a closed-cell, expanded polyethylene foam to obtain the appropriate depth of the sealant. The backer rod shall be slightly oversized for the joint width, and shall be resilient, compressible in nature, nonabsorbent, non-shrinking and compatible with the sealant.

717.40.3.4 Sealant Placement. Sealant shall be placed in the proper configuration as shown on the plans. Joint sealer shall be protected from dust and other foreign matter until cured to a tack-free condition. The sealant shall fill the joint from the bottom to slightly below the surface currently being applied. Immediately after placement and before a skin forms, the sealant shall be tooled to force the sealant against the joint face and to recess the bead approximately 1/8 inch.

717.40.3.5 Containment and disposal of material shall be in accordance with Sec 202.2.

717.40.4 Method of Measurement. No measurements will be made.

717.40.5 Basis of Payment. No direct payment will be made for this work.

SECTION 717.50 OPEN CELL FOAM JOINT.

717.50.1 Description. This work shall consist of furnishing and installing an open cell foam joint system as shown on the plans, as directed by the Engineer and in accordance with the manufacturer’s requirements.
717.50.2 **Material.** All material shall be in accordance with [Division 1000](#), Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Cell Foam Joints</td>
<td>1073</td>
</tr>
</tbody>
</table>

717.50.3 **Construction Requirements.** The Contractor shall have a manufacturer’s representative on site for the joint installation. The representative shall be responsible for ensuring the surface preparation and joint installation are done in accordance with the manufacturer’s requirements.

717.50.3.1 **Field Splices.** The Open Cell Foam shall be installed in one continuous piece without field splices, unless otherwise specified on the plans or directed to by the Engineer. Open Cell Foam shall be spliced with silicone called for in Sec 1057 and in accordance with the manufacturer’s recommendations.

717.50.4 **Method of Measurement.** Final measurement will not be made except for authorized changes during construction or where significant errors are found in the contract quantity. Where required, the open cell foam joint will be measured to the nearest linear foot based on measurement from roadway face of curb to roadway face of curb along the centerline of the joint. The revision or correction will be computed and added to or deducted from the contract quantity. No measurement will be made of portions of the joint that extend past the roadway face of curbs.

717.50.5 **Basis of Payment.** Open cell foam joint, including all material, coating, equipment, labor, fabrication, installation and any other incidental work necessary to complete this work, will be paid for at the contract unit price for Open Cell Foam Joint.

**SECTION 717.60 PREFORMED SILICONE OR EPDM EXPANSION JOINTS.**

717.60.1 **Description.** This work shall consist of furnishing and installing a preformed silicone or EPDM expansion joint seal for joints as shown on the plans or as directed by the Engineer and in accordance with the manufacturer’s requirements.

717.60.2 **Material.** All material shall be in accordance with [Division 1000](#), Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preformed Silicone or EPDM Expansion Joints</td>
<td>1073</td>
</tr>
</tbody>
</table>

717.60.3 **Construction Requirements.** The Contractor shall furnish to the Engineer the manufacturer’s written product information, installation procedures and instructional information at least two weeks prior to installation. The Contractor shall obtain the services of a qualified technical representative approved by the manufacturer of the expansion joint seal and acceptable to the Engineer, to assist during the installation. The Contractor, the technical representative and the Engineer shall meet to review and clarify installation procedures and requirements prior to starting the work. The start of surface preparations and seal installation shall not occur without the technical representative being present. The technical representative shall be present for at least one day at the start of surface preparations and seal installation.

717.60.3.1 **Surface Preparation.** The concrete or steel surface shall be prepared for priming and seal placement. New Portland cement concrete shall be fully cured and allowed to dry a minimum of seven days. The joint shall be cleaned of all gravel, loose material and other contaminates before sand blasting. Areas that will be in contact with the sealant shall be sand blasted with a clean, hard aggregate that will leave little to no dust residue. Sand blasted
concrete surfaces will be considered acceptable when areas that will be in contact with the sealant have a roughened surface with clean, exposed aggregate. The surface shall be free of foreign matter or plastic residue. Sand blasted steel surfaces will be considered acceptable when the steel surfaces have been cleaned to an SSPC-SP10 degree of cleanliness. Containment and disposal of material shall be in accordance with Sec 202.2. After sand blasting is completed, the joint shall be cleaned of debris using oil-free and water-free compressed air or a vacuum, either being at least 90 psi. Using a rag saturated in denatured alcohol, wipe clean both vertical faces of the expansion joint opening.

717.60.3.2 Priming. Priming shall immediately follow sand blasting and cleaning and will only be permitted to proceed when the air and substrate temperatures are at least 40°F and rising. Sand blasting, priming and installing the seal shall be performed on the same day. The entire sand blasted surface shall be primed. Application and drying times for primers shall be in accordance with the manufacturer’s recommendations. All leftover primer shall be properly disposed.

717.60.3.3 Installation. The preformed silicone or EPDM expansion joint seal shall be installed in joints in one continuous piece without field splices. The locking adhesive and seal shall be applied in accordance with the manufacturer’s recommendations, in a manner that prevents the seal from being damaged and from being in tension. Twisting, curling and nicking the seal will be prohibited. Unless the installation tool is capable of installing the seal without elongation prior to placement, the seal shall be pre-cut to the exact length for the joint plus ends as shown in the contract documents or as directed by the Engineer. The pre-cut seal shall be installed and measured for stretch. The seal shall be removed and reinstalled if the seal stretch length exceeds five percent of the pre-cut length at the Contractor’s expense.

717.60.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where significant errors are found in the contract quantity. Where required, the preformed silicone or EPDM expansion joint will be measured to the nearest linear foot based on measurement from roadway face of curb to roadway face of curb along the centerline of the joint. The revision or correction will be computed and added to or deducted from the contract quantity. No measurement will be made of portions of the joint that extend past the roadway face of curbs.

717.60.5 Basis of Payment. Preformed silicone or EPDM expansion joint, including all material, coating, equipment, labor, fabrication, installation and any other incidental work necessary to complete this work, will be paid for at the contract unit price for Preformed Silicone or EPDM Expansion Joint.
SECTION 719
MODULAR BLOCK RETAINING WALL SYSTEMS

719.1 Description

719.1.1 This work consists of furnishing and erecting modular block retaining walls as indicated on the plans. The wall shall have polymeric reinforcement meeting the requirements of the wall manufacturer. The wall units shall have a discrete modular precast facing and uniform color throughout, however unfaced welded wire wall systems may be used for temporary walls and temporary embankment support.

719.1.2 The modular block wall shall be a gray color and flat (smooth-faced) block. The actual color to be used shall be subject to the approval of the Engineer prior to installation. Any variations in color, uniformity and general appearance of the facing of the wall units may be cause for rejection.

719.1.3 Wall System Approval. The Contractor shall submit following information a minimum of 30 days prior to the installation of the wall:

   A letter requesting approval of the system.
   
   Color catalog cuts clearly showing the visual appearance of the wall.
   
   Detailed design and installation information for the wall.

719.1.3.1 The Contractor will be fully responsible for any costs incurred due to delays caused by late submittals or due to incomplete, illegible, or inaccurate information.

719.1.4 Filter Cloth. A filter cloth shall be placed at all wall joints in front of the selected granular backfill mass. The filter cloth shall be Mirafi 135N or an approved equal.

719.1.5 Leveling Pad. Wall units shall be placed on a (6") non-reinforced cast-in-place concrete leveling pad or on a twelve inch (12") thick compacted Type 1 or Type 5 Aggregate leveling pad.

719.2 Design of Wall

719.2.1 The modular block wall shall be designed in accordance with the 1996 AASHTO Standard Specification for Highway Bridges, including the 1997 Interim Specifications, Section 5, Retaining Walls. The wall shall be designed for SEISMIC PERFORMANCE CATEGORY B, and shall be subject to any additional requirements as may elsewhere be shown in the plans or covered in this specification.

719.2.2 The Contractor and manufacturer are responsible for the internal and external stability of the structure. The Contractor and manufacturer shall be further responsible for overall or global stability. The design angle of internal friction, $\Phi$, for the retained earth shall not be taken to be less than 27 degrees.

719.2.3 Shop Drawings and Design Calculations. The successful bidder shall submit five (5) sets of completed wall plans, design calculations and shop drawings. These plans and shop drawings shall be submitted regardless of whether or not earth reinforcements and select backfill are required. All design plans, calculations, and shop drawings shall be signed and sealed by a Registered Professional Engineer in the State of Missouri. The shop drawings shall demonstrate that the wall meets the minimum elevation requirements shown on the plans. The Contractor will be fully responsible for any costs incurred due to delays caused by late submittals or due to incomplete, illegible, or inaccurate shop drawings and calculations.
719.2.4 Completed wall design plans shall also contain all material specifications, fabrication requirements, and all construction requirements for erecting the wall complete in place. Polymeric reinforcing grid may be required and shall extend into the fill as indicated on the approved shop drawings. Any requirements on the design plans conflicting with this special provision shall not be used.

719.2.5 Underdrains. All retaining walls should include an underdrain system. The underdrain pipes shall be polyvinyl chloride with a nominal internal diameter of four (4") or six inches (6") and shall be perforated or unperforated in accordance with the details shown in the plans. The underdrain pipes shall extend to daylight or a drainage structure.

719.2.6 The Contractor shall indemnify and save harmless the County from all claims for infringement by reason of the use of any patented process by others without the consent of the patent owner.

719.3 Selected Granular Backfill Material

719.3.1 To insure proper functioning of the structure, all select backfill materials used in the structure volume shall conform to the following gradation limits and be obtained from natural sources, have a Plasticity Index (P.I.) as determined by AASHTO T-90 of less than 6 and conform to the following gradation limits:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Inches</td>
<td>100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 – 60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

719.3.2 If the select granular backfill proposed for use by the Contractor does not meet the above requirements, the Contractor must provide the following information:

(a) (1) The direct shear test - AASHTO T-236, utilizing a sample of the material compacted to 95 percent of maximum density as determined by AASHTO T-99 Methods C or D (with oversize correction, as outlined in Note 7) at optimum moisture content;

(2) The triaxial compression test - AASHTO T-234; or

(3) Other means meeting the approval of the Engineer. Tests will ordinarily be waived for crushed stone products where 80 percent of the particles exceed

(b) Test results demonstrating that the dry unit weight of the backfill material is not less than 110 pounds per cubic foot.

(c) Test results indicating that the material is substantially free of shale or other soft, poor durability particles, and has a magnesium sulfate soundness loss of less than 30 percent after 4 cycles.

(d) Test results demonstrating that the selected granular backfill materials also meet the following electrochemical requirements:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Test Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistivity 3000-ohm centimeters</td>
<td>California DOT 643</td>
</tr>
<tr>
<td>pH 5-10</td>
<td>California DOT 643</td>
</tr>
<tr>
<td>Chlorides # 200 parts per million</td>
<td>California DOT 422</td>
</tr>
<tr>
<td>Sulfates # 1000 parts per million</td>
<td>California DOT 417</td>
</tr>
</tbody>
</table>
719.3.2.1 Excepting pH, the electrochemical requirements are waived for wall systems with a totally nonmetallic reinforcement and connecting system to the wall units.

719.3.3 Backfill not conforming to this specification shall not be used without the written consent of the Engineer. The Contractor shall furnish to the Engineer a Certificate of Compliance certifying the selected granular backfill material complies with this section of the specifications. A copy of all test results performed by the Contractor or its supplier necessary to assure contract compliance shall also be furnished to the Engineer.

719.3.4 Acceptance will be based on the Certificate of Compliance, accompanying test reports, and any applicable tests performed by the Engineer.

719.3.5 The frequency of sampling of selected granular backfill, necessary to assure gradation control throughout construction, shall be as directed by the Engineer.

719.4 Foundation Preparation. The foundation for the structure shall be graded level for a width equal to or exceeding the length of the reinforcing strips, or as shown on the approved shop drawings. Prior to wall construction, the foundation, if not in rock, shall be compacted as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed and replaced at the Contractor's sole expense, as directed by the Engineer.

719.4.1 At each wall unit foundation level, a six inch (6") thick by eighteen inches (18") wide nonreinforced concrete leveling pad or twelve inches (12") thick by eighteen inch (18") wide compacted Type 1 or Type 5 Aggregate leveling pad shall be provided as shown on the approved shop drawings. Concrete leveling pads shall be constructed from Class B or B1 concrete, be cured a minimum of 12 hours before placement of wall blocks, and have a 28-day strength, f'c, of 3,000 p.s.i.

719.5 Backfill Placement. Backfill placement shall closely follow the erection of each course of blocks. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels. Any wall materials which become damaged or disturbed during backfill placement shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall blocks due to placement of backfill outside the limits of this specification shall be corrected, as directed by the Engineer.

719.5.1 Backfill shall be compacted in accordance with Sec 203 of the Standard Specifications with the following exceptions:

(a) Minimum density shall not be less than 95 percent of maximum dry density.

(b) For backfills containing more than 30 percent retained on the three-quarter inch (3/4") sieve, a method of compaction consisting of at least four (4) passes by a heavy roller shall be used.

(c) The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content.

(d) Compaction within three feet (3') of the back face of the wall shall be achieved by at least three (3) passes of a lightweight mechanical tamper, roller, or vibratory system.

(e) At the end of each day's operation, the Contractor shall slope the last level of the backfill away from the wall facing to rapidly direct runoff away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

719.6 Cap Blocks and Miscellaneous Requirements
719.6.1 Cap blocks are required for the top wall course of each wall tier. Adjustments to the bottom of wall elevation shall be made such that the elevation of the top wall course meets the elevations indicated on the plans. The cap blocks shall be permanently attached utilizing either a resin anchor system or an equivalent system.

719.6.2 The Contractor will be required to fill any open space in joints between the modular block wall and any adjacent structures (buildings, reinforced concrete walls, etc.) with a weatherproof caulk of tan-brown color. The color of the caulk shall be approved by the Engineer prior to use.

719.7 Technical Assistance. The Contractor shall obtain the services of a technical representative from the manufacturer to advise the Engineer, if necessary. This advisor shall be a qualified representative, acceptable to the Engineer. It will not be necessary for this representative to be present during wall construction, unless specifically requested by the Engineer.

719.8 Method of Measurement

719.8.1 The unit of measurement for furnishing and fabricating all materials for the walls, including modular blocks, excavation, reinforcement, joint materials, selected granular backfill as specified above, and incidentals, will be per square foot. The quantity to be paid will be measured from the wall outline as shown on the plans. No adjustments in the measured quantity will be permitted for additional wall area required to meet the minimum wall elevations shown on the plans for any particular wall system.

719.8.2 Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

719.9 Basis of Payment. The accepted quantity, determined as provided above, will be paid for at the contract unit price, for the pay item shown on the design plans. The contract unit price and payment will be full compensation for providing a technical advisor as needed, furnishing all materials, fabricating modular wall blocks and cap blocks, excavation, leveling pad placement and constructing the modular block wall in place. Over excavation for unsuitable soils will be paid for in accordance with Sec 206.
SECTION 720
MECHANICALLY STABILIZED EARTH WALL SYSTEMS

720.1 Description. This work shall consist of furnishing and constructing mechanically stabilized earth wall systems in accordance with these specifications, as shown on the plans or as directed by the Engineer.

720.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>501</td>
</tr>
<tr>
<td>Select Granular Backfill for Structural Systems</td>
<td>1010</td>
</tr>
<tr>
<td>Geotextile</td>
<td>1011</td>
</tr>
<tr>
<td>Miscellaneous Drainage Material</td>
<td>1013</td>
</tr>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
<tr>
<td>Epoxy Resin Material</td>
<td>1039</td>
</tr>
<tr>
<td>Mechanically Stabilized Earth Wall System</td>
<td>1052</td>
</tr>
</tbody>
</table>

720.2.1 Whenever a wall system is located adjacent to and within ten feet of the limits of a permanent roadway, the steel reinforcement used in the concrete elements of the wall system shall be epoxy coated. This requirement will not apply to soil reinforcement and corresponding attachments used for connecting the reinforcement to the wall system units.

720.2.2 Reinforcement for wall system units shall be either Grade 60 deformed bars or an equivalent welded steel wire fabric. Reinforcement for coping or top cap units shall be Grade 60 deformed bars.

720.2.3 Joint material for large block wall systems shall be used in accordance with the wall manufacturer’s recommendations.

720.2.4 The unit fill that is used for small block wall systems shall consist of a granular backfill in accordance with Gradation D or E of Sec 1005.

720.2.5 Class B or B-1 air entrained concrete shall be used for the coping or top cap units used for the wall system. Class B or B-1 concrete shall be used for cast-in-place concrete leveling pads used for the wall system.

720.3 Design Requirements.

720.3.1 Only the mechanically stabilized earth wall systems shown in the bridge prequalified products listing will be allowed for use by the Contractor. The bridge prequalified products list may be obtained through MoDOT’s web site. Any deviations from the prequalified wall system details previously submitted to the Engineer shall be specifically outlined in the cover letter submitted with the design plans, details and computations.

720.3.2 Small block wall systems will be permitted for uses where the wall height does not exceed ten feet. This limit may be exceeded up to a maximum height of 12 feet to accommodate peaks in the wall or to accommodate lengths of the wall that do not exceed more than ten percent of the total wall length. The height of the wall will be determined by measuring from the top of the concrete leveling pad to the top of the cap on the wall.

720.3.3 The Contractor shall submit six complete sets of the manufacturer’s design plans, details and computations for each individual wall structure to the Engineer. All submitted information shall be clear and complete, and thoroughly checked before the information is submitted. All submitted information shall be legible and of sufficient contrast.
720.3.4 The Contractor will be solely responsible for the content of the design plans, details and computations that are submitted, including global stability, and for the performance of the wall system. The Contractor shall be solely responsible for ensuring that the information submitted by the manufacturer is in accordance with all contract plans and specifications and with the wall system used. Completed design plans shall contain all material, fabrication and construction requirements for erecting the wall system complete in place. The completed design plans shall show the longitudinal and lateral layout of the drainage systems used for the wall system.

720.3.5 All design plans, details and computations submitted for distribution shall be signed, sealed and stamped in accordance with the laws relating to architects and professional Engineers (Chapter 327, RSMo).

720.3.6 Mechanically stabilized earth wall systems shall be designed in accordance with the AASHTO specifications shown on the plans and in accordance with additional publications or specifications referenced within the AASHTO specifications. The seismic performance category, angle of internal friction for the selected granular backfill for structural systems and other design requirements shown on the plans shall be incorporated into the design of the wall system.

720.4 Construction Requirements.

720.4.1 Not used.

720.4.2 Large Block Wall Systems.

720.4.2.1 A Class 1 geotextile filter cloth shall be placed between the wall and the select granular backfill for structural systems at all joints between the individual wall system units.

720.4.2.2 Precast or cast-in-place coping shall be placed on large block wall systems in accordance with the design plans. Capstone may be used in lieu of coping whenever coping is specified on the design plans. When coping is used, the maximum distance between construction joints shall be 30 feet.

720.4.3 Drainage Requirements. A drainage system shall be provided at the base of the wall system near the facing elements and at the interface of the select granular backfill for structural systems and the retained backfill. The drainage system shall consist of a perforated pipe wrapped in a Class 2 geotextile to prevent clogging of the perforations. The pipe shall be placed in such a manner that water drains freely from the pipe. When the wall length is such that the slope of the pipe becomes excessive in the Engineer’s judgment, lateral drain pipes shall be installed underneath the concrete leveling pad.

720.4.4 Foundation Preparation. The foundation for the wall system shall be graded level for a width equal to or exceeding the length of the reinforcing strips, or as shown on the plans. Prior to wall construction, the foundation, if not on rock, shall be compacted as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed and replaced, as directed by the Engineer.

720.4.5 Leveling Pad. An unreinforced cast-in-place concrete leveling pad shall be provided at the foundation level for each base unit of the wall system. The leveling pad shall be built to the elevations shown on the plans and shall not be raised in elevation to allow for the use of a particular wall system. The leveling pad shall be built a minimum width of 12 inches and a minimum depth of 6 inches. The concrete on the leveling pad shall be cured a minimum of 12 hours before any of the wall system panels are placed.

720.4.6 Batter Requirements. Wall systems shall be built with some inward batter, as determined by the wall system manufacturer, to accommodate the horizontal movement created by the placement and compaction of selected granular backfill for structural systems. Facing elements out of alignment shall not be pulled or pushed into proper place, as that may cause damage to the facing element or soil reinforcement strips. If misalignment occurs,
the select granular backfill for structural systems and the soil reinforcement strips shall be removed and the facing elements reset to the proper alignment.

**720.4.7 Select Granular Backfill for Structural Systems Placement.**

**720.4.7.1** Select granular backfill for structural systems shall be placed concurrently with the placement of the retained backfill. The placement of the select granular backfill for structural systems shall closely follow the erection of each course of the wall system and shall be placed in such a manner to avoid any damage or disturbance to the wall material or any misalignment of the facing elements of the wall system. Any wall system material that becomes damaged or disturbed during the installation of the wall system shall be removed, replaced or corrected at the Contractor’s expense, as directed by the Engineer. Whenever placement of the select granular backfill for structural systems results in the wall facing system being misaligned or distorted outside the limits of this specification, the Contractor shall correct the misalignment or distortion as directed by the Engineer.

**720.4.7.2** The select granular backfill for structural systems shall be compacted in accordance with Sec 203, with the following exceptions:

(a) The minimum density shall be no less than 95 percent of maximum density, determined in accordance with AASHTO T 99.

(b) When the material used contains more than 30 percent retained on the 3/4 inch sieve, a method of compaction consisting of at least four passes by a heavy roller shall be used.

(c) The moisture content of the material prior to and during compaction shall be uniformly distributed throughout each layer. The placement moisture content shall be no lower than three percentage points less than the optimum moisture content and shall be no more than the optimum moisture content.

(d) Compaction within 3 feet of the back face of the wall system shall be achieved by at least three passes of a lightweight mechanical tamper, roller or vibratory system.

(e) The Contractor shall ensure that runoff within the wall system construction site is directed away from the wall facing during construction, and that runoff from adjacent areas of the general construction site is directed such that runoff does not enter the wall system construction site.

(f) Class 1 geotextile material shall be placed between the select granular backfill for structural systems, and the retained backfill and over the top of the select granular backfill for structural systems to prevent piping of in-situ soil into the wall system.

(g) Tamping-type (sheep’s foot) rollers shall not be used for compaction of the select granular backfill for structural systems.

**720.4.7.3** The select granular backfill for structural systems shall be initially placed parallel to the wall system, and at the rear and middle of the soil reinforcement strips, and then moved toward the facing elements of the wall system. Construction equipment shall at no time come in direct contact with the soil reinforcement strips. Each course or layer shall be compacted up to or slightly above the location of the next connection for the reinforcement strips prior to placing the next layer of reinforcement strips as designated in the erection sequence provided by the manufacturer of the wall system.

**720.4.8 Construction Tolerances.**
720.4.8.1 Wall systems shall be built in accordance with the dimensions and elevations specified on the plans and in accordance with the requirements of the system manufacturer. Alignments shall be maintained within the following dimensional tolerances:

<table>
<thead>
<tr>
<th>Dimensional Item</th>
<th>Dimensional Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjacent Face Panel Joint Gaps (Large Block Walls)</td>
<td>± 3/4 in.</td>
</tr>
<tr>
<td>Adjacent Face Panel Joint Gaps (Small Block Walls)</td>
<td>± 1/4 in.</td>
</tr>
<tr>
<td>Vertical and Horizontal Alignment of Facing Elements (All Wall Systems)</td>
<td>± 1/16 in. per ft</td>
</tr>
<tr>
<td>Soil Reinforcement Strip Elevations (All Wall Systems)</td>
<td>± 1 in.</td>
</tr>
</tbody>
</table>

720.4.8.2 Vertical alignments shall be measured along a theoretical vertical line established from the top of the wall system to the base of the wall system. For small block walls that have a built-in setback, the alignment shall be measured along the theoretical vertical line and the straight line that describes the horizontal setback.

720.4.9 Technical Assistance. The Contractor shall be responsible for having a technical advisor from the wall system manufacturer available for assistance during the installation of the wall system.

720.5 Method of Measurement.

720.5.1 Measurement of mechanically stabilized earth wall systems will be made to the nearest square foot. The quantity to be paid will be measured from the wall outline as shown on the plans. No adjustments in the measured quantity will be permitted for additional wall area required to meet the minimum wall elevations shown on the plans for any particular wall system.

720.5.2 Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

720.5.3 No measurement will be made for required excavation for placement of the leveling pad for the wall system. All other excavation required for the construction of the wall system will be included in roadway items.

720.6 Basis of Payment. The accepted quantity of mechanically stabilized earth wall systems, complete in place, will be paid for at the contract unit price for each of the pay items included in the contract. Replacement of unsuitable material will be paid in accordance with Sec 206.
SECTION 725
METAL PIPE AND PIPE-ARCH CULVERTS

725.1 Description.

725.1.1 This work shall consist of providing corrugated metal pipe or pipe-arch of the diameter or shape designated, laid upon a firm bed and backfilled as specified. Where pipe is referred to, this specification shall also apply to pipe-arch where appropriate.

725.1.2 The overfill height shown on the plans or in the contract shall be used to determine the proper sheet thickness and size of corrugation for the individual pipe culvert. The minimum cover shall be measured from top of pipe to the bottom of the pavement.

725.1.3 The thickness of metal, type of coating or size of corrugation shall not be changed throughout the length of any individual pipe culvert.

725.1.4 The type of pipe permitted in extending an existing pipe shall be the same type used in place, except as otherwise specified in the contract, or unless prohibited by any of the requirements set out herein.

725.2 Material

725.2.1 All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated Metallic-Coated Steel Culvert Pipe, Pipe-Arches and End Sections</td>
<td>1020</td>
</tr>
<tr>
<td>Corrugated Aluminum Alloy Culvert Pipe and Corrugated Aluminum Alloy Structural Plate</td>
<td>1024</td>
</tr>
<tr>
<td>Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches</td>
<td>1021</td>
</tr>
</tbody>
</table>

725.2.2 Shop drawings of the pipe shall be submitted for review.

725.3 Construction Requirements

725.3.1 Handling. All pipe shall be unloaded and handled with reasonable care. Pipe shall not be dragged over gravel or rock and shall be prevented from striking rock or other hard objects during placement on bedding. Pipe with protective coatings shall be handled with special care to avoid damage. Pipe on which such coatings have been damaged shall, unless repaired to the satisfaction of the Engineer, be rejected at the site of the work regardless of previous approvals. Pipe having any localized bends in excess of 5 percent of the specified pipe diameter or any dent in excess of 1/2 inches shall be rejected. Rejected damaged pipe may be used if repaired to the satisfaction of the Engineer. Repair may be made by jacking or by any other method meeting the approval of the Engineer.

725.3.2 Laying Pipe.

725.3.2.1 The pipe shall be carefully laid true to lines and grades shown on the plans. Riveted pipe shall be installed with the outside laps of circumferential joints pointing upstream and with no longitudinal lap placed on the bottom 120° of the pipe on the sides. Any pipe which is not in true alignment or which shows any undue settlement after laying shall be taken up and re-laid at the Contractor's expense. If shown on the plan or directed by the Engineer, camber shall be built into the pipe structure to compensate for settlement from fill loads.

725.3.2.2 Transverse field joints shall be of such design that the successive connection of pipe sections will form a continuous line free from appreciable irregularities in the flow line. Each successive length of pipe in a field joint
shall be adjusted longitudinally or circumferentially when necessary so that coupling bands will properly engage the
corrugations in both lengths of pipe. Bands with projections or dimples shall not be used.

725.3.2.3 For sewer pipe with a design grade less than one percent, verification of the pipe grade will be required
for each installed reach of sewer, prior to any surface restoration or installation of any surface improvements. The
Contractor will be required to provide daily documentation verifying that the as-built pipe grade meets the design
grade through the submittal of signed cut sheets to the Engineer upon request. The Contractor will be required to
remove and replace any sewer reach having an as-built grade which is flatter than the design grade by more than
0.1%. Sewers with grades greater than the design slope may be left in place, provided no other sewer grade is
reduced by this variance in the as-built grade. The County also reserves the right to require the Contractor to remove
and replace any sewer (at any time prior to construction approval) for which the as-built grade does not comply
with the grade tolerance stated above. Field surveyed verification must be made under the direction of a licensed
land surveyor of registered Engineer. The Contractor shall be responsible for any cost associated with the field
verification of the sewer grade, or removal and replacement of the sewer pipe or associated appurtenances.

725.3.3 Bedding & Backfill Material.

725.3.3.1 Backfill material for metal culverts shall consist of gravel, sand or sandy silt soil as shown on the plans.

725.3.3.1.1 Gravel and sand shall consist of a well-graded mixture of stone fragments, gravel and sand and shall
meet the requirements of AASHTO M 145, classification A1 or A3.

725.3.3.1.2 Sandy silt soil shall consist of moderately plastic granular material with silt content higher than that of
gravel or sand and shall meet the requirements of AASHTO M 145, Classification A2.

725.3.3.2 Bedding material shall have a maximum particle size of 1.5 inches. Backfill shall be free of organic material
or frozen clumps and shall not contain stones larger than 3 inches.

725.3.4 Installation.

725.3.4.1 Installation of Pipe for Non-Embankment Conditions. The construction sequence shall be as follows: the
trench shall be excavated to the width, depth and grade shown on the plans and approved by the Engineer. Proper
preparation of foundation, placement of foundation material where required and placement of bedding material
shall precede the installation of all culvert pipe. This shall include necessary leveling of the native trench bottom or
the top of the foundation material as well as placement and compaction of required bedding material to a uniform
grade so that the entire length of pipe will be supported on a uniform base. The material in the haunch and lower
side zones shall then be placed and compacted up to the springline of the pipe. All backfill for trenches in the right
of way shall be granular material.

725.3.4.2 Installation of Pipe Prior to Placing Embankment. After the pipe has been laid, the material in the haunch
and lower side zones shall be placed to a minimum width of one pipe diameter outside the pipe, except for pipe-
arches, where it is limited to a maximum of two-thirds the span. The pipe shall be installed and backfilled according
to the requirements of Sec 725.3.4.1. If a subtrench is required to install the pipe to the specified grade, the width
of the trench shall be as shown on the plans. Sufficient clearance shall be provided in order to attain the required
compaction in the haunch and outer bedding zones.

725.3.4.3 Installation of Pipe After Placing Embankment. The roadway embankment shall be placed and
compacted to the required density to a minimum elevation of 1 foot above the top of the pipe. A trench, conforming
to the section shown on the plans shall be excavated through the embankment to a depth sufficient to place the
required bedding and maintain the specified grade of the pipe. The pipe shall be installed and backfilled according
to the requirements of Sec 725.3.4.1.
275.3.4.4 Bedding in Unsuitable Material. If rock is encountered, the bedding depth shall be increased as shown on the plans. If soft, spongy or unstable material is encountered, it shall be removed and replaced with soil compacted to the level specified. Payment for removal of unsuitable material and for backfilling will be made in accordance with Sec 206.6.3, unless the unsuitable material is a result of the Contractor’s operations in which case the removing and backfilling shall be at the Contractor’s expense.

275.3.4.5 Backfilling. Backfilling shall be done as soon as practicable. All backfill material within the right of way shall be granular. Suitable backfill and embankment material free from large lumps, clods or rocks, shall be placed alongside the pipe in loose layers not exceeding 8 inches thick to provide a berm of compacted earth, on each side of the pipe, at least as wide as the diameter of the pipe. Each 8 inch layer shall be thoroughly compacted to the same density required for the adjacent embankment or to a minimum of 90-percent standard density. Backfill material may be moistened to facilitate compaction. Special care shall be taken to properly compact the backfill under the haunches of pipe-arch. The placement of the remainder of the backfill to at least 1 foot above the top of the pipe shall be brought up evenly on both sides of the pipe by working backfill operations from side to side. The side to side backfill differential shall not exceed 24 inches or 1/3 of the size of the pipe, whichever is less. Additional backfill shall be provided as necessary. Backfill shall be compacted to a minimum of 90 percent standard maximum density or otherwise specified embankment density.

275.3.4.6 Shop Elongation. Round corrugated steel pipe of 54 inches or greater in diameter shall be shop elongated. Corrugated steel pipe 48 inches in diameter may be furnished round or shop elongated. The Contractor shall be responsible for maintaining elongation during backfilling and embankment construction such that the vertical height of the opening after the embankment has been completed shall be not less than the diameter of the pipe, nor greater than the pre-elongated height.

275.3.4.7 Construction Loads. Before heavy construction equipment is operated over the pipe, the Contractor shall provide adequate depth and width of compacted backfill to protect it from damage or displacement as shown on the plans. Any damage or displacement shall be repaired or corrected at the Contractor’s expense.

275.3.4.8 Pipe Plugs. The ends of all pipe stubs for future connections at inlet and manhole structures and all pipe installed as part of future sewers shall be sealed with suitable plugs. The plugs shall be installed in a manner preventing infiltration of soil into the pipe. No direct payment will be made for furnishing and installing plugs.

275.3.4.9 Cleaning of Pipe Interior. As the work progresses, the interior of the sewer shall be cleaned of all dirt, cement, extruded joint material, debris and other extraneous materials.

275.3.4.10 Restoration of Pavement. When the installation of the pipe crosses an existing or temporary pavement which is open to the traveling public, the pavement shall be restored to the satisfaction of Engineer. The Contractor shall restore the pavement with either cold patch or bituminous base mix within 48 hours of installing the pipe, unless other arrangements are approved by the Engineer. The Engineer may require the installation of “Bump” signs. The restoration of pavement, maintenance of pipe crossing, and installation of “Bump” signs will be considered incidental to the pipe installation. If the pipe crosses an existing pavement which is to remain in place after the project is complete, the cost of the bituminous base mix will be paid at the contract unit price and shall be installed at the same thickness as the existing pavement.

275.4 Inspection. After the roadway has been completed and before final acceptance of the project, the Engineer will inspect the pipe for proper installation. Any section of pipe found to be improperly installed shall be replaced or repaired by the Contractor, at the Contractor’s expense and to the satisfaction of the Engineer. Repaired or replaced pipe will be retested as deemed necessary by the Engineer. The Contractor shall provide equipment and assistance deemed necessary by the Engineer to perform any testing. Pipe deflections will be determined by the Engineer by having the Contractor either pushing or pulling a mandrel through the pipe or verifying deflections by other methods approved by the Engineer. Mandrels used for deflection testing may have either fixed or adjustable arms, but shall be approved by the Engineer prior to use. The following will constitute improper installations:
(a) If any horizontal of vertical alignment is in excess of 15 percent from plan alignment, will restrict flow or will cause excessive ponding within the pipe. For pipes with a design grade of less than 1 percent see Sec 725.3.2.3.

(b) Any section of pipe with a diameter deflection of greater than 10 percent.

(c) If settlement is greater than one inch at 5 percent or more of the joints.

(d) If the pipe shows evidence of being crushed at any location.

(e) If the pipe shows evidence of joint separation.

725.5 Method of Measurement.

725.5.1 Measurement of corrugated metal pipe or pipe-arch, complete in place, will be made to the nearest foot along the geometrical center of the pipe. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

725.5.2 Excavation for placing pipe and pipe-arches will be not be measured and will be considered incidental to the pipe or pipe-arch installation.

725.5.3 If rock meeting the requirements of Class 3 in rock excavation, per Sec 206, is encountered the volume of Class 3 in rock excavation will be measured and paid for in accordance with Sec 206.

725.6 Basis of Payment.

725.6.1 The accepted quantities of pipe, complete in place, including all necessary tees, bends, wyes, coupling bands, cutting and joining new pipe to existing pipe or structures unless otherwise specified, will be paid for at the unit price for each pay item included in the contract.

725.6.2 No direct payment will be made for beveling, skewing or additional work required in laying pipe with beveled or skewed ends, or work involved in elongating or backfilling required except as specified in Sec 206.6.3.

725.6.3 No direct payment will be made for Class 3 excavation except as described in Sec 206.
SECTION 726
RIGID PIPE CULVERTS, STORM DRAINS AND SEWERS

726.1 Description. This work shall consist of concrete pipe the class, diameter or shape designated, laid upon a bed as specified on the plans and backfilled as specified.

726.1.1 The type of installation and the class of pipe shall conform to the requirements as shown on the plans for the applicable allowable overfill height.

726.1.2 If reinforced concrete pipe is specified in the contract or elected for use by the Contractor, pipe of a higher class may be used but payment will be made for the class of pipe specified in the contract for that culvert.

726.1.3 The class of pipe or type of installation shall not be changed throughout the length of any individual pipe culvert.

726.1.4 The type of pipe permitted in extending an existing pipe shall, in general, conform to the type used in place, except as otherwise specified in the contract, or unless prohibited by any of the requirements set out herein.

726.2 Material.

726.2.1 All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Concrete Culvert Pipe</td>
<td>1026</td>
</tr>
<tr>
<td>Reinforced Concrete Elliptical Culvert Pipe</td>
<td>1034</td>
</tr>
<tr>
<td>Reinforced Concrete Arch Culvert</td>
<td>1035</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Mortars and Grouts</td>
<td>1066</td>
</tr>
</tbody>
</table>

726.2.2 Substitutions. Class III Reinforced Concrete Pipe, 60 inches or less in diameter may be substituted with Polypropylene Pipe per Sec 730. If an existing pipe is to be extended, the Contractor shall install the same pipe material as the existing pipe. Class V Reinforced Concrete Pipe may not be substituted for Polypropylene Pipe.

726.3 Construction Requirements

726.3.1 Laying.

726.3.1.1 Rigid pipe shall be carefully laid true to lines and grades shown on the plans, with hub, bell or groove ends upstream and with the spigot or tongue end entered the full length into the adjacent section of pipe. Elliptically reinforced pipe shall be oriented and laid such that the top and bottom of the pipe, as marked on the pipe, are in the proper position. If the pipe is to be laid below the ground line, a trench shall be excavated to the required section and depth to permit required compaction of the backfill under the haunches and around the pipe. Any pipe which is not in true alignment or which shows any undue settlement after laying, but before the fill is placed, shall be taken up and relaid at the Contractor's expense. If shown on the plans, or directed by the Engineer, sufficient camber shall be built into the pipe structure to allow for settlement from fill loads. Rubber gasketed joints will be used. The maximum allowable joint width measured on the inside surface of concrete pipe shall not be more than: 3/4 inch for pipe sized 12 inches through 21 inches in inside diameter; 1 inch for pipe sizes 24 inches through 45 inches in inside diameter; 1 1/4 inches for pipe sizes 48 inches and larger in inside diameter. On curved alignments only, the foregoing limits may vary a maximum of fifty percent. Where permissible lift holes have been used, upon completion of laying, bedding and jointing the pipe, and before backfilling above the springline of the pipe, the lift holes shall be solidly sealed with prefabricated plugs provided by the pipe manufacturer, set in bituminous jointing.
compound uniformly applied to both the joining surfaces of the plug and the inside surfaces of the hole. The plug shall fill at least 50% of the lifting hole depth with no part of the plug protruding on the inside of the pipe. Lifting devices shall have sufficient bearing on the inside of the pipe to avoid damage resulting from a concentration of stresses around the lift holes.

726.3.1.2 Rubber gasket joints shall be installed in accordance with the manufacturer’s recommendations to ensure that joint devices are properly installed and that rubber gaskets are not displaced.

726.3.1.3 For sewer pipe with a design grade less than one percent, verification of the pipe grade will be required for each installed reach of sewer, prior to any surface restoration or installation of any surface improvements. The Contractor will be required to provide daily documentation verifying that the as-built pipe grade meets the design grade through the submittal of signed cut sheets to the Engineer upon request. The Contractor will be required to remove and replace any sewer reach having an as-built grade which is flatter than the design grade by more than 0.1%. Sewers with grades greater than the design slope may be left in place, provided no other sewer grade is reduced by this variance in the as-built grade. The County also reserves the right to require the Contractor to remove and replace any sewer (at any time prior to construction approval) for which the as-built grade does not comply with the grade tolerance stated above. Field surveyed verification must be made under the direction of a licensed land surveyor of registered Engineer. The Contractor shall be responsible for any cost associated with the field verification of the sewer grade, or removal and replacement of the sewer pipe or associated appurtenances.

726.3.1.4 Equipment used to handle, lay and joint pipe shall be so equipped and used as to prevent damage to the pipe and its jointing materials. All pipe shall be carefully handled and lowered into the trench. Damaged pipe, pipe with cracked or broken ends, bells or spigots will be reasons for rejecting the pipe. Rejected pipe shall not be installed.

726.3.1.5 Where concrete encasement is required, the pipe shall be supported at not more than two places with masonry supports of minimum size sufficient to provide the required clearance and to prevent displacement during placement of concrete.

726.3.1.6 Special care shall be taken to ensure that the pipes are solidly and uniformly bedded, cradled, or encased in accordance with the type of bedding, cradle, or encasement required by the plans and specifications. No pipes shall be brought into position until the preceding length has been bedded and secured in place.

726.4 Bedding.

726.4.1 Bedding for reinforced concrete pipe shall consist of Class 1, or Class 2.

<table>
<thead>
<tr>
<th>Class 1 Bedding (% Passing by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sieve</strong></td>
</tr>
<tr>
<td>1 inch</td>
</tr>
<tr>
<td>3/4 inch</td>
</tr>
<tr>
<td>1/2 inch</td>
</tr>
<tr>
<td># 100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class 2 Bedding (% Passing by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sieve</strong></td>
</tr>
<tr>
<td>1 1/2 inch</td>
</tr>
<tr>
<td>1 inch</td>
</tr>
<tr>
<td>3/4 inch</td>
</tr>
<tr>
<td>1/2 inch</td>
</tr>
</tbody>
</table>
726.4.1.1 Class 1 bedding shall be used for all pipes 27 inch in diameter and smaller.

726.4.1.2 Class 2 bedding shall be used for all pipes 30 inch in diameter and larger.

726.5 Installation.

726.5.1 The construction sequence shall conform to the following. The bedding shall be placed to the required thickness and grade taking care to avoid compaction of the bedding under the middle one third of the pipe. The bedding outside the middle one third of the pipe may be compacted before placing the pipe. The pipe shall be installed to grade according to Sec 726.3. If not previously accomplished, the bedding outside the middle one third of the pipe shall be compacted to the required density shown on the plans. The material in the haunch and lower side zones shall then be placed and compacted up to the springline of the pipe. The placement of the remainder of the embankment material above the springline shall conform to the requirements of Sec 203.

726.5.1.1 Installation of Pipe Prior to Placing Embankment. After the pipe has been laid, the material in the haunch and lower side zones shall be placed to a minimum width of one pipe diameter outside the pipe. The haunch and lower side material shall be compacted to the required densities shown on the plans. When all material has been placed and compacted up to the springline of the pipe, the remaining fill material shall be placed according to the requirements of the adjacent fill. If a subtrench is required to install the pipe to the specified grade, the width of the trench shall be 1.33 times the outside diameter of the pipe, but not less than 24 inches wider than the outside diameter of the pipe. In this manner, sufficient clearance is provided in order to attain the required compaction in the haunch and outer bedding zones.

726.5.1.2 Installation of Pipe After Placing Embankment. The roadway embankment shall be placed and compacted to the required density to a minimum elevation of one foot below the bottom of the pavement base material. A trench, conforming to the section shown on the plans shall be excavated through the embankment to a depth sufficient to place the required bedding and maintain the specified grade of the pipe. The pipe shall be installed and backfilled according to the requirements of Sec 726.5.1.

726.5.2 Bedding in Unsuitable Material. If rock is encountered, the bedding depth shall be increased to 1/12 the outside diameter of the pipe, but not less than 6 inches. The width of the cushion excavation shall be 1.33 times the outside diameter of the pipe, but not less than 24 inches wider than the outside diameter of the pipe. If soft, spongy, or unstable material is encountered, it shall be removed and replaced with soil compacted to the level specified for the lower side zone. Payment for removal of unsuitable material and for backfilling will be made in accordance with Sec 206.6.3, unless the unsuitable material is a result of the Contractor's operations in which case the removing and backfilling shall be at the Contractor's expense.

726.5.3 Protection of Pipe. Whenever pipe laying is stopped for any significant length of time, such as at the end of the workday, the unfinished end shall be protected from displacement, flotation, cave-in, wash-in of soil or debris, or other injuries. A suitable temporary tight-fitting plug, stopper, or bulkhead shall be placed in the exposed bell, groove or socket end. No direct payment will be made for furnishing and installing plugs.

726.5.4 Backfilling. Backfilling shall be done as soon as practicable. All trenches within the right of way shall be backfilled with 3/4 inch minus crushed limestone and screenings in loose layers not exceeding 6 inches. Trenches outside of the right of way shall be backfilled with suitable material, free from large lumps, clods or rocks, shall be placed alongside the pipe in loose layers not exceeding 6 inches thick to provide a berm of compacted or undisturbed earth on each side of the pipe. Each 6 inch layer shall be compacted to the required density shown on the plans. Backfill material shall be moistened, if necessary, to facilitate compaction. Special care shall be taken to properly compact the embankment under the haunches of the pipe. Before heavy construction equipment is operated over
the pipe, the Contractor shall provide an adequate depth and width of compacted backfill to protect it from damage or displacement. Any damage or displacement shall be repaired or corrected at the Contractor’s expense.

726.5.5 Cleaning of Pipe Interior. As the work progresses, the interior of the sewer shall be cleaned of all dirt, cement, extruded joint materials, debris, and other extraneous materials.

726.5.6 Restoration of Pavement. When the installation of the pipe crosses an existing or temporary pavement which is open to the traveling public, the pavement shall be restored to the satisfaction of Engineer. The Contractor shall restore the pavement with either cold patch or bituminous base mix within 48 hours of installing the pipe, unless other arrangements are approved by the Engineer. The Engineer may require the installation of “Bump” signs. The restoration of pavement, maintenance of pipe crossing, and installation of “Bump” signs will be considered incidental to the pipe installation. If the pipe crosses an existing pavement which is to remain in place after the project is complete, the cost of the bituminous base mix will be paid at the contract unit price and shall be installed at the same thickness as the existing pavement.

726.6 Inspection. After the roadway has been completed, and before final acceptance of the project, all pipe culverts will be inspected. Any section of pipe found to be improperly installed shall be replaced or repaired by the Contractor, at the Contractor’s expense and to the satisfaction of the Engineer. Any separation at joints deemed not detrimental to the pipe performance by the Engineer shall be resealed with either plastic joint compound, cement mortar, or other approved material. Repaired or replaced pipe will be retested as deemed necessary by the Engineer. The Contractor shall provide equipment deemed necessary by the Engineer to perform any testing. The following will constitute improper installation:

(a) If misalignment is in excess of 15 percent, will restrict flow or will cause excessive ponding within the pipe. For pipes with a design grade of less than 1 percent see Sec 726.3.3.

(b) If settlement is greater than one inch at five percent or more joints.

(c) If the pipe shows evidence of separation at any location.

726.7 Method of Measurement.

726.7.1 Measurement of rigid pipe, complete in place, will be made to the nearest foot along the geometrical center of the pipe. Measurement will be made through all line manholes, to the center of new manholes, and through the walls of structures and existing manholes at the points of connection therewith.

726.7.2 Excavation for placing rigid pipe will be not be measured and will be considered incidental to the pipe installation.

726.7.3 If rock meeting the requirements of Class 3 in rock excavation, per Sec 206, is encountered the volume of Class 3 in rock excavation will be measured and paid for in accordance with Sec 206.

726.8 Basis of Payment.

726.8.1 The accepted quantities of pipe, complete in place, including all necessary tees, bends, wyes, cutting and joining new pipe to existing pipe, unless otherwise specified, will be paid for at the unit price for each of the pay items included in the contract.

726.8.2 No direct payment will be made for any backfilling required except as specified in Sec 206.6.3.

726.8.3 No direct payment will be made for the construction of bedding or for bedding material.
SECTION 730
THERMOPLASTIC PIPE CULVERT

730.1 Description. This work shall consist of providing thermoplastic pipe of the diameter designated, placed and backfilled as specified in the contract documents or as directed by the Engineer.

730.1.1 If the contract specifies thermoplastic pipe or if the contract specifies culvert pipe by group and the Contractor elects to furnish thermoplastic pipe, the allowable overfill height shall be in accordance with the plans, unless specified otherwise. Minimum cover will be measured as shown on the plans.

730.1.2 When furnishing thermoplastic pipe, the pipe shall meet the properties described in the appropriate section of this specification and be installed in accordance with the standard plans. When section properties or fill heights outside of the specification are required for use, a special design shall be prepared by the Contractor for approval by the Engineer. The special design shall include all relevant Engineering data, stub compression values, and be stamped by a professional Engineer registered in the State of Missouri.

730.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metallic-Coated Steel End Sections</td>
<td>1020</td>
</tr>
<tr>
<td>Polyvinyl Chloride (PVC) Culvert Pipe</td>
<td>1028</td>
</tr>
<tr>
<td>Precast Concrete Flared End Sections</td>
<td>1032</td>
</tr>
<tr>
<td>Polypropylene Culvert Pipe</td>
<td>1041</td>
</tr>
<tr>
<td>Polyethylene Culvert Pipe</td>
<td>1047</td>
</tr>
</tbody>
</table>

730.2.1 Polypropylene Pipe Walls.

<table>
<thead>
<tr>
<th>Wall</th>
<th>Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Wall</td>
<td>≤ 30”</td>
</tr>
<tr>
<td>Triple Wall</td>
<td>30” – 60”</td>
</tr>
</tbody>
</table>

730.3 Construction Requirements.

730.3.1 Handling. All pipe shall be handled to avoid damage. Damaged pipe will be unacceptable and shall be repaired or replaced at the Contractor’s expense to the satisfaction of the Engineer.

730.3.2 Laying.

730.3.2.1 Flexible pipe shall be laid as shown on the plans, with bell ends upstream and with the spigot end entered the full length into the adjacent section of pipe. Any pipe that is not in true alignment or that shows any undue settlement after laying shall be taken up and relaid at the Contractor’s expense. Camber shall be built into the pipe structure to allow for settlement from fill loads if shown on the plans or directed by the Engineer.

730.3.2.2 Joints shall be soil tight and shall be installed such that the connection of pipe sections will form a continuous line free from appreciable irregularities in the flow line. Field joints may be corrugated bands, double bell couplings, bell and spigot pipe ends with a rubber O-ring gasket in accordance with ASTM F 477, or an alternative connection approved by the Engineer. All joints shall comply with the soil tight joint performance criteria of AASHTO PP-63.

730.3.3 Ultraviolet Protection. If PVC pipe is specified in the contract or elected for use by the Contractor, none of the PVC pipe shall be exposed to sunlight after installation. The minimum distance required to protect the exposed
open end of a PVC pipe from sunlight will be one-half of the pipe diameter from the opening. The use of a different pipe material from the appropriate pipe group other than PVC is required in areas requiring ultraviolet protection.

730.3.4 Bedding and Backfill Material. Thermoplastic pipe bedding and backfill material shall consist of stone or crushed limestone that is sound, durable, and free from cracks and other structural defects that would cause it to deteriorate. It shall not contain any soapstone, shale, or other material easily disintegrated. Bedding and backfill materials shall be free of organic material or frozen clumps.

730.3.4.1 Bedding Material. A minimum of 4 inches (compacted) bedding material shall be provided prior to placement of the pipe unless otherwise specified.

730.3.4.1.1 Bedding for thermoplastic pipe shall consist of Class 1, or Class 2.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Class 1 Bedding (% Passing by Weight)</th>
<th>Class 2 Bedding (% Passing by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>1 inch</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>60</td>
<td>35</td>
</tr>
<tr>
<td># 100</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

730.3.4.1.2 Class 1 bedding shall be used for thermoplastic pipe diameters 18 inches or less.

730.3.4.1.3 Class 2 bedding shall be used for thermoplastic pipe with diameters greater than 18 inches.

730.3.4.2 Backfill Material.

730.3.4.2.1 Backfill Material for thermoplastic pipe shall consist of Class 1, or Class 2.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Class 1 Backfill (% Passing by Weight)</th>
<th>Class 2 Backfill (% Passing by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>1 inch</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>60</td>
<td>35</td>
</tr>
<tr>
<td># 100</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>
730.3.4.2.2 Class 1 backfill shall be used for thermoplastic pipe diameters 18 inches or less.

730.3.4.2.3 Class 2 backfill shall be used for thermoplastic pipe with diameters greater than 18 inches.

730.3.5 Installation.

730.3.5.1 Trench Requirements. Thermoplastic pipe shall be installed in a trench, whether installed below grade or in an embankment. The construction sequence shall be as shown on the plans. When pipe is installed in an embankment, the embankment shall be placed and compacted to the required density to a minimum elevation of one foot above the top of pipe before a sub-trench is excavated. The backfill shall be placed to the required thickness and grade taking care to avoid compaction of the backfill under the middle one third of the pipe. The backfill outside the middle one third of the pipe shall be compacted to the required density shown on the plans before placing the pipe. Compaction of backfill material under the haunches of the pipe shall be accomplished without disturbing the pipe alignment.

730.3.5.2 Bedding in Unsuitable Material. If rock is encountered, the bedding depth shall be increased to 6 inches below the bottom of the pipe. If soft, spongy, or unstable material is encountered, the material shall be removed and excavated to a minimum depth of 10 inches below the bottom of the pipe and replaced with suitable granular material. Payment for removal of unsuitable material and for backfilling will be made in accordance with Sec 206.6.3, unless the unsuitable material is a result of the Contractor's operations, in which case removing and backfilling shall be at the Contractor's expense.

730.3.5.3 Backfill Construction. Backfilling shall be completed as soon as practical. Suitable backfill material free from large lumps, clods, or rocks shall be placed alongside the pipe and compacted as shown on the plans. The placement of the remainder of the backfill shall be conducted in a manner to prevent misalignment of the pipe and in accordance with Sec 203.

730.3.5.3.1 Structural backfill shall be placed and compacted in layers not exceeding a loose lift thickness of 8 inches and brought up evenly and simultaneously on both sides of the pipe to an elevation not less than 1 foot above the top of the pipe. Structural backfill shall be worked into the haunch area and compacted by hand. All backfill shall be compacted to a minimum 90 percent standard density based upon standard proctor test. Special compaction means may be necessary in the haunch area. Ponding or jetting structural backfill to achieve compaction shall not be permitted without the permission of the Engineer.

730.3.5.4 Construction Loading. Before heavy construction equipment is operated over the pipe, the Contractor shall provide adequate depth and width of compacted backfill or other cover to protect the pipe from damage or displacement. Any damage or displacement shall be repaired or corrected at the Contractor’s expense.

730.3.5.5 Pipe Plugs. The ends of all pipe stubs for future connections at inlet and manhole structures and of all pipe installed as a portion of future sewers shall be sealed with suitable plugs. Plugs shall be installed in a manner preventing infiltration of dirt into the pipe. No direct payment will be made for furnishing and installing plugs.

730.3.5.6 Skewed Ends. A pipe end may be cut to a maximum angle of 10 degrees to provide a skewed end.

730.3.5.7 Restoration of Pavement. When the installation of the pipe crosses an existing or temporary pavement which is open to the traveling public, the pavement shall be restored to the satisfaction of Engineer. The Contractor shall restore the pavement with either cold patch or bituminous base mix within 48 hours of installing the pipe, unless other arrangements are approved by the Engineer. The Engineer may require the installation of “Bump” signs. The restoration of pavement, maintenance of pipe crossing, and installation of “Bump” signs will be considered incidental to the pipe installation. If the pipe crosses an existing pavement which is to remain in place
after the project is complete, the cost of the bituminous base mix will be paid at the contract unit price and shall be installed at the same thickness as the existing pavement.

730.4 Inspection. The internal diameter of the barrel shall not be reduced by more than 5 percent of the pipe’s nominal inside diameter when measured no less than 30 days following completion of installation. After the roadway has been completed and before final inspection of the project, the Engineer will inspect all pipe locations for proper installation. Any section of pipe found to be improperly installed, shall be replaced, or repaired by the Contractor at the Contractor’s expense and to the satisfaction of the Engineer. Repaired or replaced pipe will be re-inspected by the Engineer. The Contractor shall provide equipment and assistance as deemed necessary by the Engineer to perform any testing. Pipe deflections will be determined by the Engineer by having the Contractor either pushing or pulling a mandrel through the pipe, or verifying deflections by other methods approved by the Engineer. Mandrels used for deflection testing may have either fixed or adjustable arms, but shall be approved by the Engineer prior to use. The following will constitute improper installation:

a) If any horizontal or vertical alignment is in excess of 15 percent from plan alignment, will restrict flow or will cause excessive ponding within the pipe.

b) Any section of pipe with deflections greater than 5 percent, based upon the units of measurement used in fabricating the pipe.

c) If settlement is greater than one inch at 5 percent or more joints.

d) The pipe shows evidence of being crushed or buckled at any location.

e) The pipe shows evidence of joint separation.

730.5 Method of Measurement.

730.5.1 Measurement of thermoplastic culvert pipe, complete in place, will be made to the nearest foot along the geometrical center of the pipe. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

730.5.2 Excavation for placing pipe will be not be measured and will be considered incidental to the pipe installation.

730.5.3 If rock meeting the requirements of Class 3 in rock excavation, per Sec 206, is encountered the volume of Class 3 in rock excavation will be measured and paid for in accordance with Sec 206.

730.6 Basis of Payment.

730.6.1 The accepted quantities of pipe, complete in place, including all necessary tees, bends, wyes, cutting and joining new pipe to existing pipe unless otherwise specified will be paid for at the unit price for each pay item included in the contract.

730.6.2 No direct payment will be made for material or work required for placing couplings on exposed ends of the pipe.

730.6.3 No direct payment will be made for any backfilling required except as specified in Sec 206.6.3.

730.6.4 No direct payment will be made for the construction of bedding or for bedding material.
SECTION 731
PRECAST REINFORCED CONCRETE
MANHOLES AND INLETS

731.1 Description. This work shall consist of furnishing and installing precast concrete manholes and inlets as shown on the plans.

731.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precast Drainage Units</td>
<td>1033</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Mortars and Grouts</td>
<td>1066</td>
</tr>
</tbody>
</table>

731.2.1 Footings. Concrete for footings shall be Class B, Class, B-1, or concrete of a commercial mixture meeting the requirements of Sec 501.15. Air entrainment will not be required. Concrete shall be placed and float finished. After finishing, concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane shall be used in lieu of pigmented membrane.

731.2.2 Pipe Connections. Connections for inlet and outlet pipes shall be an approved patented compression type and will not be allowed through joints; therefore, the height of riser sections shall be designed accordingly. The maximum percent grade and/or horizontal deflection for the use of “A-Lock” or “Z-Lock” connections are 12% (7°) and 46% (25°), respectively.

731.2.3 The minimum inside diameter for the base and riser sections shall be 42” for all storm sewers.

731.2.4 Grade Rings. The use of precast reinforced concrete grade rings in lieu of brick is allowable provided the rings have minimum dimensions of 26.5 inch opening, 3 inch height and 8 inch width. No more than one grade ring used per adjustment unless the total height of adjustment is 6 inches or greater. Then a maximum of two will be allowed. The maximum dimension from top of cone to top of frame is 18 inches.

731.2.5 Precast Base. The precast base of all structures will require that the inlet and outlet openings be installed prior to delivery to the project site, except when installation has been approved on existing pipes.

731.2.6 Concentric Cones. Precast manholes will require concentric cones in all cases. Flat slabs and eccentric cones will be allowed with special permission.

731.2.7 Tops. The top surface of all inlet stones shall be cast against patterned steel forms to achieve an approved non-skid surface and the upper surface of inlet stones shall be steel-troweled or cast against steel forms. All inlet stones shall be provided with cast iron covers. No concrete inlet covers will be allowed.

731.3 Construction Requirements.

731.3.1 Precast concrete manhole and inlet sections shall be carefully placed true to line and grade.

731.3.2 Footings shall be constructed to the size and shape shown on the plans. Forms will not be required.

731.3.3 Joints shall be sealed with a flexible rubber mastic sealant conforming to the requirements of AASHTO M-198B. The flexible rubber mastic shall be installed on the upper and lower portion of the male portion of the joint at the job site prior to joining the manhole sections. All foreign materials, such as dirt, mud and stones shall be
removed from the joint surfaces prior to placing the sealant. Elastomeric O-ring joints conforming to ASTM C443, may be used with approval of the Engineer.

731.3.4 The project plans shall indicate the required orientation of the precast concrete unit.

731.3.5 Damaged, cracked or imperfect sections will not be allowed to be installed unless approved by the Engineer.

731.3.6 No field modifications will be allowed to the structure unless it is determined that such modifications will not adversely affect the strength of the structure.

731.3.7 After the excavation has been completed to the required dimensions specified on the detailed plan, the base shall be leveled off to receive the bottom section. If necessary, to provide a more level and solid foundation, a crushed limestone base may be required. The base must be set level so all water in the structure will drain toward the designed outlet.

731.3.8 The allowable variance in vertical plumb is 1 foot in 30 vertical feet.

731.3.9 To insure joint integrity, give particular attention to removing all foreign materials such as dirt, mud, and stones from the joint surfaces and see that all sealing materials are placed in accordance to the manufacturer’s recommendation.

731.3.10 If a misalignment of sections occurs during installation, remove the upper section. If the sealing material is damaged, clean the joint surfaces before replacing new sealing material.

731.4 Method of Measurement.

731.4.1 Measurement of precast concrete manholes and inlets, complete in place, will be made per each, complete and in place.

731.4.2 Excavation is considered incidental to the manhole or inlet construction and will not be measured unless rock meeting the requirements to Sec 206 are encountered.

731.5 Basis of Payment.

731.5.1 The accepted quantities of precast manholes and inlets, complete in place, including any necessary cutting or joining new pipe or existing pipe to the structure unless otherwise specified will be paid for at the unit price for each of the pay items included in the contract.

731.5.2 No direct payment will be made for:

(a) Backfilling except as specified in Sec 206.6.3.

(b) Footing Concrete.

(c) Steps.

(d) Weep holes, including excavation, permeable granular backfill, 4 inch drain tile, screen for inlet, or any other work incidental thereto.

(e) Excavation for the precast manhole or inlet, unless rock meeting the requirements of Sec 206 is encountered.
(f) No direct payment will be made for furnishing or installation and will be considered incidental to the structure.
SECTION 732
FLARED END SECTIONS

732.1 Description. This work shall consist of furnishing and installing precast concrete or metal flared end sections of the size and shape shown on the plans.

732.1.1 Precast concrete flared end sections shall be used with concrete culvert pipe, polypropylene pipe, polyethylene pipe, and PVC pipe.

732.1.2 Metal flared end sections shall be used with metal culvert pipe.

732.1.3 Safety slope end sections may be used with either concrete, plastic, polypropylene pipe, polyethylene pipe, PVC, or metal culvert pipe.

732.1.4 At the option of the Contractor and at no cost to the County, the Contractor may use a tapered sleeve to join thermoplastic pipe to flared end sections when not required by the plans.

732.1.5 At the option of the Contractor and at no cost to the County, the Contractor may use a one size larger flared end section when joining to thermoplastic pipe to aid fitment.

732.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Flared End Sections</td>
<td>1020</td>
</tr>
<tr>
<td>Precast Concrete Flared End Sections</td>
<td>1032</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Mortars and Grouts</td>
<td>1066</td>
</tr>
<tr>
<td>Safety Bars and Longitudinal Bars</td>
<td>ASTM A-53 Schedule 40</td>
</tr>
<tr>
<td>Bar Grate</td>
<td>ASTM A575 Grade 1020</td>
</tr>
</tbody>
</table>

732.2.1 Cast-in-place toe walls for precast concrete flared end sections shall be constructed of Class B or B-1 concrete, or concrete of a commercial mixture meeting the requirements of Sec 501. Material, proportioning, air-entraining, mixing, slump and transporting of the Portland cement concrete shall be in accordance with Sec 501. Air-entrained concrete will not be required. Concrete shall be placed and cured in accordance with the applicable provisions of Sec 703. Precast toe walls shall be constructed of any of the above specified concrete mixtures or they may be constructed of the same mixture used to fabricate the precast concrete flared end sections. Precast toe walls may be cured in accordance with Sec 703 or in the same manner as the flared end sections.

732.3 Construction Requirements.

732.3.1 Flared end sections shall be joined to pipes or pipe-arches as shown on the plans and shall be placed to the line and grade of the structure on a uniformly firm soil foundation shaped to fit the lower part of the end section.

732.3.1.1 Precast Concrete Flared End Sections. The joint material between the end section and the adjoining pipe shall be the same as that used for the pipe joints and shall be installed in the same manner. Toe walls shall be of the size and shape shown on the plans and may be precast or cast-in-place. Forming of cast-in-place toe walls will not be required.
732.3.1.2 Metal Flared End Sections. The end section shall be joined to the pipe or pipe-arch as shown on the plans. The toe plate, if specified, shall be set in a trench or driven to the proper elevation. Care shall be taken to avoid damage to the metal.

732.3.2 Safety Slope End Section. Safety slope end section shall consist of a metal-flared end section, a safety bar system or a bar grate system, toe plate extension, if required in the contract, and any fasteners required for attachment to the culvert pipe.

732.3.2.1 Construction Requirements. Safety slope end sections shall be attached as shown on the plans. They shall be carefully placed to the line and grade of the structure on a uniformly firm soil foundation shaped to fit the lower part of the end section.

732.3.2.2 Toe Plate Extension. The toe plate extension, if required in the contract, shall be attached to the end section as shown on the plans.

732.3.2.3 Safety Bars. The number, size and spacing of safety bars shall be as shown on the plans. A bar grate system, as shown on the plans, may be substituted for safety bars.

732.3.2.4 Bar Grate System. In lieu of the safety bar system, the bar grate system may be used. If used, the bar grate system shall be fabricated and installed as shown on the plans.

732.4 Method of Measurement. Measurement of precast concrete, plastic or metal end sections and safety slope end sections will be made per each.

732.5 Basis of Payment. The accepted quantity of flared end sections and safety slope end sections complete in place will be paid for at the contract unit price per each of the items included in the contract. No direct payment will be made for any excavation or bedding required for placement of the end section, nor for toe walls or toe plates. Any damaged sections required to be replaced due to the Contractor’s action shall be at the Contractor’s expense. Payment for tapered sleeves will be included in the contract unit price for pipe.
SECTION 733
PRECAST CONCRETE BOX CULVERTS

733.1 Description. This work shall consist of furnishing and installing precast concrete box culverts as shown on the plans or as directed by the Engineer. Unless otherwise required in the contract, where the construction of cast-in-place single or multi-cell reinforced concrete box culverts is specified, the Contractor shall have the option of constructing such culverts using precast reinforced concrete box sections and headwalls subject to the conditions specified in the contract.

733.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precast Concrete Box Culverts</td>
<td>1049</td>
</tr>
<tr>
<td>Material for Joints</td>
<td>1057</td>
</tr>
<tr>
<td>Mortars and Grout</td>
<td>1066</td>
</tr>
</tbody>
</table>

733.3 Construction Requirements.

733.3.1 Subgrade Preparation and Bedding. The excavation and backfilling for the precast box sections and end sections shall be in accordance with Sec 206, except a layer of granular material at least 12 inches thick shall be placed immediately below the elevation of the bottom of the box and end sections. The granular material shall be in accordance with Sec 1007 for Type 1 aggregate and shall be placed to extend at least 18 inches on each side of the structure. The bedding shall be compacted to provide uniform support for the bottom of the box and end sections. No direct payment will be made for furnishing, placing or compacting the granular material.

733.3.2 Placement. The individual box section shall be placed as shown on the plans with the groove end upstream and the spigot end extended full length into the adjacent downstream section of box.

733.3.2.1 Joints.

733.3.2.1.1 All joints between individual box sections shall be sealed with an approved plastic joint compound or a tubular joint seal. Trowel grade compounds shall be applied to both mating surfaces. Rope or tape-type plastic joint compounds and tubular joint seals shall be applied in accordance with the manufacturer's recommendations. Excess compound shall extrude from both the inside and outside of the joint when box sections are assembled. Excess compound shall be removed from the interior surface. The joint gap between individual box sections shall be uniform for the full perimeter.

733.3.2.1.2 Filter cloth 2 feet in width and double thickness shall be centered over the top and sides of all joints between individual box sections with edges sealed with mastic or two-sided tape. Filter cloth shall be a subsurface drainage geotextile in accordance with Sec 1011.

733.3.2.1.3 When cast-in-place concrete box culvert collars are shown on the plans and the alternate precast option is used, precast box culvert ties shall be used in accordance with standard plans to connect individual box sections. Regular strength connections shall be supplied unless specified otherwise.

733.3.2.2 Lift Holes. Lift holes shall be filled with expansive mortar or tapered precast mortar plugs to provide a permanent watertight section, and shall be finished flush on the inside of the box. Lifting devices shall have sufficient bearing on the inside of the box section to avoid damage resulting from a concentration of stresses around the lift holes.
733.3.2.3 Multi-Cell Box Culvert. When multi-cell box culverts are used, a 1 1/2 inch minimum space shall be left between the adjacent precast sections. Following the installation of the end sections, the 1 1/2 inch space between the parallel sections shall be entirely filled with mortar for grout. After the mortar has attained sufficient strength, sections shall be backfilled in accordance with Sec 206.

733.4 Method of Measurement.

733.4.1 If the Contractor chooses to construct the alternate precast box culvert, measurement will be made as provided for the equivalent cast-in-place structure.

733.4.2 Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, if a precast box culvert is specified in the contract, the precast box culvert, complete in place including end sections, will be measured to the nearest foot along the geometrical center of the culvert floor. The revision or correction will be computed and added to or deducted from the contract quantity.

733.5 Basis of Payment.

733.5.1 The accepted optional precast concrete box culvert, including end sections, will be paid for at the contract unit price for each of the pay items included in the contract.

733.5.2 If a precast box culvert is specified in the contract, the accepted quantities for the precast box culvert, complete in place including end sections, will be paid for at the contract unit price for each of the pay items included in the contract.

733.5.3 No direct payment will be made for furnishing, placing or compacting the Type 1 granular bedding material. Replacement of unsuitable material below the 6 inch bedding will be paid for in accordance with Sec 206.
Division 800

ROADSIDE DEVELOPMENT
801.1 Description. This work shall consist of the application of agricultural lime and commercial fertilizer and soil preparation for seeding and sodding on areas shown on the plans or designated by the Engineer.

801.2 Materials.

801.2.1 Material used for soil neutralization, unless otherwise specified, shall be agricultural lime with no less than 90 percent passing the No. 8 sieve and containing not less than 65 percent calcium carbonate equivalent.

801.2.2 Agricultural lime shall be furnished from a source that has been tested and certified in accordance with the Missouri Agricultural Liming Materials Act. The quantity of material required to provide the specified pounds of effective neutralizing material (E.N.M.) per acre shall be determined from the producer or distributor’s certification of analysis furnished by the Director of the Missouri Agriculture Experiment Station, Columbia, Missouri in accordance with the Missouri Agricultural Liming Materials Act. The Contractor shall provide a copy of this certification to the Engineer prior to application. If agricultural lime is furnished as a commercially bagged product, pelletized or otherwise, with a guaranteed product analysis shown on the bag listing the elemental properties and gradation, the E.N.M. shall be provided to the Engineer. Material may be accepted on the basis of bag label analysis.

801.2.3 Fertilizer shall be a standard commercial product which, when applied at the proper rate, will supply the quantity of total nitrogen (N), available phosphoric acid (P₂O₅) and soluble potash (K₂O), as specified in the contract. Material may be accepted on the basis of bag label analysis or supplier’s certification and shall comply with all applicable Missouri Fertilizer Laws. Commercial fertilizer shall have a minimum composition of 12% nitrogen, 12% available phosphoric acid and 12% soluble potash (12-12-12 Formula). The application of commercial fertilizer shall be at the rate of 300 lbs.-325 lbs. per acre or as otherwise directed by the Engineer.

801.3 Equipment. Lime and commercial fertilizer shall be applied by mechanical equipment designed for this purpose. Small areas may be applied by hand methods with prior approval of the Engineer.

801.4 Construction Requirements.

801.4.1 The area to be limed and fertilized will be the area specified within the limits of construction. The area shall have a uniform surface free from rills, washes and depressions, and shall conform to the finished grade and cross section shown on the plans. The soil shall be thoroughly broken up, worked, tilled and loosened to a minimum depth of 2 inches. The seedbed or sodbed shall be prepared by loosening the existing soil on the slope, rather than by the addition of loose soil.

801.4.2 Lime and fertilizer shall be applied evenly at the rates specified in the contract, and only when the soil is in a tillable condition. After application, the lime and fertilizer shall be thoroughly mixed into the soil to a minimum depth of 2 inches, except when applied hydraulically on slopes steeper than 2:1.

801.4.3 Lime and fertilizer shall be applied separately but may be incorporated into the soil in one operation. Lime and fertilizer shall be applied not more than 48 hours before the seed is sown unless authorized by the Engineer.

801.5 Method of Measurement. Measurement of the area which has been limed and fertilized will be made to the nearest 1/10 acre.

801.6 Basis of Payment. The accepted quantity of liming and fertilizing will be paid for at the contract unit bid price. No direct payment will be made for liming and fertilizing areas for which seeding or sodding items are included in the contract.
SECTION 802
MULCHING

802.1 **Description.** This work shall consist of applying vegetative mulch and a specified stabilization covering as indicated in the contract.

802.2 **Material.**

802.2.1 **Vegetative Mulch.** Vegetative mulch shall be prairie hay or straw from oats, rye, wheat or barley. Prairie hay shall consist of any combination of any of the following plants: Big Bluestem, Little Bluestem, Indiangrass, Sideoats Grama and native wildflowers. Mulch may also be composted material from clearing and grubbing operations. If composted material from clearing and grubbing operations are used the particle size shall be such it can be adequately spread and does not exceed 6 inches in length. Mulch shall be free of prohibited weed seed as stated in the Missouri Seed Law and shall be relatively free of all other noxious and undesirable seed. The mulch shall be clean and bright, relatively free of foreign material and shall be dry enough to spread properly.

802.2.2 **Mulch Overspray.** Mulch overspray shall be either virgin wood cellulose fibers or recycled paper mulch. The mulch shall be produced by either the ground or cooked fiber process, shall not be water soluble and shall have the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture Content, percent by weight, max</td>
<td>15</td>
</tr>
<tr>
<td>Organic Matter-Wood Fiber, percent by weight, min</td>
<td>80</td>
</tr>
<tr>
<td>pH</td>
<td>4.3 – 8.5</td>
</tr>
</tbody>
</table>

802.2.3 **Certification.** The Contractor shall furnish a certification for mulch and a manufacturer’s certification that the mulch overspray material are in accordance with these specifications.

802.3 **Construction Requirements.** All seeded areas shall be mulched. Disturbed areas outside of authorized construction limits shall be mulched at the Contractor’s expense.

802.3.1 **Application.** Vegetative mulch shall be applied at a minimum rate of 2 1/2 tons per acre. All mulch shall be distributed evenly within 24 hours following the seeding operation. Following the mulching operation, precautions shall be taken to prohibit foot or vehicular traffic over the mulched area. Any mulch that is displaced shall be replaced at once, but only after the work preceding the mulching which was damaged as a result of the displacement has been repaired to the satisfaction of the Engineer. The Contractor may use erosion control blankets in lieu of mulch.

802.3.2 **Stabilization.** Vegetative mulch shall be secured from movement by either mulch overspray or embedment as indicated in the contract documents, or other methods as approved by the Engineer.

802.3.2.1 **Mulch Overspray.** Mulch overspray shall be applied over the vegetative mulch as a separate operation. Mulch overspray shall be applied in accordance with the manufacturer’s recommendations at a minimum rate of 750 pounds per acre.

802.3.2.2 **Vegetative Mulch Embedment.** Mulch shall be embedded in the soil a sufficient depth to prevent the loss of mulch by wind or water erosion and approximately parallel to the roadbed grade.

802.4 **Method of Measurement.** This item will not be measured for payment.
802.5 Basis of Payment. No direct payment will be made for providing and securing mulch. The accepted quantities of mulch will be considered completely covered by the contract unit price for seeding.

802.5.1 No direct payment will be made for maintaining mulch prior to acceptance for maintenance. On previously accepted mulched areas, the Engineer may authorize areas to be repaired in accordance with Sec 104.3.

802.5.2 No additional payment will be made for erosion control blankets used in lieu of mulch at the Contractor’s option.
SECTION 803
SODDING

803.1 Description. This work shall consist of furnishing and placing sod on areas shown on the plans or as designated by the Engineer.

803.2 Material.

803.2.1 Unless otherwise specified in the contract, the sod shall be Turf Type Tall Fescue, densely rooted and robust. The sod shall be densely rooted and thriving, free of all prohibited and noxious weeds as defined by the Missouri Department of Agriculture and reasonably free of all other weeds. The sod shall be grown from seed varieties that are favorable for the Missouri climate conditions. The sod may be cut in strips or rolls.

803.2.2 Turf type tall fescue and Kentucky bluegrass sods shall be grown from a blend of at least three separate varieties for each sod. Buffalo grass sod shall be of a variety exhibiting salt tolerance.

803.2.3 All sod shall be in accordance with the Missouri Plant Law and the Missouri Department of Agriculture’s Code of State Regulations regulating the growth, sale and shipping of nursery stock in the state of Missouri. The Contractor shall provide a valid certificate of inspection from the state of origin to the Engineer prior to the placement of any sod.

803.3 Construction Requirements.

803.3.1 Turf Type Tall Fescue and Kentucky Bluegrass. Turf type tall fescue and Kentucky bluegrass sods shall not be placed during a drought nor during the period from June 1 to September 1 unless authorized by the Engineer, and shall not be placed on frozen ground. No dry or frozen sod shall be used.

803.3.2 Zoysia. Zoysia sod can be placed year-round but shall not be placed on frozen ground. No dry or frozen sod shall be used. If sod is placed in a dormant state, sod will not be accepted until the Engineer determines the sod is thriving.

803.3.3 The sod bed shall be prepared, limed, and fertilized in accordance with Sec 801. The bed shall be in a firm but uncompacted condition with a relatively fine texture at the time of sodding. Sod shall be moist and shall be placed on a moist earth bed. Sod strips shall be laid along contour lines, by hand, commencing at the base of the area to be sodded and working upward. The transverse joints of sod strips shall be broken, and the sod carefully laid to produce tight joints. The sod shall be firmed, watered, and refirmed immediately after it is placed. The firming shall be accomplished by use of a lawn roller or tamper. On slopes steeper than 3:1 and in ditches and on ditch slopes, the sod shall be pegged with wood pegs approximately 1/2 inch square x 12 inches in length driven into the ground, leaving about 1/2 inch of the peg above sod, and spaced not more than 2 feet apart. Pegging of sod shall be done immediately after the sod has been firmed. When sodding is completed, the sodded areas shall be cleared of loose sod, excess soil, or other foreign material, and a thin application of topsoil shall be scattered over the sod as a top dressing, and the areas thoroughly moistened.

803.3.4 The Contractor shall keep all sodded areas thoroughly moist for 21 days after laying. If the Contractor is authorized to install sod during the period from June 1 to September 1, an additional watering period may be required by the Engineer at their sole discretion.

803.4 Acceptance. No sodded areas will be accepted until the sod is fully rooted into the sod bed and thriving. Sod will not be accepted in the dormant state.

803.5 Method of Measurement. Measurement will be made to the nearest square yard of accepted sodded surface area. Disturbed areas outside of authorized construction limits shall be sodded at the Contractor's sole expense.
803.6 Basis of Payment. The accepted quantities of sodding will be paid for at the contract unit price. No direct payment will be made for watering, pegging, liming, or fertilizing sodded areas, additional sod bed preparation, for the replacement of sodded areas not accepted by the Engineer.
804.1 Description. This work shall consist of approved selected topsoil furnished and placed at the locations shown on the plans in the manner specified.

804.2 Materials. Topsoil shall be obtained from approved sources. It shall be a fertile, friable, and loamy soil of uniform quality, without admixture of subsoil materials, and shall be free from materials such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than one inch in diameter, and any other similar impurities. Topsoil shall be relatively free from grass, roots, weeds, and other objectionable plant material or vegetable debris undesirable or harmful to plant life or which will prevent the formation of a suitable seedbed. A report shall be submitted by the supplier to the Engineer for review and approval that contains sample identification information, technician name and date tested and record as a minimum the following test information:

1) pH; and
2) Report the percentages by mass of the following:
   a) Deleterious materials;
   b) Organic material;
   c) Sand content; and
   d) Silt and Clay content.

804.3 Construction Requirements.

804.3.1 The Engineer shall be notified sufficiently in advance of the opening of any material source to permit the Engineer to prepare for necessary checking and measurement. Topsoil shall be secured from areas from which the topsoil has not been previously removed, either by erosion or mechanical methods. The soil shall not be removed in excess of the depth approved by the Engineer. The Contractor shall furnish the source of material, unless otherwise shown on the plans. During the period of removal of the topsoil material, the site shall be kept drained, and when all material has been removed, the site shall be left in a neat and presentable condition to the satisfaction of the Engineer.

804.3.2 The surface on which the topsoil is to be placed shall be free of all loose rock and foreign material greater in any dimension than one-half the depth of the topsoil to be added. It shall be raked or otherwise loosened just prior to being covered with topsoil. Topsoil shall be placed and spread over the designated areas to a depth sufficiently greater than shown on the plans so that after settling, the completed work will conform with the thickness shown on the plans. After spreading, all large clods and foreign material shall be removed by the Contractor.

804.4 Method of Measurement. Topsoil will be measured to the nearest cubic yard of material in vehicles at the point of delivery.

804.5 Basis of Payment. The accepted quantity of topsoil will be paid for at the contract unit price, including hauling from any distance.
805.1 Description.
This work shall consist of furnishing and sowing seed as specified in the contract. All disturbed areas shall be seeded except for sodded areas, surfaced areas, solid rock, and slopes consisting primarily of broken rock.

805.2 Materials.

805.2.1 The seed shall be grown and processed in the United States or Canada and shall comply with the requirements of the Missouri Seed Law. Certain lots of seed may be desirable for the advancement of a local ecotype when specified, and will be the only seed permitted. The following percentages for purity and germination or pure live seed will be the minimum requirements in the acceptance of seed, unless otherwise permitted by the Engineer.

<table>
<thead>
<tr>
<th>Seed Requirements</th>
<th>Scientific Name</th>
<th>Purity</th>
<th>Germination</th>
<th>Pure Live Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-native Grasses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bermuda Grass</td>
<td>Cynodon dactylon</td>
<td>95</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Smooth Bromegrass</td>
<td>Bromus inermis</td>
<td>85</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td>Poa pratensis</td>
<td>85</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>Dactylis glomerata</td>
<td>85</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Perennial Ryegrass</td>
<td>Lolium perenne</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>Festuca arundinacea</td>
<td>97</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Red Fescue</td>
<td>Festuca rubra</td>
<td>97</td>
<td>85</td>
<td></td>
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<tr>
<td>Timothy</td>
<td>Phleum pratense</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td><strong>Cereal or Cover Crop</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Ryegrass</td>
<td>Lolium multiflorum</td>
<td>98</td>
<td>85</td>
<td></td>
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<tr>
<td>Redtop</td>
<td>Agrostis alba</td>
<td>92</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Oat Grain</td>
<td>Avena sativa</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Rye Grain</td>
<td>Secale cereale</td>
<td>98</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Wheat Grain</td>
<td>Triticum aestivium</td>
<td>97</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Wildrye, Virginia</td>
<td>Elymus virginicus</td>
<td>60</td>
<td>Pure Live Seed</td>
<td></td>
</tr>
<tr>
<td>Wildrye, Canada</td>
<td>Elymus canadensis</td>
<td>60</td>
<td>Pure Live Seed</td>
<td></td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korean Lespedeza</td>
<td>Lespedeza stipulacea</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Alsike Clover</td>
<td>Trifolium hybridum</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Red Clover</td>
<td>Trifolium pratense</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>White Clover</td>
<td>Trifolium repens</td>
<td>98</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>Vicia villosa</td>
<td>97</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Partridge Pea</td>
<td>Chamaecrista fasciculate</td>
<td>98</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td><strong>Native Grasses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big Bluestem</td>
<td>Andropgon gerardii</td>
<td>Mo. Ecotype Roundtree Kaw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue Grama</td>
<td>Bouteloua gracilis</td>
<td>40</td>
<td>Pure Live Seed</td>
<td></td>
</tr>
<tr>
<td>Buffalograss</td>
<td>Buchloe dactyloides</td>
<td>40</td>
<td>Pure Live Seed</td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Variety</td>
<td>Mo. Ecotype</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------</td>
<td>--------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Indiangrass</td>
<td>Sorghastrum nutans</td>
<td>Sharp’s Improved</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Texoka</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Bluestem</td>
<td>Schizachyrium scoparium</td>
<td>Mo. Ecotype</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rumsey Cheyenne</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Gamagrass</td>
<td>Tripsacum dactylloides</td>
<td>Mo. Ecotype</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sideoats Grama</td>
<td>Bouteloua curtipendula</td>
<td>Mo. Ecotype</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>El Reno Trailway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switchgrass</td>
<td>Panicum virgatum</td>
<td>Mo. Ecotype Trailblazer Cave-in-Rock</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Wildrye, Virginia</td>
<td>Elymus virginicus</td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Wildrye, Canada</td>
<td>Elymus canadensis</td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Cluster Fescue</td>
<td>Festuca paradoxa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rough Dropseed</td>
<td>Sporobolus compositus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prairie Dropseed</td>
<td>Sporobolus heterolopus</td>
<td>Mo. Ecotype</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prairie Cordgrass</td>
<td>Spartina pectinata</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a Does not apply if unhulled or unscarified seed is specified.

**805.2.2** If the specified quantity is in pounds of seed, no reduction will be permitted in the specified quantity of seed if the purity or germination, or both, are higher than the minimum required by the specification. If the specified quantity is in pounds of pure live seed, the pure live seed quantity shall be determined from the actual percentage shown by the supplier for native grasses or by multiplying the actual percentages of purity times the actual percentage of germination including hard seed for other seed.

**805.2.3** All leguminous seeds shall be inoculated or treated with the proper quantity of cultures approved for the particular legume to be sown. Leguminous seeds include Alsike Clover, Korean Lespedeza, Red Clover, Sericea Lespedeza, Sweet Clover, and White Clover.

**805.2.3.1** The inoculant for treating leguminous seeds shall be a pure culture of nitrogen fixing bacteria. The containers of the inoculant shall be plainly marked with the expiration date for use and the manufacturer's directions for inoculating seed.

**805.2.3.2** The process of inoculation shall be in accordance with the manufacturer's directions for the particular species of legume. The time lapse for sowing the seed following inoculation shall not exceed 24 hours. When hydraulic slurry seeding is used, an amount of inoculant equal to five times the normal rate required to inoculate only the legume seed shall be used. The inoculant shall be placed directly into the slurry and thoroughly mixed immediately before seeding. When other than the hydraulic slurry method is used, the legume seed may be inoculated at the normal rate if it is to be sown alone or if the legume seed is inoculated prior to mixing with other seed. A seed mixture which contains a legume that was not inoculated prior to mixing and is not to be seeded by the slurry method, shall be inoculated with sufficient inoculant to cover all seed.

**805.2.3.3 Prohibited Weed Seeds.** No tolerance will be applied to grass mixtures for prohibited weed seeds, namely: Field Bindweed (Convolvulus arvensis), Johnson Grass (Sorghum halerenge), and Canada Thistle (cirsium arvense).
805.3 Construction Requirements.

805.3.1 The seedbed shall be prepared, limed, and fertilized in accordance with Sec 801. Seeding shall be done before the seedbed becomes eroded. Seed shall be uniformly applied at no less than the rates specified. Unless otherwise shown in the plans, the rate of application will be:

<table>
<thead>
<tr>
<th>Seed Name</th>
<th>Pounds of Pure Live Seed/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alta Fescue</td>
<td>50</td>
</tr>
<tr>
<td>Annual Ryegrass</td>
<td>30</td>
</tr>
<tr>
<td>Creeping Red Fescue</td>
<td>50</td>
</tr>
<tr>
<td>Sweet Clover</td>
<td>20</td>
</tr>
</tbody>
</table>

805.3.2 Disturbed areas outside of authorized construction limits shall be seeded at the Contractor's expense.

805.3.3 During the months of December through May, August, and September, all lime, fertilizer, seed and mulch shall be applied to the finished slopes. During the months of June, July, October, and November, lime, fertilizer, seed, and mulch shall be applied at the following rates:

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>100 percent of the specified quantity</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>75 percent of the specified quantity</td>
</tr>
<tr>
<td>Seed</td>
<td>50 percent of the specified quantity</td>
</tr>
<tr>
<td>Mulch</td>
<td>100 percent of the specified quantity</td>
</tr>
</tbody>
</table>

805.3.3.1 Alternate methods of seeding will be considered when submitted for approval but will not relieve the Contractor of compliance with Sec 805.4.

805.3.3.2 Seeding shall be done before the proposed seedbed becomes eroded, crusted over, or dried out and shall not be done when the ground is in a frozen condition or covered with snow. When the partial application has been made during June, July, October, or November, the remainder of the fertilizer plus 75 percent of the specified quantity of seed shall be applied by overseeding during August, September, December, January, or February. Seeds shall be uniformly applied at the rates prescribed. Provisions shall be made by markers or other means to ensure that the successive seeded strips will overlap or be separated by a space no greater than the space left between the rows planted by the equipment being used. If inspection during the seeding operations indicates that strips wider than the space between rows planted have been left unplanted, additional seed shall be planted on these areas. Hand seeding will be permitted in isolated areas with prior approval of the Engineer.

805.3.3.3 Hydraulic Seeding and Fertilizing. In lieu of mechanical application of seed and fertilizer, hydraulic application may be used. Seed and fertilizer may be applied hydraulically provided the seed and fertilizer are applied separately. The seed and fertilizer shall be incorporated into the soil as specified in Sec 801.4.2 and Sec 805.3.3.4, in separate operations except that raking will not be required when seeding a previously seeded and mulched area. On slopes steeper than 2:1, or when seeding is applied to a previously seeded and mulched area, seed and fertilizer may be applied hydraulically in a single operation, and incorporation into the soil will not be required. Seed and fertilizer, separately or in combination, shall be mixed with water and constantly agitated so that a uniform mixture can be applied hydraulically to the designated areas. The ratio of seed and fertilizer to water shall be calculated by determining the surface area covered by a given quantity of water. Seed shall not be added to the water more than 4 hours before application.

805.3.3.4 Dry Seeding. Dry seeding shall be done mechanically with equipment designed for even distribution of dry seed. The equipment may either be hand operated, such as knapsack seeder, or be tractor drawn, such as seed
drill, except that tractor drawn equipment will not be permitted on a previously seeded and mulched area. After completing the seeding operation, if in the judgment of the Engineer the seedbed is either too loose or contains clods which would reduce the germination of the seed, the Contractor shall firm the area by rolling. When rolling is required, a lawn type roller shall be used, and care shall be taken to avoid over compacting the soil.

805.4 Acceptance. Acceptance of permanent seeding will be made when seeded disturbed areas meet the requirements for final stabilization as defined in the Current Missouri State Operating Permit for Land Disturbance. Inspection for acceptance will be made within 60 days after seeding, excluding seeding dates that fall between September 30 and March 1. Seeding that occurs between September 30 and March 1 will be inspected no earlier than May 1.

805.4.1 Final payment for seeding will be contingent upon project acceptance. Seed must have germinated and produced a green and growing ground cover, regardless of method used to apply seed, before acceptance will be made.

805.5 Corrective Action. Inadequate stands shall be reworked and reseeded within a time period determined by the Engineer, at the Contractor’s expense. On previously accepted seeded areas, the Engineer may authorize eroded areas to be repaired in accordance with Sec 104.3.

805.6 Method of Measurement. Measurement will be made of the area seeded to the nearest 1/10 acre. Disturbed areas outside of authorized construction limits shall be seeded at the Contractor’s expense.

805.7 Basis of Payment. The accepted quantity of seeding will be paid for at the contract unit price. No direct payment will be made for liming, fertilizing or seedbed preparation. No direct payment will be made for additional work and seed required when seeding during the months of June, July, October, and November.
SECTION 806
POLLUTION, EROSION AND SEDIMENT CONTROL

806.1 Description. This work shall consist of furnishing, installing, maintaining and removing temporary pollution, erosion and sediment control measures; furnishing and placing permanent erosion control features; or a combination of both as shown on the plans or as directed by the Engineer.

806.2 Schedule of Work. Prior to the preconstruction conference and the start of construction, the Contractor shall submit schedules for the implementation of temporary pollution control and temporary and permanent erosion control work, as applicable, for construction operations. The Contractor's schedule shall address specifically the pollution and erosion control measures planned at all streams or other bodies of water. No work shall start until the pollution and erosion control schedules and methods of operations have been approved by the Engineer. Any delay of the work resulting from failure to submit acceptable pollution and erosion control schedules and methods of operations will be considered nonexcusable.

806.3 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as herein.

806.4 Construction Requirements. The Engineer will limit the surface area of erodible earth material exposed by clearing and grubbing or by excavation, borrow and fill operations in accordance with the following. The Engineer may direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other bodies of water. Such work may involve the construction of temporary berms, dikes, dams, sediment basins and slope drains, and use of temporary mulches, seeding or other control devices or methods as necessary to control erosion and pollution.

806.4.1 If erosion and sediment control measures, as shown on the plans, are not suitable due to site conditions, a suitable system of Best Management Practices (BMP) as defined by the applicable Missouri State Operating Permit for land disturbance activities and the Stormwater Pollution Prevention Plan (SWPPP), shall be applied as approved by the Engineer.

806.4.2 The Contractor shall exercise effective management practices throughout the life of the project to control pollution. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage or other harmful material shall not be discharged on or from the project. Temporary pollution control measures, such as storage and handling of petroleum products and other pollutants, shall be coordinated with temporary and permanent erosion and sediment control features specified in the contract to ensure economical, effective and continuous erosion and pollution control. These requirements will also apply to work within easements designated by the County.

806.4.3 The Contractor shall incorporate all permanent erosion, sediment, and pollution control features into the project at the earliest practical time. Temporary measures shall be used to correct conditions that develop during construction which were not foreseen during the design stage, that are needed prior to installation of permanent pollution control features, or that are needed temporarily to control erosion and sediment that develops during normal construction practices, but are not associated with permanent control features on the project.

806.4.4 Installation of temporary control measures shall be scheduled to coincide with clearing and grubbing operations, but before grading operations begin. The project land area disturbance shall not exceed one acre without installation of erosion and sediment controls. The total project land disturbance area shall not exceed 20 acres without written approval from the Engineer.

806.4.5 The Engineer may allow additional land disturbance acreage if appropriate BMP's including temporary seeding and mulching, have been applied to previously disturbed areas and the Contractor has the resources to apply the BMP's to the expanded area.
806.4.6 Unless otherwise provided or approved in writing by the Engineer, construction operations in streams or other bodies of water shall be restricted to those areas that must be entered for the construction of temporary or permanent structures. Streams or other bodies of water shall be promptly cleared of all falsework, piling, debris or other obstructions placed therein or caused by construction operations.

806.4.7 Fording of streams or other bodies of water with construction equipment will not be permitted, except as allowed by the Engineer. Temporary bridges or other structures shall be used when frequent crossing of streams or other bodies of water is necessary. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in streams or other bodies of water except as may be required to construct channel changes and temporary or permanent structures. If a Corps of Engineer Section 404 or Department of Natural Resources Section 401 permit is applicable for a project, the permit requirements and conditions will prevail.

806.4.8 The Contractor shall obtain all necessary permits to cover all project-associated activities on external sites that are not located on County right of way or easements. Project-associated activities includes borrow areas, plant sites, and staging areas. All costs associated with the permits and pollution control shall be at the Contractor’s expense, including providing, installing, maintaining, and removal of all erosion and sediment control devices, and final stabilization of disturbed areas.

806.4.9 In the event of conflict between these requirements and the pollution control laws, rules or regulations of other federal, state or local agencies, the more restrictive laws, rules or regulations will apply.

806.4.10 The Contractor is encouraged to incorporate mulch from the clearing and grubbing operation into the BMP’s on the project. BMP’s may consist of compost filled socks, compost filter berms, soil protection cover or any other method as approved by the Engineer.

806.4.11 Unless otherwise specified, or directed by the Engineer, all temporary erosion and sediment control measures shall be removed by the Contractor after permanent erosion and sediment control measures are established and the project has achieved final stabilization as defined in the SWPPP. Biodegradable erosion and sediment control materials may be allowed to be incorporated into the project in accordance with the SWPPP, as approved by the Engineer. Rock from ditch checks and other temporary sediment devices may be repositioned to serve as ditch liner in accordance with the SWPPP, and as directed by the Engineer.

806.4.12 Portland cement concrete residue and wash water and other operations that produce sediment laden runoff shall be managed by an appropriate control measure.

806.4.12.1 Portland cement concrete residue and wash water shall be discharged into a plastic lined pit, plastic lined straw bale enclosure, or other commercially available water tight enclosure suitable for containing concrete residue and wash water as approved by the Engineer.

806.4.12.2 Water from aggregate washing and other operations that produce sediment laden water shall be treated by filtration, settling basins, or other means sufficient to comply with the general water quality criteria established by MDNR.

806.4.12.3 No direct payment will be made for the design, installation, maintenance or removal of controls necessary to contain Portland cement concrete residue and wash water or other water from sediment producing operations.

SECTION 806.10 TEMPORARY BERMS.

806.10.1 Description. This work shall consist of constructing and maintaining temporary berms at the top of slopes or transverse to the centerline of fills as shown on the plans.
806.10.2 Material. Type B berms shall consist of graded material from within the project limits, rock, or other suitable material approved by the Engineer. Type C berms shall consist of rock with a predominant size between 4 inches and 12 inches.

806.10.3 Construction Requirements. Temporary berms shall be constructed and maintained to the approximate dimensions shown on the plans.

806.10.3.1 Type B Berms. Type B berms shall be machine compacted with a minimum of three passes over the entire width of the berm. Material removed from Type B berms shall be incorporated in the embankment when possible. The Contractor shall remove and dispose of any excess or unsuitable material to a location approved by the Engineer.

806.10.3.1.1 Type B berms shall drain to a compacted outlet at slope drain. On transverse berms, the top width of the berms may be wider and the side slopes flatter to allow equipment to pass over these berms with minimal disruption.

806.10.3.2 Type C Berms. Vegetative mulch, erosion control blanket or geotextile fabric shall be placed on the upslope of the Type C berm. The vegetative mulch shall be placed in such a manner that the final compacted thickness is 2 inches. The material for the vegetative mulch shall be in accordance with Sec 802. The straw layer erosion control blanket or geotextile fabric shall be removed and replaced as directed by the Engineer.

806.10.4 Method of Measurement. Measurement of Type B and C berms will be made to the nearest linear foot.

806.10.5 Basis of Payment. The accepted quantities of Type B and C berms will be paid for at the contract unit price and will be considered full compensation for material, installation, maintenance, removal and any other hand work necessary to construct the berms. No payment will be made for the straw layer, erosion control blanket or geotextile fabric on the Type C berm. No payment will be made for any seeding and mulching needed after removal.

SECTION 806.20 TEMPORARY SLOPE DRAINS.

806.20.1 Description. This work shall consist of furnishing, constructing maintaining and removing temporary slope drains to carry water down slopes and to reduce erosion. The method selected shall be approved by the Engineer prior to construction.

806.20.2 Construction Requirements. The Contractor shall provide temporary, impermeable slope drains to carry water or water with suspended solids down fill slopes until permanent erosion control measures are established. The Contractor shall provide temporary slope drains on fill slopes at approximately 500 foot intervals or as directed by the Engineer. All temporary slope drains shall be adequately anchored to the slope to prevent disruption of flow. The inlet ends shall include a ditch check and be constructed to channel water into the temporary slope drain. Outlet ends shall have some means of dissipating the energy of the water to reduce erosion downstream and have the ability to capture sediment. After removal, the Contractor shall restore the site of the slope drains to the satisfaction of the Engineer.

806.20.3 Method of Measurement. Measurement of temporary slope drains will be made to the nearest linear foot.

806.20.4 Basis of Payment. The accepted quantities of temporary slope drains will be paid for at the contract unit price. Payment shall include furnishing, constructing, maintaining and removing temporary slope drains, and restoration of the slope drain sites. No payment will be made for any seeding and mulching needed after removal.

SECTION 806.30 TEMPORARY DITCH AND INLET CHECKS.
806.30.1 **Description.** This work shall consist of furnishing, constructing, maintaining, removing and disposing of temporary ditch and inlet checks.

806.30.2 **Construction Requirements.**

806.30.2.1 **Rock Ditch Checks.** Rock ditch checks shall be constructed in accordance with the plans, or as directed by the Engineer, and shall have a minimum effective height of 18 inches. The predominant size of the rock used shall range between 4 inches and 12 inches.

806.30.2.2 **Alternate Ditch Checks.** Alternate ditch checks shall be constructed in accordance with the manufacturer's specifications, and as shown on the plans, or as directed by the Engineer. Alternate ditch checks shall have a minimum effective height of 9 inches, shall follow guidance provided in the SWPPP, and shall perform to the level that meets or exceeds the requirement of the current Missouri Operating Permit.

806.30.2.2.1 Unless otherwise disallowed, the Contractor has the option to construct rock ditch checks in lieu of alternate ditch checks. Rock ditch checks constructed in lieu of alternate checks shall have a minimum effective height of 18 inches. Spacing shall be increased, as determined by the Engineer, to account for the additional height of rock ditch check. The toe-to-top capacity requirements shown on the plans will be used to determine the spacing.

806.30.2.3 **Inlet Checks.** Inlet checks shall be installed in accordance with the plans or as directed by the Engineer to prevent sediment entering closed drainage systems.

806.30.2.3.1 Inlet checks at drop inlets, manholes, flared end sections, and other openings to culverts shall be constructed in accordance with Sec 806.30.2.1 and shall completely surround the inlet or other structure, as indicated on the plans. Other allowable methods of protecting inlets will be listed in the SWPPP.

806.30.2.3.2 Inlet checks at curb inlets shall consist of socks filled with rock, or other fillers of sufficient weight to keep the device in place. Curb inlet checks shall be installed in the gutter or as shown on the plans. Other proprietary devices may be used, as approved by the Engineer.

806.30.3 **Maintenance.** The Contractor shall monitor the condition of all temporary checks and repair or replace checks that are not functional. The Contractor shall remove sediment in accordance with Sec 806.110. Alternate ditch checks shall be maintained in accordance with this provision and the manufacturer's specifications or as directed by the Engineer.

806.30.4 **Removal.** All types of temporary checks shall remain in service until removal has been approved by the Engineer. Removal shall be in accordance with Sec 806.4.11 and as stated herein. The Contractor shall remove any sediment from the check, remove the check, and restore the area to match existing ground condition. When necessary, seeding and mulching shall be in accordance with Sec 802 and Sec 805 respectively, and shall be considered incidental.

806.30.5 **Method of Measurement.**

806.30.5.1 Measurement of rock ditch checks, alternate ditch checks, and inlet checks will be made per each check.

806.30.6 **Basis of Payment.**

806.30.6.1 The accepted quantities of rock ditch checks, alternate ditch checks, and inlet checks will be paid for at the contract unit price for each pay item included in the contract. If the Engineer determines unusual conditions warrant complete replacement of a check, payment will be made for the replacement check at the contract unit price.
806.30.6.2 Payment for sediment removal shall be in accordance with Sec 806.110.

SECTION 806.40 SEDIMENT BASINS.

806.40.1 Description. This work shall consist of constructing and maintaining temporary or permanent sediment basins as shown on the plans or as directed by the Engineer. This work shall include clearing and excavation to construct the basin, disposal of excavated material, and providing and installing rock or other stabilizing material as approved by the Engineer. For temporary basins, removal, backfilling, and site restoration is also included in the work.

806.40.2 Construction Requirements. The sediment basin shall be an excavated or dammed storage area with defined side slopes. Inlet and outlet areas shall be lined with rock of sufficient size to withstand the water flow. In lieu of rock, other allowable liners may be used as described in the SWPPP. Outlets may be constructed with a riser pipe, surface skimmers, or stabilized spillway, or a combination of one or more of these features.

806.40.2.1 The inlet of a sediment basin shall be constructed with a wide cross-section and a minimum grade to prevent turbulence and to allow deposition of soil particles.

806.40.2.2 Sediment shall be removed and disposed in accordance with Sec 806.110, and before the depth reaches approximately one-half the original depth of the sediment basin in any part of the pool.

806.40.2.3 Temporary sediment basins shall remain in service until removal has been approved by the Engineer. Removal shall be in accordance with Sec 806.4.11 and as stated herein. The Contractor shall remove any sediment from the basin, backfill, compact all excavations, restore the area to match existing ground conditions, and seeding and mulching in accordance with Sec 802 and Sec 805 respectively.

806.40.3 Method of Measurement.

806.40.3.1 Measurement of excavation to construct sediment basin will be made to the nearest tenth of a cubic yard.

806.40.3.2 Measurement of rock placed to construct sediment basins will be made to the nearest tenth of a cubic yard.

806.40.4 Basis of Payment.

806.40.4.1 The accepted quantities for excavation to construct sediment basins will be paid for at the contract unit price. Payment includes clearing, excavation, removal, backfilling and final grading.

806.40.4.2 The accepted quantity for rock used to construct sediment basins will be paid for at the contract unit price. Payment shall include furnishing, placing, and removal of rock.

806.40.4.3 No direct payment will be made for seeding and mulching necessary to restore the area after removal.

806.40.4.4 Payment for sediment removal shall be in accordance with Sec 806.110.

SECTION 806.50 TEMPORARY SEEDING AND MULCHING.

806.50.1 Description. This work shall consist of furnishing and applying fertilizer, seed, vegetative mulch or other acceptable cover, in disturbed areas authorized by the Engineer. Temporary seeding and mulching is utilized to establish a quick ground cover that reduces erosion in disturbed areas where staging requires the area to be disturbed again at a later date, and for areas that are complete but current seasonal conditions are not favorable.
for applying permanent seeding. Finish grading will not be required except for areas that will not receive further grading prior to permanent seeding. Hydraulic seeding and fertilizing in accordance with Sec 805 will be permitted.

806.50.2 Construction Requirements. Seeding and mulching shall be a continuous operation on all cut and fill slopes, excess material sites and borrow pits during the construction process. All disturbed areas shall be seeded and mulched as necessary to control erosion. When a project is shown in the contract to be constructed in stages and operations in those staged areas are suspended for a significant amount of time, the Contractor shall receive payment for temporary seed and mulch. When the Engineer allows the Contractor to disturb additional ground beyond the restrictions in Sec 806.4.4 solely to enhance the Contractor’s operation, the Contractor shall not receive compensation for temporary seed or mulch, as required by the Engineer, for ground cover for areas exceeding the restrictions in Sec 806.4.4.

806.50.2.1 The Contractor shall provide permanent seeding and mulching as shown on the plans following temporary seeding. Any preparation of the seed bed that might be necessary prior to permanent seeding shall be considered incidental to temporary seeding.

806.50.2.2 Temporary seeding mixtures of cereal grains shall be applied at a minimum rate of 100 pounds per acre. All erodible seeded areas shall provide a minimum of 20 plants of the species planted per square foot on at least two random counts per acre in representative areas of the field. For areas with a large percentage of rock, the number of living plants shall be proportional to the percentage of erodible surface, as determined by the Engineer. The counts will be conducted 60 days after the species is planted.

806.50.2.3 Mulch placed over temporary seed mixtures shall be applied in accordance with Sec 802.

806.50.2.4 Fertilizer shall be applied at a rate of 40 pounds nitrogen (N) per acre.

806.50.2.5 Lime will not be required for temporary seeding.

806.50.3 Method of Measurement. Measurement of temporary seeding areas will be made to the nearest tenth of an acre. No measurement will be made for mulch.

806.50.4 Basis of Payment. The accepted quantities of temporary seeding will be paid for at the contract unit price per acre. Payment for fertilizer and mulch shall be included in the cost of temporary seeding.

SECTION 806.60 SEDIMENT TRAP.

806.60.1 Description. This work shall consist of constructing, maintaining and removing sediment traps as shown on the plans or as directed by the Engineer.

806.60.2 Construction Requirements.

806.60.2.1 Sediment traps shall be constructed as shown on the plans or as directed by the Engineer. Traps may require excavation, or placement of rock of sufficient size to impound water, or a combination of excavation and placement of rock.

806.60.2.2 Sediment traps shall be installed with clearing and grubbing operations or as directed by the Engineer. The Contractor shall monitor sediment levels and remove sediment in accordance with Sec 806.110.

806.60.2.3 Sediment traps shall remain in service until removal has been approved by the Engineer. Removal shall be in accordance with Sec 806.4.11 and as stated herein. The Contractor shall remove any sediment from the trap, backfill, compact all excavations, restore the area to match existing ground condition, and seeding and mulching in accordance with Sec 802 and Sec 805 respectively.
806.60.3 Method of Measurement.

806.60.3.1 Measurement of excavation to construct sediment traps will be made to the nearest tenth of a cubic yard.

806.60.3.2 Measurement of rock placed to construct sediment traps will be made to the nearest tenth of a cubic yard.

806.60.4 Basis of Payment.

806.60.4.1 The accepted quantity for excavation to construct sediment traps will be paid for at the contract unit price. Payment includes clearing, excavation, removal, backfilling, and final grading.

806.60.4.2 The accepted quantity for rock used to construct sediment traps will be paid for at the contract unit price. Payment shall include furnishing, placing, and removal of rock.

806.60.4.3 No direct payment will be made for seeding and mulching necessary to restore the area after removal.

806.60.4.4 Payment for sediment removal will be in accordance with Sec 806.110.

SECTION 806.70 SILT FENCE.

806.70.1 Description. This work shall consist of furnishing, installing, maintaining, and removing of a silt fence to control sediment along slopes and other designated areas. The quantity of silt fence shown on the plans may be increased or decreased, as directed by the Engineer. The Engineer may also modify the location as necessary to improve the effectiveness of the silt fence. Variations in quantity and location will not be considered as a change in work.

806.70.2 Material. When geotextile fabric is used, material shall be in accordance with Sec 1011. All other material shall be as specified in the SWPPP.

806.70.2.1 Posts. Wood, steel or synthetic posts may be used. Posts shall be of sufficient length, but no less than 4 feet, to ensure adequate embedment while fully supporting the fence and shall have sufficient strength to resist damage during installation and to support applied loads while in service.

806.70.2.2 Prefabricated Fence. Prefabricated fence systems may be used if the systems meet all of the above material requirements.

806.70.3 Construction and Maintenance Requirements.

806.70.3.1 Fabric Fence. The Contractor shall install silt fence as shown on the plans and at other locations directed by the Engineer. Fence construction shall be adequate to handle the stress from hydraulic and sediment loading. Fabric at the bottom of the fence shall be buried a minimum of 6 inches to prevent flow under the barrier. The trench shall be backfilled, and the soil compacted over the fabric. Fabric splices with a minimum 2-foot overlay shall be located only at a support post. Any installation method acceptable to the Engineer will be allowed as long as the effectiveness and intent of the silt fence is achieved.

806.70.3.1.1 Post spacing shall not exceed 5 feet. Posts shall be driven a sufficient depth into the ground or placed on closer spacing as necessary to ensure adequate resistance to applied loads.
806.70.3.1.2 The silt fence shall be fastened securely to the upslope side of the post. When wire support fence is used, the wire shall extend into the trench a minimum of 2 inches.

806.70.3.2 Alternate Fence Types. Alternate silt fence types shall be in accordance with the SWPPP or as approved by the Engineer.

806.70.3.3 Maintenance. The Contractor shall monitor the condition of all fences and repair or replace fences that are not functional as long as the fences are necessary to contain sediment runoff. Any deficiencies shall be corrected by the Contractor in accordance with the SWPPP. In addition, the Contractor shall review the effectiveness of silt fences in areas where construction activities have changed the natural contour and drainage runoff. Where deficiencies exist, additional silt fences shall be installed as approved or directed by the Engineer.

806.70.3.4 Sediment. The Contractor shall remove and dispose of sediment in accordance with Sec 806.110. Segments of silt fence that receive heavy sediment loading may require a secondary silt fence or installation of other controls to adequately contain sediment.

806.70.3.5 Removal. Silt fence shall be removed in accordance with Sec 806.4.11 and as specified herein. The Contractor shall remove and dispose of any excess silt accumulation along the fence, shall restore the area to match existing ground condition, and seeding and mulching in accordance with Sec 802 and Sec 805 respectively.

806.70.4 Method of Measurement. Silt fence will be measured to the nearest linear foot from end to end of each separate installation.

806.70.5 Basis of Payment.

806.70.5.1 The accepted quantities of silt fence will be paid for at the contract unit price.

806.70.5.2 No direct payment will be made for seeding and mulching necessary to restore the area after removal.

806.70.5.3 Payment for sediment removal will be in accordance with Sec 806.110.

SECTION 806.80 TEMPORARY PIPE.

806.80.1 Description. This work shall consist of installing and removing temporary pipe utilized to carry water under temporary roadways, silt fences, berms or other locations determined by the Engineer and to prevent the Contractor’s equipment from coming in direct contact with water when crossing an active stream, intermittent streams created during heavy rainfalls or other bodies of water.

806.80.2 Material. Any pipe approved by the Engineer may be used.

806.80.3 Construction Requirements. Installation of temporary pipe shall be in accordance with the specifications for permanent pipe and shall prevent water from causing erosion around the pipe. All backfill material for pipes shall be placed in 6 inch lifts and mechanically compacted. Compaction tests will not be required. Temporary pipe placed in intermittent or active streams shall be backfilled with clean rock of sufficient size to withstand normal stream flows.

806.80.4 Method of Measurement. Measurement of temporary pipe will be made to the nearest linear foot for those pipes specified on the plans.

806.80.5 Basis of Payment. The accepted quantities of temporary pipe will be paid for at the contract unit price for temporary pipes specified on the plans. No payment will be made for temporary pipes that the Contractor chooses.
to install to facilitate construction. Unless provided as a pay item in the contract documents, no direct payment will be made for the placement and removal of the backfill material or rock.

SECTION 806.90 EROSION CONTROL BLANKETS AND TURF REINFORCEMENT MATS.

806.90.1 Description. This work shall consist of furnishing and placing erosion control blankets (ECBs) and turf reinforcement mats (TRMs) on slopes or ditches for short-term or long-term protection of seeded areas at locations shown on the plans or as directed by the Engineer.

806.90.2 Material. ECBs and TRMs shall be used as designated in the contract or as approved by the Engineer. The Contractor shall provide ECBs and TRMs of the type specified in the contract and shall provide a manufacturer's certification stating that they are in accordance with Sec 1011.

806.90.3 Construction Requirements. ECBs and TRMs shall be installed and maintained according to the manufacturer's recommendations.

806.90.4 Method of Measurement. Measurement of ECBs and TRMs will be made to the nearest square yard of surface area covered without regard to any overlap.

806.90.5 Basis of Payment. The accepted quantity of ECBs and TRMs will be paid for at the contract unit price for each of the pay items included in the contract. If ECBs and TRMs are used in lieu of other erosion control measures, payment will be made at the contract unit price for the pay items in the contract for the respective items that the blanket replaces.

SECTION 806.100 TEMPORARY STREAM CROSSING.

806.100.1 Description. This work shall consist of constructing a temporary stream crossing to facilitate the movement of equipment across a stream.

806.100.2 Construction Requirements. The Contractor shall be responsible for the design, installation, maintenance and removal of the temporary stream crossing and any structures installed for the construction of the temporary stream crossing. Appropriate measures shall be taken to maintain near normal downstream flows and to minimize flooding upstream. The temporary stream crossing shall be constructed to permit the free movement of the stream’s aquatic life. Fill material shall be clean rock of sufficient size to withstand expected high flows. Only graded rock and/or quarry-run rock shall be used. The rock must be reasonably well graded, with no particle dimension greater than approximately 12 inches, and no particle dimension less than approximately 9 inches. Gravel and dirt should not exceed 15% of the total fill volume.

806.100.2.1 Prior to construction of the temporary stream crossing, all information shall be submitted to the Engineer to ensure that it meets the terms and conditions of the Corps of Engineer permit. The Contractor shall not begin construction on any temporary stream crossing without written permission from the Engineer.

806.100.2.2 All approaches to the temporary stream crossing shall be maintained such that all storm water runoff is diverted to retention devices.

806.100.2.3 When the temporary stream crossing is no longer needed, the crossing shall be removed as soon as possible and the area shall be restored to pre-project conditions or to the satisfaction of the Engineer.

806.100.3 Basis of Payment. No direct payment will be made for the design, installation, maintenance or removal of temporary stream crossings. The Contractor shall be responsible for all costs, including damage and penalties.
806.110.1 Description. This work shall consist of removing and disposing of sediment from sediment control devices, such as ditch and inlet checks, sediment basins, sediment traps, silt fence, and other devices that accumulate sediment.

806.110.2 Construction Requirements. The Contractor shall monitor sediment levels in all sediment control devices and remove sediment prior to the level reaching approximately one-half the design heights for checks and fences, and one-half the storage capacities for basins and traps. The Engineer may require sediment removal from devices prior to levels reaching the specified limits.

806.110.2.1 The Contractor shall dispose of the sediment in a location that does not allow the sediment to erode back into the sediment devices or to pollute streams or other bodies of water.

806.110.3 Basis of Payment. No direct payment will be made for sediment removal. The costs of preforming sediment removal shall be included in the unit price of each BMP.
SECTION 808
PLANTING TREES, SHRUBS, AND
OTHER PLANTS

808.1 Description. This work shall consist of furnishing and planting materials in the locations designated on the plans or established by the Engineer.

808.1.1 Shrubs designated to be removed and relocated shall be protected as required for new stock during the temporary removal interim, and then be replanted as hereinafter specified.

808.2 Materials.

808.2.1 Plants.

808.2.1.1 Unless otherwise specified or permitted by the Engineer, trees, shrubs, and other plants shall be nursery stock and shall be true to type and name in accordance with the current edition of Standardized Plant Names published by the American Joint Committee on Horticultural Nomenclature. A nursery is defined as a place where trees and plants are grown in established rows for the purpose of replanting at a new location. The nursery stock shall have well developed branch systems and vigorous healthy root systems. All stock shall be well formed and the trunks of trees shall be uniform. All plants shall have a normal habit of growth and shall be sound, healthy, and vigorous. They shall be free from insects, disease, and defects such as knots, sun-scald, injuries, serious abrasions of the bark, or objectionable disfigurements. Thin weak plants will not be accepted. All nursery stock shall qualify under the AAN Horticultural Standards of the current American Standard for Nursery Stock, ANSI Z 60.1. Substitution of plant stock of other materials will not be permitted except by approval of the Engineer.

808.2.1.2 All measurements for height, spread, branching, diameter, and root spread or ball size shall be as specified in the current AAN American Standard for Nursery Stock, ANSI Z 60.1, except as modified herein. For bare root trees, the minimum root spread in inches shall be equal to 12 inches for each inch diameter, plus 12 inches, except that if the natural root spread does not meet this requirement, the plant may be accepted provided no roots have been cut. Pine and spruce trees shall be full to the base and have a ratio of approximately 5 height to 3 spread. All trees for which the number of branches are shown shall have not less than the number specified. A branch shall have a minimum length of 24 inches. For trees and shrubs having a spread or base width specified, the spread or base width shall be measured not more than 10 inches from the ground line from tip to tip of branches in their natural position. The height of all plants shall be measured from the ground line to the tip of the uppermost branch.

808.2.1.3 Inspection of nursery stock may be made at the nursery by the Engineer. Approval of material on such inspection shall not be construed as an acceptance. Inspection and acceptance of plant materials will be made only at the planting site following the completion of the planting work with the exception that acceptance for height, spread, and number of branches will be made before pruning the plant. Each shipment shall be accompanied by an invoice showing sizes and varieties of materials included.

808.2.1.4 Invoices showing size and grade of materials shipped, plus all necessary state, federal, and other inspection certificates, showing the source of origin and the health of the plant materials shall be presented to the County Engineer prior to final acceptance.

808.2.1.5 All stock shall be dug and packed with special care to avoid unnecessary injury to or removal of roots. Each variety shall be packed in separate bundles, clearly and accurately labeled. Roots shall be carefully protected with wet straw, moss, or other material so that the plants arrive with roots in a moist and healthy condition. All stock shall have been grown within a 150-mile radius of St. Louis, Missouri.

808.2.1.6 Plants indicated by ball diameter shall be balled and burlapped and shall be lifted from the ground so as to retain as many roots as possible. Such plants shall be so dug and transported as to provide and retain a firm ball
of the original soil. The ball shall be wrapped with burlap and securely tied to keep the ball firm and intact. Balls shall be adequately protected from rain or sudden changes in weather. Trees or other plants will not be accepted if the balls of earth are loosened or broken.

808.2.1.7 Plants specified as container grown shall have grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the containers; however it shall not have grown in container long enough to have become pot bound. The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping. The containers of all container grown plants, except Crown Vetch, shall be removed just prior to planting.

808.2.2 Mulching Material. The mulching material shall be wood chips substantially free of foreign material.

808.2.3 Tree Wrapping Paper and Binder Twine. Wrapping paper for trees shall be a waterproofed tree wrapping paper of good commercial quality furnished in 4 inch width. Twine for tying paper shall be any approved commercially available binder twine.

808.2.4 Supporting Stakes for Trees. Supporting stakes for trees shall be an approved 2 inches x 2 inches x 6 feet posts of sound wood and free from knots that would affect the serviceability of the posts.

808.2.5 Peat Moss. Peat moss shall be a natural domestic product consisting of partially decomposed stems and leaves of any variety of sphagnum mosses and shall be substantially free of woody substances and mineral matter such as sulphur and iron. Peat moss shall be granulated and used in an air-dry, loose condition.

808.3 Construction Requirements.

808.3.1 Planting Dates. Planting shall be performed during either the fall phase or the spring phase or both, as designated in the contract. The beginning dates established in the contract for the respective phases shall be considered to be the effective date of the Notice to Proceed.

808.3.2 On roadways open to traffic, the Contractor shall avoid crossing the pavement with men, equipment, or materials.

808.3.3 Care of Plants Before and During Planting. Immediately following delivery and inspection at the job site, all bare root plants shall be “heeled in” in a manner satisfactory to the Engineer. All “heeled in”, balled and burlapped, and container grown plants shall be protected and their roots kept moist until planted. While bare root plants are being transported to and from “heeling in” grounds, distributed in planting beds, or awaiting planting after distribution, their roots shall be protected from drying out by means of wet canvas, burlap, or straw, except as specified in Sec 808.3.6.6. The trunks and branches of all trees shall be carefully protected from injury of any kind during all operations. Any injured tree may be rejected.

808.3.4 Location and Spacing of Plants. The general location of each individual tree or shrub and the areas for ground cover plants will be shown on the plans. To facilitate the staking operations, the Contractor shall notify the Engineer in writing at least 2 weeks in advance of the date on which they intend to begin planting. Stakes for indicating plant locations shall be furnished by the Contractor in accordance with the requirements of Sec 105.8.

808.3.5 Pruning Roots. A maximum of root growth shall be preserved and no root pruning will be permitted except as noted herein. Any large or fleshy roots that have been broken, crushed, or badly bruised shall be cleanly cut back to sound wood. Interfering roots shall be pruned if directed by the Engineer.

808.3.6 Planting.
808.3.6.1 The planting of all plants shall be subject to the inspection of the Engineer. Any rock, rubble, or other underground obstructions shall be removed to the required depth. If underground obstructions, not feasible to move are encountered in the planting areas, then other locations may be selected by the Engineer. The Contractor shall notify the County Engineer at least 24 hours before proceeding with planting operations.

808.3.6.2 Preparation of Holes. Holes for trees shall be not less than 18 inches larger in diameter than the ball diameter, container, or root spread. Holes for shrubs shall not be less than 12 inches larger than the ball diameter, container, or root spread. Holes for vines and seedlings shall be not less than 9 inches in diameter. The holes shall be of such depth to set the plants at the same height at which they grew in the nursery. If the holes are dug too deep, it shall be necessary to add enough backfill material to the bottom of the hole to allow for settling. Depth of holes for vines and seedlings shall be sufficient to allow for proper spreading of roots.

808.3.6.3 Backfill Material. In general, backfill material for planting shall consist of the existing excavated soil broken into less than one inch clods and thoroughly mixed with peat moss as required. Plants with a ball diameter, container, or root spread of 15 inches or less require one bushel of peat moss. Plants with a ball diameter, container, or root spread of over 15 inches require 2 bushels of peat moss. Peat moss will not be required for vines or seedlings.

808.3.6.4 Bare Root Trees and Shrubs. Plants with bare roots shall be held firmly in the proper position with the roots spread out during backfilling. Backfill material shall be worked and puddled around the roots and thoroughly firmed during backfilling. Sufficient water shall be used to insure thorough saturation of the backfill material around the plant roots.

808.3.6.5 Balled and Burlapped and Container Grown Stock. Plants which are balled and burlapped or container grown shall be set to proper position and grade. The backfill material shall be carefully worked and puddled around the ball. Sufficient water shall be used to insure thorough saturation of the backfill material around the plant roots.

808.3.6.6 Vines and Seedlings. Vines and seedlings shall be planted on 3 foot centers and 3 foot staggered rows within designated areas. When a bundle of plants is opened, all plants in that bundle shall immediately be placed in a container of water and each plant planted from the container. Plants placed in the holes shall be backfilled immediately. Backfill material shall be thoroughly firmed, and all plants shall be watered the same day of planting.

808.3.6.7 Preparation of Plant Beds. Prior to planting in areas designated on the plans as plant beds, the existing sod shall be removed by stripping with a sod cutter set for a 1 inch depth of cut. The sod so removed shall be disposed of by the Contractor outside the limits of the right-of-way or as directed by the Engineer.

808.3.6.8 Mulching. Individual plants except for vines and seedlings shall be mulched with a 4 inches layer of wood chips over the backfill or as shown on the plans. All areas shown on the plans as plant beds shall be mulched with a 4 inches thick layer of wood chips in a continuous bed over the entire area. Mulch will not be required for vines or seedlings.

808.3.6.9 Fertilizing. A 10-8-6 inorganic commercial fertilizer shall be applied to all plant materials at the time of planting. The fertilizer shall be delivered to the site in unopened containers bearing the manufacturer’s statement of analysis. Apply fertilizer at the rate of 1/4 lb./inch to 1/2 lb./inch of caliper for trees, and 2 lb./100 sq. ft. of planting bed.

808.3.7 Pruning Branches or Stems.

808.3.7.1 Deciduous trees shall be pruned to balance the loss of roots. Pruning shall retain the natural form of the plant type. Only thinning cuts will be permitted on trees. A single trunk shall be preserved on all shade trees. All dead, broken, and interfering branches shall be removed. When branches are removed, they shall be cut off flush with the parent branch. All cut surfaces over 1 inch in diameter shall be painted with tree paint or tar.
808.3.7.2 Deciduous shrubs shall be pruned by removing all dead wood and broken branches and by removing or heading approximately 1/3 to 1/2 of the branches.

808.3.7.3 Evergreens shall be pruned only to the extent of removing dead or damaged portions of the branches, except as permitted by the Engineer.

808.3.7.4 Vines shall be pruned to the extent necessary to retain approximately 6 inches of runner above the ground surface.

808.3.8 Wrapping Trees. The trunks of all deciduous trees, and the lower part of the largest branches of trees more than 5 inches caliper, shall be carefully wrapped with tree wrapping paper immediately after planting. The wrapping shall begin at the ground line and extend upward in a spiral to the lowest major branch. The spiral paper shall overlap not less than 1 inch. Multiple stemmed trees shall have each stem separately wrapped to the lowest major branch. Suckers and small twigs shall be removed to permit proper wrapping. The wrapping paper shall be held in place with binder twine.

808.3.9 Supporting Methods for Trees. Trees 2 inches or more in caliper, or as determined by the Engineer shall be properly supported using 3 guy wires securely anchored to approved stakes not less than 5 feet from the trunk and at a height as indicated on the plans. The trunk shall be adequately protected from the guy wires. The guy wires are to be No. 12 gage wire. The supports shall be installed within 2 days of planting.

808.3.10 Finishing. Waste material, including sod, subsoil, rock, branches, twigs, packing material, and other debris shall be disposed of by the Contractor outside the limits of the right-of-way or as directed by the Engineer. All roadway shoulders and other areas damaged by the Contractor’s operations shall be restored to a satisfactory condition as directed by the Engineer. Finishing in accordance with this section shall be performed following the completion of each planting phase when fall and spring planting phases are required.

808.4 Care and Replacement.

808.4.1 Starting with the first day of planting for each phase and continuing through a period of 45 days following the last day of planting within the respective phase, the Contractor shall keep all plants watered sufficiently to maintain moist soil in the root zone. The Engineer may direct watering as necessary to maintain moist soil and may halt further planting within the respective phases until sufficient water is applied to those plants in place. In addition to watering, the Contractor shall perform such weeding, adjusting tree supporting posts, pruning, chemical spraying for insect and disease control, and keep all bedded areas substantially clear of weeds and grass to insure healthy plants. The Contractor, at no cost to the county, will be permitted to apply commercial wilt-proofing compound or liquid fertilizer on plants during the planting or the watering period of the contract.

808.4.1.1 In addition to the 10 percent retained percentage specified in Sec 808.6, there will be withheld an amount equal to 15 percent of the price bid for plants until satisfactory completion of the watering requirements specified for each phase of planting, at which time the 15 percent will be released.

808.4.2 The Contractor shall be responsible for the proper care of all plants until final inspection and acceptance of the plants has been made by the Engineer.

808.4.2.1 Any plant, which in the judgment of the Engineer, is not in a healthy growing condition at the time of final plant inspection shall be replaced by the Contractor in accordance with the original specifications except that additional peat moss will not be required for the backfill material, and except that the specified 45-day watering period will not be required. No maintenance will be required for those plants replaced under this replacement specification.
808.4.3 Final Plant Inspection. For those contracts requiring fall phase planting only, the final inspection of plants will be made as soon as practicable after May 15. For those contracts requiring spring phase planting only, or requiring both fall and spring phase planting, the final plant inspection will be made as soon as practicable following either the specified spring watering period or May 15 whichever comes last. Plants not accepted at the time of final plant inspection will be marked and shall be replaced in the fall in accordance with the dates established in the contract. The Contractor will be relieved of all further responsibility for plants that are accepted at the time of final plant inspection.

808.5 Liquidated Damages Liquidated damages will not be charged during required watering periods.

808.6 Method of Payment Trees will be planted and, upon satisfactory completion of the watering period, the Contractor shall be paid 90 percent of the bid price within 30 days of receipt of invoice for the planting. The Contractor will receive the final 10 percent payment following the first successful leafing out of the trees, within 60 days of the first following growing season when leafing out occurs. The replacement of unsuccessful planting material shall be the responsibility of the Contractor at no cost to the County. Replacement shall be made at the direction of the Engineer or an authorized representative.

808.7 Basis of Payment. The accepted quantities of plants will be paid for at the contract unit bid price for each plant of the types, species, and sizes required, complete in place. No direct payment will be made for any incidental items such as supporting posts, mulch, edging, and water necessary for this work.
Division 900

TRAFFIC CONTROL FACILITIES
SECTION 901
HIGHWAY LIGHTING

901.1 Description. This work shall consist of furnishing and installing lighting equipment and material as shown on the plans. All work shall meet NEC, NESC and NEMA standards. Existing lighting shall be maintained in effective operation by the Contractor except for shutdowns with approval from the Engineer for alterations or final removal.

901.2 Temporary Lighting.

901.2.1 Temporary lighting shall consist of furnishing, installing and maintaining wood poles, luminaires, bracket arms, power cable, connection to a power source, mounting hardware and all other material necessary to provide the temporary installation. Any County furnished items shall be installed by the Contractor. Temporary lighting specified as part of a temporary signal installation shall be installed on the signal poles unless otherwise shown on the plans.

901.2.2 Luminaires shall be LED with a Type III medium distribution, semi-cutoff light distribution. Luminaires shall be mounted 30 feet above the pavement unless otherwise shown on the plans. Bracket arms shall be oriented at right angles to traffic flow, unless otherwise shown on the plans, and be between 10 feet and 15 feet in length. Photoelectric controls shall be provided and may be installed in the luminaires or in a separate control box at the option of the Contractor, unless otherwise shown on the plans. Any existing lighting shall not be taken out of operation until the temporary lighting is ready for operation and with approval from the Engineer. All temporary lighting equipment shall be removed by the Contractor after the new installation is in operation or as directed by the Engineer. Contractor furnished equipment that will remain the property of the Contractor may be new or used stock. Contractor furnished equipment that will become the property of the County shall be of new stock and shall meet all applicable specifications. County owned equipment will remain the property of the County and shall be disposed of as shown on the plans or as directed by the Engineer.

901.2.3 The Contractor shall pay all electrical costs incurred by operation of the temporary lighting until the lighting is removed or until the lighting is accepted for maintenance. For temporary lighting installations where there is not an existing power supply, the Contractor shall make any necessary arrangements for providing power to the temporary lighting. Portable generators may be used to provide power to temporary lighting, but any failure of the lighting system due to generator failure will be considered a malfunction as specified in Sec 901.14.2. No direct payment will be made for power costs. All wire and cable for temporary lighting shall be suspended overhead with proper clearance or buried as shown on the plans.

901.2.4 Temporary lighting shall be installed to meet the construction schedule. The Contractor shall maintain the lighting in proper operating condition in accordance with Sec 901.14.2. Any damage to the lighting installation shall be repaired by the Contractor at the Contractor’s expense.

901.3 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

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<td>Reinforcing Steel for Concrete</td>
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<td>Wood Poles for Power Supplies and Temporary Installation</td>
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### Lighting Equipment

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<td><strong>High-Strength Anchor Bolts</strong></td>
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<td><strong>Structural Low Alloy Steel for Base Plates</strong></td>
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<td><strong>Stainless Steel Bolts, Screws and Washers</strong></td>
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<td><strong>Steel H-Pile Foundation</strong></td>
<td>ASTM A 709, Grade 36</td>
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<tr>
<td><strong>Screw Anchor Foundation</strong></td>
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<tr>
<td><strong>Shaft</strong></td>
<td>ASTM A 575, Grade M 1010 or AASHTO M 270, Grade 36 (ASTM A 709, Grade 36)</td>
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<td><strong>Helix</strong></td>
<td>ASTM A 575, Grade M 1023 or AASHTO M 270, Grade 36 (ASTM A 709, Grade 36)</td>
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<td><strong>Helix Core</strong></td>
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<tr>
<td><strong>Connector Plates and Steel Closure Plates for Circular Pipes</strong></td>
<td>AASHTO M 270, Grade 36 (ASTM A 709, Grade 36)</td>
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<tr>
<td>and Connector Plates for H-Pile and Screw Anchor Foundations</td>
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#### 901.3.1 **Bolts, nuts and washers**

Bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with AASHTO M 232 (ASTM A 153), Class C, or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. For anchor bolts and nuts and for high strength bolts and nuts, except those in accordance with ASTM A325, the Contractor shall furnish to the Engineer a test report certified to be the last completed set of mechanical tests for each size in each shipment. For high strength bolts and nuts in accordance with ASTM A325, the Contractor shall furnish to the Engineer a copy of the manufacturer's inspection test report for each production lot or shipping lot furnished and shall certify the bolts furnished are in accordance with the specifications. Bolts and nuts in accordance with ASTM A 307 shall be accompanied by a manufacturer's statement that the bolts and nuts were manufactured in accordance with ASTM A 307.

#### 901.3.2 **Concrete**

Concrete shall be of the class specified in the contract. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Sec 501 for the specific class specified. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 703.

#### 901.3.3 **Equipment and material**

Equipment and material shall be of new stock unless the contract provides for relocation of existing units or use of units furnished by others. New equipment and material shall be in accordance with ICEA, NEMA, NESC, NFPA and the regulations of the National Board of Fire Underwriters, as applicable, and shall meet the approval from the Engineer.

#### 901.4 **Equipment List**

Two copies of the list of equipment and material to be installed will be furnished to the successful bidder, along with the contract for execution. The contractor shall complete the list by writing in the name of the equipment manufacturer and catalog number of each item listed. Two copies of the completed list shall be submitted to the engineer and be approved in writing before the items are installed. Approval of the items on the list does not relieve the contractor of responsibility for satisfactory performance of the installation.

#### 901.5 **Lighting Poles**

The Contractor shall furnish the length of pole and bracket rise shown or referenced on the plans. The cable entrance at the bracket arm shall be a field drilled 1 1/4 inch hole. The edges of the hole in steel poles shall be deburred and coated with commercially available inorganic zinc-rich paint. All cable entrance holes shall be fitted with a suitable rubber grommet. A grounding conductor shall provide grounding continuity for all
metallic, noncurrent carrying poles in one circuit. The grounding conductor shall be securely connected to the
grounding electrode on the supply side at the main disconnect switch.

901.6 Not Used.

901.7 Contactors. At the option of the Contractor, mercury load relays may be used in lieu of contactors.

901.8 Power Supply Assembly. The power supply assembly shall comply with Sec 902.4.5 when not specifically
detailed on the plans.

901.9 Rigid Conduit System. Conduit shall be placed as shown on the plans. Rigid conduit shall be installed in
accordance with the applicable requirements of Sec 902.

901.10 Trenching and Backfilling.

901.10.1 The depth of trenching and backfilling for conduit and cable-conduit shall be no less than shown on the
plans. If depths are not indicated on the plans, cable-conduit shall be placed in a Type 1 Trench when not class C
excavation. Conduit or cable-conduit shall not be placed in a trench prior to inspection of the trench by the Engineer.
All disturbed areas shall be restored to the satisfaction of the Engineer.

901.10.2 Type I, 24 inch trenching for cable-conduit will be specified if the excavated material would be classified
as Class A Excavation, as defined in Sec 203 and no material is in evidence that might cause mechanical damage to
cable-conduit. The cable-conduit shall be laid on the bottom of the trench and the trench backfilled. In lieu of Type
I, 24 inch trenching, the cable-conduit may be installed by plowing. The cable-conduit shall be placed at a minimum
depth of 18 inches and the soil over the installation shall be recompacted to the approximate original in-place
density.

901.10.3 Type II, 24 inch trenching for cable-conduit will be specified if the excavated material would be classified
as Class A Excavation, as defined in Sec 203 and material is in evidence that might cause mechanical damage to
cable-conduit. Type II trenching will also include trenching in rock embankment. The cable-conduit shall be
embedded in sand as shown on the plans and the trench backfilled.

901.10.4 Type III, 21 inch trenching for cable-conduit will be specified if material that would be classified as other
than Class A Excavation, as defined in Sec 203, is encountered. The cable-conduit shall be embedded in sand as
shown on the plans and the trench backfilled.

901.10.5 Trenches shall be excavated to the width and depth necessary for conduit installation as shown on the
plans. All trenches shall be backfilled as soon as practical after the installation of conduit or cable-conduit. Cinders,
broken concrete and other hard or objectionable material that might cause mechanical damage to conduit or cable-
conduit shall not be used for backfilling to an elevation 12 inches above the top of conduit or cable-conduit. The
bottom of the trench shall be free of such material before the conduit is placed. Backfill material shall be deposited
in layers not exceeding 6 inches deep and each layer shall be compacted to the approximate density of the adjacent
material by an approved method before the next layer is placed. Red burial tape imprinted with "CAUTION - BURIED
CABLE BELOW" shall be installed in all trenches and plowing operations at approximately 1/3 to 1/2 of the depth of
the trench. If the trench is to be located under a shoulder that is to be stabilized, the trenching, installation of
conduit or cable-conduit and backfilling the trench shall be completed before the shoulder stabilization construction
is started. Unless the lighting poles are in place, a coil of cable or cable-conduit of sufficient length to reach the
proposed handhole shall be buried near each pole location. The coil shall be covered such that damage will not
occur.

901.11 Pull and Junction Boxes. Pull and junction boxes shall be installed at locations shown on the plans in
accordance with Sec 902 and Sec 1062.
901.12 Pole Foundations and Installation.

901.12.1 Concrete foundations for ground mounted poles shall be Class B concrete and shall have dimensions no less than shown on the plans. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 703. Forms will not be required for concrete placed below the finished ground line. All conduit and anchor bolts shall be rigidly installed before the concrete is placed. All portions of the anchor bolts extending above the foundation shall be threaded. Anchor bolts shall align with bolt holes on the transformer base or base plate. Installation of poles on integral concrete median and foundations shall be as shown on the plans. The concrete foundation shall be flush with the finished grade or surface and shall not extend above the finished grade on slopes.

901.12.2 Steel circular and H-pile foundations for ground mounted poles shall be installed in a hole of the approximate dimensions shown on the plans and secured by tamped, wet limestone screenings. Steel pile foundations with poles attached may be installed as a unit. The steel connector plate shall be at the proper elevation and properly oriented to receive the transformer base. The connector plate shall be flush with the finished grade or surface and shall not extend above the finished grade on slopes.

901.12.3 The torque for screw anchor foundations shall not exceed the maximum torque rating shown on the fabricator's shop drawings. The steel connector plate shall be at the proper elevation and properly oriented to receive the transformer base. The connector plate shall be flush with the finished grade or surface and shall not extend above the finished grade on slopes.

901.12.4 Leveling and raking of poles on structures may be accomplished by the use of shims, not to exceed a total of 1/2 inch on bolts.

901.12.5 If poles are to be placed on existing foundations or structures with anchor bolts in place, the Contractor shall furnish poles with a base plate to fit the anchor bolt spacing.

901.13 Luminaires. Luminaires for roadway lighting shall be adjusted to give proper illumination on the roadway. Luminaires for underpass lighting shall be interconnected with one inch minimum rigid conduit in accordance with Sec 1060 unless other provisions are incorporated into the structure. The Contractor shall place the standard identification marker, which is included with the lamp, in accordance with the latest version of ANSI C136.15.

901.14 Circuits. Circuits shall be properly labeled in all handholes, pull boxes and junction boxes by means of round aluminum identification tags with a minimum thickness of 0.1 mil attached to the cables with copper wire. Prior to energizing any circuit, the insulation resistance to ground of each completed lighting circuit shall be tested and shall be no less than 10 megaohms. Any circuit less than 10 megaohms to ground will be rejected. The Contractor shall provide a suitable 500-volt direct current, zero to 100-megohm range resistance measuring device for making the resistance test. The circuit test shall be performed by the Contractor in the presence of and documented by the Engineer.

901.14.1 After the circuits have been tested and found acceptable, the Contractor shall, upon approval from the Engineer, energize the lighting circuits for a 15 consecutive day test period. All circuits being energized from a control station shall be tested as a system. The entire system shall be tested as a unit. Any malfunction on any circuit shall be corrected and the system tested for an additional 15 consecutive day period. This procedure shall be repeated until the lighting system has operated to the Engineer's satisfaction for 15 consecutive days.

901.14.2 When the test period is initiated and until completed, or following the turn-on of temporary lighting, the Contractor shall furnish at least one service technician to remain in the area and be available for day, night and weekend trouble calls. The Contractor shall furnish the name, address and telephone number where each designated technician can be reached at all times. If the lighting system malfunctions and a designated technician cannot be reached or cannot arrive at the location in a reasonable time in the judgment of the Engineer, the
Engineer may exercise the option to direct County personnel or a third party to correct the malfunction. If this option is invoked, the entire cost of the work performed by County personnel or the third party will be computed in accordance with Sec 108.9 and deducted from monies due the Contractor. Whether or not the Engineer elects to correct the malfunction, nothing in this specification shall be construed or interpreted to relieve the Contractor of any liability for personal injury or property damage resulting either directly or indirectly from a malfunction during the test period. The Contractor and surety shall indemnify and save harmless the County, its agents, employees and assigns for any legal liability for such a malfunction.

901.15 Installation of Cable and Cable-Conduit.

901.15.1 Cable-conduit shall be installed in a trench of the type specified. Cable-conduit runs shall be continuous without splice between the control panel, handholes, pull boxes, poles and junction boxes. All conduit ends shall be sealed around the cables with a readily workable, soft, sealing compound. The compound shall be workable at 30°F and shall not melt or run at temperatures up to 175°F. Cable-conduit shall be allowed to "snake" in the trench, but there shall be no sharp bends and if two or more cable-conduits are placed in a common trench, the cable-conduit shall not cross each other. For concrete foundations, rigid conduit of sufficient size to facilitate the pulling of cable-conduit shall be cast in the foundation as shown on the plans. The cable-conduit shall be installed through the rigid conduit. Cable-conduit shall extend a minimum of 18 inches above the top of the foundation. The conduit of the cable-conduit shall then be cut off circumferentially approximately 6 inches above the base plate in the transformer base or pole, leaving the cables exposed for connection. Where placed under paved roadways, other paved areas and any type of shoulder, the cable-conduit shall be installed in rigid conduit. Standard commercial duct fittings shall be used to connect conduit of cable-conduit to rigid conduit as shown on the plans and the cables shall continue without splice through the conduit to the nearest pole base. The ground wire shall be attached to a ground lug.

901.15.2 Splices shall be made only in pull boxes, junction boxes and pole bases. More than four cables shall not be spliced in above ground tee splices in pole bases and junction boxes immediately adjacent to wall mounted brackets or underpass luminaires. More than three pairs of power cables shall not be spliced at any other location. Straight or line splices shall only be made in pole bases and junction boxes immediately adjacent to underpass luminaires or wall-mounted brackets unless otherwise approved by the Engineer. For underpass lighting or wall-mounted brackets, the cables shall continue unspliced to the nearest junction box or luminaire housing if junction boxes are not shown on the plans. Tee splices shall only be made at the locations shown on the plans.

901.15.2.1 Cables shall be continuous and unspliced to the first light pole. Line splicing in all types of poles, above ground junction boxes and luminaire housings shall be accomplished with a pre-molded fused connector assembly. Line splicing in all breakaway pole bases shall be accomplished with a pre-molded fused slip connector assembly as shown on the plans. After a conductor splice is made, the conductor splices shall be insulated with a protective rubber boot designed for the pre-molded connector. All above ground tee splices shall be accomplished with a splice block with a molded plastic insulating cover. Any required taping shall be accomplished with splice tape. All sharp points and edges of the connector shall be padded and all voids filled with extra wraps of plastic tape. Tape shall not be stretched excessively or in such a manner as to cause creeping.

901.15.2.2 Underground cable splices, if specified, shall be made in a pull box. Straight or line splices shall be made with copper-clad pressed sleeves or an approved equivalent. Tee splices shall be made with a pressed sleeve, split or unsplit type, or an approved equivalent. All splices shall be protected with a resin splice kit in accordance with the manufacturer's recommendations.

901.15.3 Cable shall be pulled with a minimum of dragging on the ground or pavement. Frame mounted pulleys or other suitable devices shall be used for pulling cables out of conduits into pull boxes. Lubricants may be used to facilitate pulling cable. Slack in each cable shall be provided by coiling 6 feet of cable in each pull box and 3 feet of cable in each junction box. Where cable-conduit enters a pull box, conduit shall be cut away from cables in accordance with MoDOT Standard Drawing 902.02.
901.16 Maintenance Information. Before acceptance of the work, the Contractor shall furnish the Engineer four copies of the manufacturers' written instructions for maintenance and operation of all lighting equipment and wiring diagrams of the installation or system. At a minimum, the manufacturer's instructions shall include documented, organized instructions, wiring and component layout diagrams, and parts lists with part numbers.

901.17 Final Clean Up. Final cleanup of right of way shall be in accordance with Sec 104.

901.18 Method of Measurement.

901.18.1 Measurement of trenching, including backfilling, except for rigid conduit, will be made to the nearest linear foot along the centerline of the trench. No measurement of trenching will be made for rigid conduit.

901.18.2 Measurement of rigid conduit will be made to the nearest linear foot as shown on the plans. Contract quantities will be used in final payment except as hereinafter provided.

901.18.3 Measurement of power cable, pole and bracket cable, multi-conductor cable, wire and cable-conduit will be made to the nearest 10 linear feet as shown on the plans. Contract quantities will be used in final payment except as hereinafter provided.

901.18.4 Measurement of luminaires and bracket arms, including all required material and hardware, will be made per each as separate item.

901.18.5 Measurement of Type AT poles, including the transformer base and all specified hardware, will be made per each. Foundations for Type AT poles, including all specified material, will be made per each.

901.18.6 Measurement of Type B poles, including all specified hardware, will be made per each. Bridge safety barrier curb blisters will not be measured for payment with the Type B pole.

901.18.7 Measurement of Type MB poles, complete in place, will be made per each as a single item, including the footing and the integral portion of median barrier. No direct payment will be made for the footing or integral portion of median barrier for Type MB poles.

901.18.8 Measurement of control stations, including all specified equipment, will be made per each.

901.18.9 Measurement of power supply assemblies, including all specified equipment and cable, will be made per each. The conduit attached to the power supply pole or pedestal and any necessary attachment hardware shall be included with the power supply and no direct payment will be made.

901.18.10 Measurement of pull boxes, including all specified material, will be made per each.

901.18.11 For those items on which final payment is based on contract quantities, final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

901.18.12 Measurement of temporary lighting installations will be made per lump sum.

901.18.13 Measurement of substituted items in accordance with Sec 901.15 will be made based on metric dimensions, quantities and contract unit price.

901.19 Basis of Payment.
901.9.1 Accepted highway lighting will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

901.9.2 If material classified as Class C Excavation, as defined in Sec 203, is encountered during trenching operations for conduit and/or Cable, payment for such trenching will be made at a unit price of three times the contract unit price for item being trenched.
SECTION 902
TRAFFIC SIGNALS

902.1 Description. This work shall consist of furnishing and installing traffic signal materials and equipment as shown on the design plans and as specified in the contract.

902.2 General Requirements for Materials and Equipment.

(a) Materials and equipment shall be new stock unless the contract provides for relocation of existing equipment or use of equipment furnished by others. New materials and equipment shall be the product of reputable manufacturers; shall conform to current requirements of IPCEA, NEMA, RETMA, NEC, IMSA, NESC, ITE, AASHTO, ASTM and regulations of the National Board of Fire Underwriters, as applicable; shall be in accordance with the County's current specifications; and shall meet the approval of the Engineer. Special approval of manufacturers' controller equipment, including panel wiring, is required and may be obtained by fulfilling the requirements as specified in Sec 902.4.6.1 and Sec 902.4.6.

(b) Each Bidder shall indicate on its proposal the major manufacturers of the traffic signal materials and equipment to be installed and the time required for their delivery.

(c) If all signal materials and equipment for which a bid is submitted are not in exact accordance with these specifications, the Bidder shall attach to its proposal a detailed list wherein all deviations from these specifications shall be expressly listed and detailed.

(d) Upon request by the Engineer, the Contractor shall produce manufacturers' letters of certification or certified test reports to show that traffic signal materials and equipment follow the specifications.

(e) Four sets of catalog cuts identifying the project name and the manufacturers' model numbers of traffic signal equipment shall be submitted by the Contractor to the Engineer for approval before signal construction commences. Approval of these catalog cuts does not relieve the Contractor of responsibility for satisfactory performance of this equipment. Catalog cuts shall be submitted at least 2 weeks in advance of the Contractor's need for approval. This time requirement for approval does not relieve the Contractor of its responsibility for delivery of signal materials and equipment and completion of construction within the time specified on the bid forms.

(f) If mast arms are specified in the contract, 4 sets of shop drawings shall be submitted by the Contractor to the Engineer for approval prior to fabrication, as specified in Sec 902.4.3 (m).

902.3 Materials. All materials shall conform to Division 1000, Materials Details, unless otherwise indicated herein or on the contract documents.

902.3.1 Conduit. The size of conduit to be installed shall be as specified in the contract or noted on the plans. Electrical conduits shall meet or exceed Sec 1060 requirements. The type of conduit to all power sources shall be zinc coated rigid steel. The type of conduit to all other structures and facilities shall be either polyvinyl chloride (PVC) or high-density polyethylene (HDPE), as chosen by the Contractor, unless otherwise specified in the contract or noted on the plans.

902.3.1.1 Polyvinyl Chloride Conduit. Polyvinyl chloride (PVC) conduit and fittings shall be Schedule 40, heavy-wall type, and conform to the requirements of the current Underwriters Laboratories Standard for Rigid Nonmetallic Conduit, UL 651, as specified in Sec 1060.
902.3.1.2 High-density Polyethylene (HDPE) Conduit. High-density polyethylene (HDPE) conduit should be a smooth walled duct and conform to ASTM D 3035 SDR11. Conventional PVC couplings shall not be attached to HDPE duct. All couplings used with HDPE duct shall be approved by the Engineer.

902.3.2 Conductor Cable and Wire. All electrical conductors must meet the requirements of Sec 1061, unless otherwise stated herein or approved by the Engineer.

902.3.2.1 Power Cable. All power cable shall be 600 volt, single conductor cable, with type THHN-THWN polyvinyl chloride insulation. The single conductor shall be soft drawn, Class B, 19 strand, copper wire conforming to the current requirements of IPCEA S-61-402, Part 2. All power cable shall be plainly marked on the outside of the insulation with the manufacturer's name and identification of the type of cable.

(a) Polyvinyl chloride insulation shall be Type THHN-THWN and shall conform to the current requirements of IPCEA S-61-402, Paragraph 3.8, or Underwriters Laboratories Standard UL 83. The insulation shall be applied directly to and shall tightly fit the surface of the conductor.

(b) The polyvinyl chloride insulation shall be color coded so that the AC (+) cable is black and the neutral cable is white.

(c) The average thickness of insulation shall be as specified in Table I, with a minimum thickness of 90 percent thereof for insulation. Conductor sizes and thickness of insulation may be increased if approved by the Engineer.

<table>
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<tr>
<th>Conductor Size (AWG No.)</th>
<th>Insulation Thickness (Inch)</th>
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902.3.2.2 Multi-Conductor Signal Cable. All signal cable shall be 600 volt, multi-conductor cable, meeting the requirements of the current IMSA Specification 19-1 or 20-1. The conductors shall be No. 12 or 14 AWG, copper wire, with color coded polyethylene insulation. The signal cable shall have a black polyvinyl chloride outer jacket and shall be plainly identified. 7-wire multi-conductor cable for traffic signals shall be No. 14 AWG.

902.3.2.3 Ground Wire. A ground wire shall be used to ground each signal post, mast arm assembly, power supply and controller cabinet to a ground rod inside the nearest pull box and shall be No. 6 AWG or larger, 7 strand, soft drawn bare copper wire. Each pull box is required to have a ground rod installed at no additional cost and it shall be fusion welded to all ground wires needing to be grounded.

902.3.2.4 Vehicle Induction Loop Detector Cable. Vehicle induction loop detector cable shall be installed in sawed slots as shown on the plans. The cable shall be 600 volt, single conductor, meeting the requirements of the current IMSA Specification 51-7. The conductor shall be No. 14 AWG, stranded copper wire, with Type XHHW insulation.

902.3.2.5 Push Button and Vehicle Induction Loop Detector Lead-In Cable. This type of cable shall be 600 volt, two conductor shielded cable, and twisted two to three turns per foot, meeting the requirements of the current IMSA Specification 50-2. The conductors shall be No. 14 AWG, stranded tinned copper wire, and have color coded polyethylene insulation. The cable shall also be provided with a mylar-backed aluminum foil shield, a stranded tinned copper un-insulated drain wire over the twisted pair, and a polyethylene outer jacket.
902.3.2.6 Communication Cable for Traffic Signal Interconnect. Interconnect cable shall consist of multi-conductor, twisted pair, fiber optic, or a combination of these cables as indicated on the design plans or other contract documents.

902.3.2.6.1 Multi-Conductor Cable. The multi-conductor interconnect cable shall be 600 volt and meet the requirements of the current IMSA Specification 19-1. The conductors shall be No. 12 or 14 AWG, copper wire, with color coded polyethylene insulation, or as shown on construction prints. The interconnect cable shall have a black polyvinyl chloride outer jacket and shall be plainly identified.

902.3.2.6.2 Twisted Pair Cable. This type of cable shall be 600 volts and have 3 twisted pairs. The conductors in each pair shall be No. 16 AWG, stranded copper wire, with polyvinyl chloride insulation (0.016 inch thick) color and/or number coded with a nylon overcoat. Each twisted pair shall be wrapped with a mylar-backed aluminum foil shield and a No. 16 AWG stranded tinned bare copper drain wire. The 3 twisted pair shall be wrapped with an overall aluminum foil shield and a No. 16 AWG stranded tinned bare copper drain wire. The communication cable shall have a black polyvinyl chloride outer jacket (0.5 inch thick) and be plainly identified. The nominal outside diameter of the cable shall be approximately 0.5 inches.

902.3.2.6.3 Fiber Optic Cable

902.3.2.6.3.1 Description. This work shall consist of installing, splicing and terminating fiber optic cables.

902.3.2.6.3.2 Materials.

902.3.2.6.3.2.1 Cable. Fiber optic cable shall be loose tube, single mode dielectric cable. The cable shall be listed in the latest edition of the Rural Utilities Service (RUS) List of Materials Acceptable for Use on Telecommunications Systems of RUS Borrowers, category OC-D-F, and shall have a short-term tensile rating of at least 600 lbs. The cable sheath shall have length markings in feet and shall indicate that the unit of measure is feet. The cable shall have an operating temperature range of -40°C to 70°C.

902.3.2.6.3.2.1.1 All fibers shall be suitable for transmission using both 1310 nm and 1550 nm wavelengths. Attenuation shall not exceed 0.35 dB/km and 0.25 dB/km for 1310 nm and 1550 nm signals, respectively.

902.3.2.6.3.2.1.2 The cables shall be constructed with 12 fibers per tube, 6 tubes per cable (72 SMFO), or 12 fibers per tube, 4 tubes per cable (48 SMFO), or 12 fibers per tube, two tubes per cable (24 SMFO), or as 12 fibers per tube, one tube per cable (12 SMFO).

902.3.2.6.3.2.2 Splice Trays or Cassettes. Contractor shall be responsible to provide splice trays or cassettes that allow field connection of terminations as shown in the plans. Splice trays shall be aluminum with clear plastic covers, designed for outdoor use. Each tray shall accommodate 24 fusion splices. The trays shall have a black powder coat finish. The trays shall have both perforations for cable ties and crimp able metal tabs for buffer tube strain relief.

Splice cassettes shall support fusion splicing of individual or ribbon fibers, with heat shrinks, pigtail slack and cable slack managed within a single space. The cassette shall have a modular design to allow access to the fibers in each individual cassette without disturbing the other fibers in the housing. Cassettes shall be provided with all adapter configurations and mounting rails as needed for splicing and installation in the cabinet.

No direct payment will be made for splice trays or cassettes and will be subsidiary to cabinet and fiber bid items.

902.3.2.6.3.2.3 Connector. Connectors shall be ST compatible, with ceramic ferrules. They shall be suitable for use in traffic cabinets and shall be designed for single mode fibers.
902.3.2.6.3.2.4 Pigtails. Pigtails shall be factory-made, buffered, and strengthened with aramid yarn to reduce the possibility that accidental mishandling will damage the fiber or connection. Pigtails shall be yellow. They must use the type of connector specified in Sec 902.3.2.3.5 of this provision. Each must contain one fiber. Length shall suffice to provide two feet of slack after installation.

902.3.2.6.3.2.5 Jumper. Jumpers shall meet the requirements for pigtails but shall have a connector on each end. The second connector shall be as specified in Sec 902.3.2.3.5 of this provision except where a different connector is required for compatibility with the equipment to which the jumper connects. Length shall suffice to provide approximately five feet of slack after installation. Jumper cables contain a pair of fibers.

902.3.2.6.3.2.6 Rack-Mounted Interconnect Center. General material and construction requirements shall meet the provisions of GGL SP H – Equipment Cabinets. An interconnect center is an Equipment Cabinet that has a patch panel built into one of its walls. Within the interconnect center, fibers in cables are spliced to pigtails and the pigtails are plugged into the patch panel from the inside. This allows jumper cables (not part of the interconnect center) to plug into the patch panel from the outside, connecting the fibers to equipment in the cabinet or to other fibers on the patch panel. Within an interconnect center, some fibers may be spliced to the corresponding fiber in a mating cable, rather than to a pigtail. Other fibers may be coiled, unterminated.

The enclosure shall have brackets and all other hardware required for rack mounting in an EIA standard 19 inch equipment rack. It shall take up no more than three rack units (1-3/4 inch each) in the cabinet. It shall have front and rear doors. It shall be made of powder-coated aluminum.

The enclosure shall hold at least four splice trays or cassettes meeting the requirements of Sec 902.3.2.3.5 of this provision. Contractor shall provide enough trays for all splices made in the interconnect center. The enclosure’s patch panel shall have at least 48 positions or as indicated on the plans, compatible with the connectors specified in Sec 902.3.2.3.2.2 of this provision. It shall have provisions for cable strain relief and for connector labeling.

902.3.2.6.3.2.7 In-Ground Splice Enclosure. In-Ground splice enclosures shall provide capacity for 144 fiber splices. Enclosure shall be: suitable for outdoor applications with a temperature range of -30 to 60°C, protect splices from moisture and damage, non-reactive and not support galvanic cell action, waterproof, re-enterable, sealed with a gasket, permit selective splicing to allow one or more fiber strands to be cut and spliced without disrupting other fibers, equipped with a basket to accommodate the slack from all fibers routed into the enclosure, capable of holding splice trays from various manufacturers, input/output capacity of four 18 mm cables, equipped with a termination block to terminate the central strength members of the fiber optic cables.

Splice trays shall be: compatible with fiber splices and splice enclosure, equipped with polyethylene tubes to protect exposed individual fibers within the enclosure, stackable within the splice enclosure. Vinyl markers shall be supplied to identify each fiber to be spliced. Each splice shall be individually mounted and mechanically protected on the splice tray. Loose tube buffers shall be secured with a tube guide or channel snap. Slack fiber shall be placed in an oval shape along an inside wall of the tray.

902.3.2.6.3.2.8 Tracer Cable. The entire pathway of the fiber optic cable shall be accompanied by a blue jacketed 12 AWG solid copper trace cable for locating purposes.

902.3.2.6.3.3 Construction Requirements.

902.3.2.6.3.3.1 Cable Installation. Prior to installation, perform such tests as indicated in Sec 902.3.2.3.4 of this provision to confirm that the cable is in good condition and complies with the specifications. Any defects found after installation will be deemed the fault of the Contractor.

902.3.2.6.3.3.1.1 Install the cable such that the optical and mechanical characteristics of the fiber are not degraded. Do not violate the minimum bend radius or the maximum tension, both during and after installation.
902.3.2.6.3.1.2 Before any cable installation is performed, provide the Engineer with four copies of the cable manufacturer’s recommended maximum pulling tensions for each cable size. These pulling tensions shall be specified for pulling from the cable’s outer jacket. Also, provide a list of the minimum allowable cable bending radius and the cable manufacturer’s approved pulling lubricants. Only those lubricants approved by the cable manufacturer will be permitted.

902.3.2.6.3.1.3 If the cable is pulled by mechanical means, use a clutch device to ensure the allowable pulling tension is not exceeded. Also, attach a strain gauge to the pulling line at the cable exit location, and at enough distance from the take-up device, such that the strain gauge can be read throughout the entire cable pulling operation.

902.3.2.6.3.1.4 Do not leave the let-off reel unattended during a pull, in order to minimize the chance of applying excess force, center pull, or back feeding.

902.3.2.6.3.1.5 Use an approved lubricant, in the amount recommended by the cable manufacturer, to facilitate pulling the cable. After the cable has been installed, wipe the exposed cable in a pull box, junction box, or field terminal cabinet clean of cable lubricant with a cloth before leaving the pull box, junction box, or cabinet.

902.3.2.6.3.1.6 In each intermediate pull box, store a minimum of 50 feet of slack fiber optic cable for each cable that passes through the pull box unless otherwise noted in the plans. Store slack cable neatly on the walls of the pull box using racking hardware acceptable to the Engineer. Additional slack cable that is included in the pay quantity includes 50 linear feet of each cable at a splice point within the GGL or Agency fiber pull box.

902.3.2.6.3.1.7 Seal the fiber optic cable ends to prevent the escape of the filling compound and the entry of water.

902.3.2.6.3.1.8 Label every cable immediately upon installation. Label the cables at every point of access, including junction boxes, pull boxes, and termination points. Use self-laminating vinyl labels at least 1.5 inches wide and long enough that the translucent portion of the label completely covers the white area bearing the legend. The vinyl shall have a layer of pressure sensitive acrylic adhesive. The labels shall resist oil, water, and solvents and shall be self-extinguishing. The legend shall be machine printed in letters at least 1/8 inches high. Consult with the Engineer concerning the desired method of identifying each cable. Labeling cables is incidental to the installing the cable and will not be paid separately.

902.3.2.6.3.2 Splicing. Splice all optical fibers, including spares, to provide continuous runs. Splices shall be allowed only in equipment cabinets and splice enclosures except where shown on the plans.

902.3.2.6.3.2.1 Make all splices using a fusion splicer that automatically positions the fibers using either the Light Injection and Detection (LID) system or the High-resolution Direct Core Mounting (HDCM) system. Provide all equipment and consumable supplies.

902.3.2.6.3.2.2 Secure each spliced fiber in a protective groove. Completely re-coat bare fibers with a protective room temperature vulcanizing (RTV) coating, gel or similar substance, prior to insertion in the groove, to protect the fiber from scoring, dirt or microbending.

902.3.2.6.3.2.3 Prior to splicing to a fiber installed by others, measure and record the optical loss over that fiber. See Sec 902.3.2.6.3.4 of this provision.

902.3.2.6.3.2.4 Use a different splice tray for each buffer tube color. If an enclosure contains multiple buffer tubes of the same color, but none of the fibers in one of the tubes are spliced to fibers in other tubes of the same color, use a separate splice tray for that tube.
902.3.2.6.3.3 Termination. Terminate fibers by splicing them to factory-made pigtails. Cap all connectors that are not connected to a mating connector. If the existing termination panel does not have the capacity to conform to the project documents and specifications, it is the Contractor’s responsibility to replace or expand the termination panel at no additional cost to the project. Pigtails are subsidiary to this bid item.

902.3.2.6.3.4 Jumper Management. Use spiral wrap to guide and protect bundles of jumpers between the patch panel and equipment. Affix the spiral wrap to the wall of the field terminal cabinet or vertical member of the rack. Label the jumpers at each end, numbering them sequentially.

902.3.2.6.3.5 Splicing Existing Fiber. When making splices to the existing fiber if allowed, equally distribute the slack fiber on either side of the splice enclosure.

902.3.2.6.3.4 Acceptance Testing.

902.3.2.6.3.4.1 General. Test the fiber after installation, including all splicing and terminations. For each fiber optic link terminated at the field terminal cabinet patch panels, determine whether the optical loss is within the limits permitted by these specifications. A link is a continuous segment of fiber between one connector (or unterminated end) and another connector (or unterminated end).

902.3.2.6.3.4.2 Test Procedure. For each fiber link, follow this procedure:

(a) For each fiber link, the Contractor shall test one fiber strand per each tube of the fiber cable. If any individual fiber in a tube if found to be broken or nonfunctioning, the Contractor shall test at a minimum two additional random fibers from the same tube to confirm that the fiber acceptance issue is not widespread. If additional fibers in tube are found to be deficient, corrective measures, including replacement of the cable through the identified trouble segment, may be required at the Engineer’s discretion, at no additional cost to the project.

(b) Calculate the maximum allowable losses for the Contractor installed fiber link, both at 1310 nm and at 1550 nm. Use the following formula:

Maximum link loss = (Fiber length in km) x (0.35 for 1310 nm and 0.25 for 1550 nm) + (Number of fusion splices) x (0.05) + (Number of mechanical splices [for temp. connection]) x (0.3) + (Number of connections) x (0.5)

Provide this calculation to the Engineer along with the test results.

(c) Provide the Engineer documentation that the optical time domain reflectometer to be used in testing has been calibrated and is working properly.

(d) Use an optical time domain reflectometer to assess the losses along the Contractor furnished and installed fiber paths (connector in camera cabinet though the fusion splice in the handhole) from the camera cabinet end of the fiber only. Record the result at both 1310 nm and 1550 nm. Arrange for the Engineer or an authorized representative to witness these tests.

(e) Use an optical time domain reflectometer and other test equipment to troubleshoot the link. Take whatever corrective action is required, including cable replacement, to achieve a loss less than the calculated maximum.
902.3.2.6.3.4.3 **Test Result Documentation.** Prepare a diagram showing all the links tested in this project. For the portions installed in this project, show the field terminal cabinets, splices, and pigtails. On each line representing a link, show the maximum allowable loss and the actual loss. The actual loss shall be the one measured after all corrective actions have been taken. Submit this diagram to the Engineer, along with the calculations for the maximum allowable loss. Submit the diagrams and calculations in an electronic format acceptable to the Engineer.

902.3.2.6.3.5 **Documentation.** Provide the County with a copy of the final plans in Acrobat Reader .PDF and Visio 2016+ *.VSDX formats along with any relevant notes aiding in the understanding of the fiber configuration.

902.3.2.6.3.6 **Certifications.** The fiber optic cable shall be factory certified to meet the requirements in this specification. In addition, the manufacturer shall certify that the fiber optic cable has a life expectancy of 20 years.

902.3.2.6.3.7 **Guarantee.** All items covered by this specification shall carry a two-year guarantee from the date of acceptance against any defects in workmanship or materials.

902.3.2.6.3.8 **Basis of Payment.** Measurement and payment for items covered by this specification include the documentation and acceptance testing, in addition to all materials and equipment necessary for a fully operational system. Payment will be made as indicated on this project’s contract bid items.

902.3.2.7 **Cable for Vehicle Detection Cameras.** This cable shall meet or exceed the video manufacture’s minimum requirements as approved by the Engineer. The cable shall be UL Listed and CSA Certified for outdoor use, having the manufacturer’s name and identification of the type of cable plainly marked on the outside.

902.3.2.7.1 **Video Power/Communication Cable.** The power/communication cable may be connected to the camera’s Machine Vision Processor (MVP) cable in the mast arm pole handhole above the mast arm base and run to the communications interface panel inside the controller cabinet. The Ethernet over power cable shall meet or exceed the video manufacture’s minimum requirements as approved by the Engineer. It should be 300 volt, stranded copper wire, twisted pairs with aluminum/polyester foil shield, and have stranded tinned drain wire. The cable shall be UL Listed, and CSA certified for outdoor use, and be plainly identified on the outside.

902.3.2.8 **Aerial Signal Cable (Figure 8 Type).** Aerial signal cable shall be 600 volt, multi-conductor cable, meeting the requirements of the current IMSA Specification 19-3. The conductors shall be No. 12 or 14 AWG, copper wire, with color coded polyethylene insulation. The messenger shall be 0.250 inch stranded galvanized steel. The aerial cable conductors and messenger shall be jacketed in parallel with black polyvinyl chloride to form a figure 8. The jacket shall be plainly identified on the outside.

902.3.3 **Pull and Junction Boxes.** Each preformed pull box and cover(s) shall be installed at locations as shown on the plans or as directed by the Engineer. They shall meet the requirements of Sec 1062. Conduit shall enter into the side of the boxes and shall extend a minimum of 2 inches and a maximum of 4 inches as detailed on the plans or other contract documents. If it becomes necessary to increase the excavation depth and extend the box, no direct payment will be made. The excavated opening outside the box shall be wide enough to allow compaction of the backfill material. Cinders, broken concrete, sharp rock or other hard or undesirable material shall not be used for backfilling. The backfill material shall be placed in layers not to exceed 6 inches deep, and each layer shall be thoroughly compacted before the next layer is placed. Where preformed pull boxes are used, the holes for conduit shall be drilled as recommended by the manufacturer. The holes shall be round and no more than 1/2 inch larger than the conduit. Type I or II drains shall be installed as shown on the plans. A pull box placed in a sodded, shoulder, or embankment area shall have a concrete pad around the perimeter as shown on the plans. Concrete for the pad shall be Class B or a commercial mixture in accordance with Sec 501. The top surface of all pull boxes shall be flush with surfaced areas and approximately one inch above earth or sodded areas. If preformed pull boxes are specified, the Contractor may use standard concrete pull boxes in lieu of the Class 1 or 2 preformed pull boxes, or the Type A double concrete pull box in lieu of the Class 3 preformed pull boxes. For installations requiring different voltages for lighting and signal applications, the Type B double concrete pull box may be used in lieu of two preformed pull...
boxes at the Contractor’s expense. If the Type B double concrete pull box is specified, no substitutions will be permitted.

902.3.3.1 Preformed Pull Box and Cover.

(a) Each preformed pull box and cover(s) shall be gray in color and manufactured from reinforced polymer concrete materials. These materials shall consist of sand and gravel aggregates, bound together with a polymer and reinforced with continuous woven glass strands. Preformed pull boxes shall conform to MoDOT’s standard drawing 902.20G or its most recent revision unless otherwise indicated in the standard specifications, contract documents, or on the design plans. Covers shall be labeled “TRAFFIC SIGNAL” for class 2 and class 3 pull boxes, while they shall be labeled “FIBER OPTIC CABLE” for class 5. All preformed pull box installations shall include type 1 drainage.

(b) The preformed pull box shall have a bolt down cover(s) fastened by 4 recessed, stainless steel hex head bolts. These bolts shall be aligned with 4 stainless steel inserts, one set in each corner of the pull box.

(c) Each preformed pull box cover shall have a skid resistant surface with a recessed pull slot for removing the pull box cover.

(d) Each preformed pull box shall have engraved labels on each cover when required to be labeled.

(e) The size of the preformed pull box to be installed shall be as specified in the contract or noted on the plans. The design of each size preformed pull box and cover shall be based upon the minimum load rating of the pull box and cover.

902.3.3.2 Concrete Pull Box Frame Cover and Cable Hooks.

(a) Each concrete pull box frame and cover shall be cast iron conforming to the requirements of ASTM A 48, Class 30, and of the dimensions shown on the standard detail drawings. The weight of the cover shall range from 65 pounds to 85 pounds. The cover shall be scoriaceous, web reinforced, and have the words “TRAFFIC SIGNAL” cast on the cover. A 3/4 inch diameter lift hole shall be provided in the cover. Each frame and cover shall be given two coats of quality commercially available heavy asphalt paint prior to delivery.

(b) Cable hooks shall be galvanized steel and have a minimum diameter of 3/8 inch and a minimum length of six inches. The cable hooks provided shall be either pole steps or carriage bolts.

902.3.4 Detector Loop Sealant. The detector loop sealant shall be a water-proof, polyester system with excellent adhesion to both concrete and asphalt substrate, whether damp or dry. The sealant shall be a self-leveling polyester system that flows easily into the sawed slots and blends into the surface of the pavement. Once applied, it shall cure to a durable, flexible compound protecting the detector loop against road abuse and seasonal thermal changes. The sealant shall cure at low temperatures and not be affected by freeze-thaw cycles, deicing salts, gasoline or oil. Unless otherwise approved by the Engineer, the loop sealant shall be in conformance with the specific values described below:

(a) The loop sealant shall be a polyester compound with excellent adhesion to both concrete and asphalt substrate. The sealant shall be pourable, self leveling and capable of total encapsulation of detector loop wires.

(b) The loop sealant shall have the following characteristics:
<table>
<thead>
<tr>
<th>Property</th>
<th>Specific Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore D Hardness</td>
<td>60</td>
</tr>
<tr>
<td>Tensile Elongation</td>
<td>15-25%</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>350 psi</td>
</tr>
<tr>
<td>Minimum Compressive Yield Strength (Ultimate)</td>
<td>2000-3000 psi.</td>
</tr>
<tr>
<td>Salt Water Absorption (5% Solution)</td>
<td>0.20% Maximum</td>
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<tr>
<td>Oil Absorption</td>
<td>0.02% Maximum</td>
</tr>
<tr>
<td>Gasoline Absorption</td>
<td>0.80% Maximum</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>0.20% Maximum</td>
</tr>
<tr>
<td>Freeze-Thaw Resistance</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

902.3.5 Concrete. Unless otherwise approved by the Engineer, materials, proportioning, mixing, slump, and transportation of Portland cement concrete shall be in accordance with the applicable provisions of Sec 501 for Class B concrete.

902.3.6 Reinforcing Steel. Reinforcing steel for concrete shall be deformed bars in accordance with the applicable provisions of Sec 1036 and meet or exceed manufacturer requirements.

902.3.7 Traffic Control Devices. Temporary and permanent traffic control devices and materials for each signal installation shall meet the minimum requirements of the latest revision of the Manual on Uniform Traffic Control Devices (MUTCD). They shall be installed as per plan unless otherwise directed by the Engineer.

902.4 Equipment.

902.4.1 Signal Head Assemblies. Each signal head shall be composed of one or more signal faces with each signal face composed of one or more signal sections. All signal head assemblies shall meet the following general requirements.

902.4.1.1 General Requirements.

(a) Each signal section shall be a self-contained assembly consisting of a sectioned housing, optical unit, terminal block and all necessary gaskets to insure a weatherproof unit.

(b) If new signal sections are to be combined with existing sections, the new signal sections shall be adaptable to the existing.

(c) Each signal face's horizontal alignment, arrangement, and location shall be as shown on the drawings.

(d) Each signal head shall be assembled in a configuration and mounted in a manner which is in conformance with the standard detail drawings. All doors shall open to a 180 degree position to allow unobstructed access.

902.4.1.2 Signal Head Hardware.

(a) Unless otherwise approved by the Engineer, all pipe and nipples used for assembling and mounting signal faces shall be Schedule 40 extruded aluminum pipe with a 1-1/2 inch nominal pipe size. The pipe and nipples shall be equal to aluminum alloy 6061-T6 and have a natural aluminum finish. Painting of pipe and nipples will not be permitted.

(b) Unless otherwise approved by the Engineer, all terminal compartment housings and fittings, including elbows, tees, crosses, connectors, and hub plates, used for assembling and mounting signal faces, shall be aluminum and have a nominal pipe size of 1-1/2 inches. These fittings and terminal compartment housings...
shall be equal to either permanent mold castings of aluminum alloy 319.0-F, 356.0-T6, or Almag 35, conforming to the requirements of ASTM B 108, or sand castings of aluminum alloy 319.0-F, 356.0-T6, or Almag 35, conforming to the requirements of ASTM B 26. All fittings and terminal compartment housings shall be free from imperfections and have a natural aluminum finish. Painting of these items will not be permitted.

(c) Unless otherwise approved by the Engineer, all pipes, nipples, elbows, tees, crosses, connectors, hub plates and terminal compartments shall have straight threads. One stainless steel square or hex head set screw shall be furnished at each connection point in all elbows, tees, crosses, hub plates, terminal compartments and post top mountings to insure rigid mounting.

(d) Fittings which attach to the signal housing shall have either integral serrations or a serrated locking ring, both of which must be compatible with the 72 serrations on the signal housing. Serrated fittings shall be secured to the signal housing by a threaded collared nipple or by a threaded nipple with a hex nut. Upon request, the signal head manufacturer shall submit a sample of their serrated locking ring to the Engineer for approval.

(e) Terminal compartments shall contain a double row barrier type terminal block with not less than 12 points using No. 8-32 NC screws. The door to each terminal compartment shall be either aluminum or aluminum colored plastic and held in place using two 1/4 inch - 20 NC, stainless steel screws.

(f) New signal heads installed vertically on a mast arm shall be mounted at locations determined in the field using brackets to mount single and cluster units with an in-line terminal compartment.

(g) Each signal head installed horizontally on a mast arm shall be assembled using two hub plates and one terminal compartment. The two hub plates shall be banded onto the mast arm using 5/8 inch by .030 inch stainless steel banding or cables.

902.4.1.3 Signal Face Types. Each signal face shall be of the type designated in the contract or shown on the plans.

902.4.1.3.1 Conventional Vehicle Signal Face.

902.4.1.3.1.1 Basic Construction and Mounting. Each 12 inch section housing shall be fabricated from ultraviolet stabilized color impregnated polycarbonate resin having back, sides, top and bottom integrally cast to form a single unit. It shall be clean, smooth, and free from imperfections. The signal housing and the lens door shall be black. Painting of signal sections will not be permitted.

(a) The top and bottom ends of each signal section shall be of a ribbed construction to produce the strongest possible assembly consistent with light weight.

(b) The top and bottom of each housing shall have an opening to accommodate standard 1-1/2 inch pipe fittings and brackets. Each opening shall have 72 integrally cast radial serrations to insure positive locking of the sections. Two corresponding serrated locking ring fittings shall be furnished with each signal face and shall be subject to the approval of the Engineer as specified in Sec 902.4.1.2(d). The connection between signal housings shall be weatherproof and capable of being directed at any angle in the horizontal plane in 5 degree increments. Housings shall be rigidly fastened together by a three bolt assembly or other connectors approved by the Engineer.

(c) A square housing door shall be suitably hinged and held securely to the body of the housing by corrosion resistant locking devices. Latching of the door shall be achieved without the use of special tools. All door hardware shall be of corrosion resistant material. Gaskets which will exclude dust and moisture shall be used between the lens and the door. Either a gasket or an integral hood recess shall be used between the body of the housing and the lens door.
(d) A minimum of two internal bosses shall be provided in each signal section for the mounting of a terminal block.

(e) Polycarbonate Housings. All material used in construction of polycarbonate signal heads shall be of ultraviolet stabilized color-impregnated polycarbonate resin that is flame retardant. The housing shall have a minimum thickness of 0.09 inch and shall be ribbed or plated to produce added strength. If signal housings are not ribbed, minimum 0.10 inch aluminum plates shall be furnished and installed inside and outside the section housing at all points of attachment of the pipe bracket.

902.4.1.3.1.2 Optical Unit Features. The signal indication module shall consist of a Light Emitting Diode (LED) unit. It shall comply with the most recent revisions of the Institute of Transportation Engineers (ITE) specifications. Installation into existing traffic signal housings built to the (ITE) Vehicle Traffic Signal Head standards shall be without modification to the housing and shall not require special tools. All LED signal modules shall be the “Incandescent Look” type, as approved by the Engineer. All LED signal modules shall meet the following:

(a) If any individual LED fails, no more than 20% of total light will be lost.

(b) The unit shall have an automatic voltage input compensating circuit.

(c) The drive current for each individual LED shall not exceed 27ma DC.

(d) Shall have wave length matched polycarbonate lens.

(e) After a 30 minute warm-up period, all signal indications shall meet or exceed the requirements of ITE intensity.

(f) Power consumption shall be as follows:

- Operating voltage shall be 80 to 135 VAC
  - 12 inch Red Ball: 15 watts or less
  - 12 inch Yellow Ball: 15 watts or less
  - 12 inch Yellow Arrow: 15 watts or less
  - 12 inch Green Ball: 15 watts or less
  - 12 inch Green and Red Arrow: 15 watts or less

(g) The LED manufacturer shall provide the following industry standard warranty provisions: Replacement or repair of an LED signal module that exhibits a failure due to workmanship or material defects within the first 60 months of field operation, including shipping costs. Each LED signal module shall be identified on its backside with the manufacturer’s name and model/serial number.

902.4.1.3.1.3 Visors and Backplates.

(a) A standard tunnel visor shall be supplied with each signal section unless otherwise specified. Tunnel visors shall be polycarbonate and not less than 0.060 inches thick. The visors shall be a removable type held in place by either four snap-on tabs or by four fastening screws. The visors shall fit tightly against the door thereby not permitting any perceptible filtration of light between them and the housing doors. Visors shall be at least 10 inches long for all 12 inch diameter signals. Visors shall angle downward not less than 3 degrees or more than 7-1/2 degrees. Polycarbonate visors shall be black with the underside flat black. Painting of visors will not be permitted.
(b) Backplates shall be provided on all signal heads. They shall be constructed of 0.250 inch thermoplastic and shall be rigidly fastened to the signal face in such a manner that the backplate extends outward a minimum of 5 inches from all parts of the signal face assembly. Non corrosive fasteners shall be used to affix the backplate to the signal face. All backplates shall be louvered to reduce wind loads.

902.4.1.3.2 Optically Limiting Vehicle Signal Face. An optically limiting signal shall permit the visibility zone of the indication to be determined optically thereby requiring no louvers. The projected indication may be selectively visible or veiled anywhere within 15 degrees of the optical axis. No indication shall result from external illumination nor shall one light unit illuminate a second.

902.4.1.3.2.1 Basic Construction and Mounting. Each 12 inch signal section housing shall be die cast aluminum having back, sides, top and bottom integrally cast to form a single unit. It shall be clean, smooth, and free from imperfections.

(a) Each signal section housing shall have the capability to mount to standard 1-1/2 inch pipe fittings as a single section, as a multiple section face, or in combination with other signals. The signal section shall be provided with an adjustable connection that permits incremental tilting from 0 degrees to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting. The terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal section shall be installed and serviced with ordinary tools.

(b) A square lens door shall be suitably hinged and held securely to the body of the housing by corrosion resistant locking devices. Latching of the door shall be achieved without the use of special tools. All door hardware shall be of corrosion resistant material. All access openings shall be sealed with weather resistant rubber gaskets. Each lens door shall be predrilled for visors.

(c) Each section housing shall be predrilled for backplates.

(d) A minimum of two internally tapped holes which do not extend completely through the signal housing shall be provided in each signal section for the mounting of a terminal block.

(e) The exterior of each die cast aluminum signal housing shall have a chromate preparatory treatment and a flat black finish.

902.4.1.3.2.2 Optical Unit Features. The optical unit for each 12 inch signal section shall consist of an objective lens, lamp, lamp collar, and optical limiter-diffuser. The optical unit shall be designed in conjunction with the visor to eliminate the return of outside rays entering the unit from above the horizontal. The light source shall be LED, and its brightness shall meet or exceed the latest edition and revision of the ITE Standard for Adjustable Face Vehicle Traffic Control Signal Heads.

902.4.1.3.2.3 Visors and Backplates.

(a) A square cut-away visor shall be supplied with each signal section unless otherwise specified. Cut-away visors shall be of sheet aluminum not less than 0.050 inches thick. The visors shall be a removable type held in place by four fastening screws and shall fit tightly against the door thereby not permitting any perceptible filtration of light between them and the housing door. Visors shall be at least 9-1/2 inches long. Each visor shall angle downward at the same angle as the tilt of each individual signal section. Aluminum visors shall be powder coated or painted flat black.

(b) Backplates shall be provided for overhead signal heads as shown on the drawings or as specified in the contract. They shall be constructed of sheet aluminum and powder coated or painted flat black. Each backplate
shall extend a minimum of 5 inches from the edges of each signal face and be rigidly secured to each signal face with non-corrosive fittings, as directed by the manufacturer.

902.4.1.3.3 Pedestrian Signal Face.

902.4.1.3.3.1 Basic Construction and Mounting. In order to facilitate installation and maintenance, the signal housing shall be designed so that all components are readily accessible from the front by merely opening the signal door.

(a) Unless otherwise approved by the Engineer, the signal housing shall be fabricated from ultraviolet stabilized black color impregnated polycarbonate resin having back, sides, top and bottom integrally cast to form a single unit. It shall be clean, smooth, and free from imperfections. The outside dimensions of the case shall be approximately 16 inches high x 18 inches wide x 9 inches deep. The signal housing, the lens door, and visor shall be black. Painting of the signal head will not be permitted.

(b) The signal head shall be suitable for either post top or side mounting. The top and bottom surfaces of each housing shall have an opening to accommodate standard 1-1/2 inch pipe fittings and brackets. Each opening shall have 72 integrally cast radial serrations to insure positive locking of the sections. Two corresponding serrated locking ring fittings shall be furnished with each signal case and shall be subject to the approval of the Engineer as specified in Sec 902.4.1.2(d). The connection between signal housings shall be weatherproof and capable of being directed at any angle in the horizontal plane in 5 degree increments. Two caps shall be furnished to seal the openings on the top and bottom of each signal housing.

(c) The signal housing shall be constructed in a manner that will also allow either right or left side mounting. Whenever side mounting is required, a side bracket shall be fastened to the housing with a watertight seal. Watertight seals shall also be provided on the side(s) of the head not used for mounting purposes. The side bracket shall have a natural aluminum finish and be designed for banding to either a signal post or a mast arm pole. A barrier type terminal block, furnished with not less than 5 points, shall be installed inside the side bracket on two bosses integrally cast in the bracket. The side bracket shall be designed to protect the terminal block from dust and moisture.

(d) The rectangular signal door shall be fabricated from ultraviolet stabilized black color impregnated polycarbonate resin. The door shall be complete with hinge lugs and latch slots. All door hardware shall be of corrosion resistant material. Either a gasket or an integral hood recess shall be used to prevent dust and moisture from entering the signal housing.

(e) Internal bosses shall be provided in the signal housing for the mounting of a terminal block and other internal components.

902.4.1.3.3.2 Optical Unit Features. The signal indication module shall consist of a Light Emitting Diode (LED) unit. Installation into existing traffic signal pedestrian housings shall be without modification to the housing and shall not require special tools. All LED signal modules shall be either Leotek, Dialight, Gelcore-GE, or equal as approved by the Engineer. All LED signal modules shall meet the following requirements:

(a) Indications shall be ITE Class 3 symbol messages. The "UPRAISED HAND" symbol shall be illuminated with a filled, Portland orange LED module. The "WALKING PERSON" symbol shall be illuminated with a filled, white LED module. Pedestrian traffic control signal faces shall be constructed such that both messages are displayed from the same message-bearing surface. The "WALKING PERSON" symbol shall be in the "UPRAISED HAND" symbol. A countdown timer LED display shall be provided.

(b) The LED signal module shall have a fuse and transient suppressor incorporated for line and load protection.
(c) The LED signal module shall not have more than 20% harmonic distortion.

(d) The LED signal module shall meet FCC Title 47, Subparagraph B, Section 15 Regulations for Electric Noise.

(e) The LED signal module shall conform to NEMA moisture resistance STD 250-1991 for Type 4 enclosures (ITE 6.4.6.2 Moisture Resistance)

(f) The LED signal module shall be rated for continuous use in the ambient temperature range of -40°C to +74°C and be protected against dust and moisture intrusion.

(g) The LED signal module shall operate between 80V to 135V.

(h) The LED manufacturer shall provide the following warranty provisions: Replacement or repair of an LED signal module that exhibits a failure due to workmanship or material defects within the first 60 months of field operation including shipping costs. Each LED signal module shall be identified on its backside with the manufacturer’s name and model/serial number.

902.4.1.3.3.3 Visors. Each signal face shall be provided with a rectangular egg crate type visor, also referred to as a screen-type louver, designed to eliminate sun phantom. The material used in construction of the crate visor shall be ultraviolet stabilized black color impregnated polycarbonate plastic. The visor assembly may be either mounted to the signal door or be molded as an integral part of the signal door into a one-piece assembly.

902.4.2 Aluminum Post with Square Pedestal Base Assembly.

(a) The aluminum post shall be straight continuous Schedule 80 extruded aluminum pipe with a 4-1/2 inch nominal outside diameter. The post shall be equal to aluminum alloy 6063-T6, in accordance with ASTM B 210, and have a spun finish. The post shall have tapered threads on one end to form a threaded connection with an aluminum base. A removable aluminum post cap, with stainless steel set screws, shall be provided when specified in the contract or noted on the plans.

(b) The aluminum square pedestal base shall be free from imperfections and equal to either a permanent mold casting of alloy 319.0-F or 356.0-T6, conforming to the requirements of ASTM B 108, or a sand casting of alloy 319.0-F or 356.0-T6, conforming to the requirements of ASTM B 26. The pedestal base shall be approximately 15 inches high x 13-1/2 inches square and weigh a minimum of 20 pounds. The pedestal base shall have a natural aluminum finish. The handhole shall have a minimum 8 inch x 8 inch cover and be either cast aluminum or aluminum colored plastic. Painting of the pedestal base and handhole cover will not be permitted. The pedestal base shall have a 12-3/4 inch diameter bolt circle with the handhole designed to provide easy access to all wiring and anchor bolt nuts. A 1/4-inch x 3/4 inch –20 NC stainless steel hex head bolt shall be used to fasten the handhole cover to the pedestal base. The top opening of the pedestal base shall be chamfered and have tapered threads to form a threaded connection with a Schedule 80, 4-1/2 inch nominal outside diameter post.

(c) A post to base collar assembly shall be provided and designed to reinforce a pedestal post at the point where the threads enter the pedestal base. The reinforcing collar shall be a two or three-piece cast aluminum unit that clamps around the top of a pedestal base with socket head bolts. The reinforcing collar shall be supplied with a roll pin for holding the collar securely in place. The collar shall have an opening to be used for drilling a pilot hole for the roll pin. Welded connections shall not be allowed between the pedestal base and the post.

(d) Anchor bolts shall conform to ASTM A-307 and have minimum yield strength of 36,000 psi. The bolts shall have a diameter of either 5/8 inches or 3/4 inches and be 18 inches long, plus a right-angle hook having a minimum length of 2 inches. Minimum top four inches of each bolt shall be threaded. Each bolt shall be
furnished with a hex nut and washer. All anchor bolts, nuts and washers shall be hot dipped galvanized and meet the requirements of ASTM A-153.

902.4.3 Steel Cantilever Mast Arm Assembly.

(a) Each steel cantilever mast arm assembly shall consist of a pole and a cantilever mast arm with various accessory items, such as plates, fasteners, end caps, anchor bolts, and a handhole with removable cover. The assembly shall be designed to support rigidly mounted signals and signs without the use of tie rods, guy wires or other supports.

(b) The pole shall have a round cross section. Each pole shall be made from not more than two sections of 7 gauge, minimum, hot rolled steel with a minimum yield strength of 50,000 psi. Not more than two longitudinal welds and no circumferential welds shall be permitted in the pole's shaft. All poles after being formed and welded shall be "cold worked" to insure roundness and straightness of the shaft. Unless otherwise approved by the Engineer, each pole shall be uniformly tapered from the bottom to top with a maximum taper of one inch in diameter for each seven feet in length (0.14 inches per foot). Unless otherwise indicated on the drawings or specified in the contract, the total height of each standard pole shall be 19 feet and the total height of each extended height type CL (with luminaire) pole shall be 28 feet. A removable corrosion resistant metal pole cap shall be provided on the top of each pole. A minimum four inch by six inch handhole reinforcing frame shall be welded into each pole, complete with a removable corrosion resistant metal cover to facilitate entry. The center of the handhole shall be located approximately 18 inches above the pole's base and at either 90 degrees or 180 degrees with respect to the traffic signal mast arm. The extended height pole shall have an additional, similar sized handhole reinforcing frame welded into each pole at the same height as and at 180 degrees with respect to the traffic signal mast arm, complete with a removable corrosion resistant metal cover attached to the pole by a chain, to facilitate entry. A grounding lug or connector shall be provided inside each pole at a location easily accessible from the lower handhole. The pole assembly shall be galvanized inside and outside and shall meet the requirements of ASTM A-123.

(c) The cantilever mast arm shall have the same cross-sectional shape as the supporting pole. Each mast arm shall be made from one section of 7 gauge, minimum, hot rolled steel having a minimum yield strength of 50,000 psi. Only one longitudinal weld and no circumferential welds shall be permitted in the mast arm's shaft. All mast arms after being formed and welded shall be "cold worked" to insure roundness and straightness of the shaft. Unless otherwise approved by the Engineer, each mast arm shall be uniformly tapered from the butt to the outer end with a maximum taper of one inch in diameter for each seven feet in length (0.14 inches per foot). Mast arm lengths shall be specified in 2 foot even increments as shown on the drawings or as specified in the contract. Mast arms 10 feet to 40 feet in length shall be 1 piece arms. Mast arms 42 feet to 44 feet in as 2 piece arms, joined by a bolted telescopic connection. The bolted telescopic connection shall be shown in detail on the manufacturer's approved shop drawing. A removable corrosion resistant metal arm cap shall be provided on the outer end of each mast arm. The mast arm assembly shall be galvanized inside and outside and shall meet the requirements of ASTM A-123.

(d) The seam welds on the supporting pole and mast arm shall be ultra-high frequency resistant or of the submerged arc process. The welds shall insure 60 percent penetration and be rated at not less than 100 percent of the yield strength of the steel. Each seam weld shall be smooth, straight and centered on its longitudinal axis.

(e) The base, pole, arm and gusset plates shall be of adequate thickness, conform to ASTM designation A-36, and have bolt spacing as dictated by the manufacturer, shown on the plans, or as illustrated on MoDOT's Standard Detail Drawing 902.30P or its most recent revision, "Traffic Signals, Post Bases". The pole plate shall be tapped. All plates shall be galvanized and meet the requirements of ASTM A-123. The distance between the center of the mast arm connection and the top of the supporting pole shall be 12 inches.
(f) Pole shaft, base plate, anchor bolts, mast arm, and structural connecting hardware, shall be designed in accordance with loading and allowable stress requirements of the latest revision of the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals". Loading shall be based on an isotach wind velocity of 90 mph at 30 feet above ground, or greater. Calculations and standard detail drawing shall be submitted by the Contractor or manufacturer for verification of compliance to these specifications and must be sealed by a Missouri licensed professional Engineer. The wind loading dimensions and design criteria specified on MoDOT's Standard Detail Drawing 902.40R, or its most recent revision, "Minimum Design Loading for Post and Mast Arm Attachments" as modified by the design plans.

(g) Projection of the mast arm longitudinal center line, at the outer end of the mast arm, shall not deflect below the horizontal plane. This criterion shall be met when the structure is fully loaded, i.e., 175 pounds at the end of the arm for arms 10 feet to 36 feet in length, and 160 pounds at the end of the arm for arms 38 feet to 44 feet in length. In no case shall the mast arm rise be more than 0.50 inch per foot in an unloaded condition.

(h) A luminaire arm of a specified length shall be provided when indicated on the plans or specified in the contract. The luminaire arm shall be a galvanized steel cantilever arm, with a plastic or metal end cap bushing, and a steel bolted clamp assembly for attachment to an extended height mast arm pole.

(i) Anchor bolts shall be fabricated from high strength steel having a minimum yield strength of 55,000 psi. The minimum size anchor bolts for mast arms 10 feet to 36 feet in length shall be 1-1/4 inches in diameter and 48 inches long, including a six-inch right-angle hook. The minimum size anchor bolts for mast arms 38 feet to 44 feet in length shall be 1-1/2 inches in diameter and 60 inches long, including a six-inch right-angle hook. Minimum top six inches of each bolt shall be threaded. Each bolt shall be furnished with 2 hex nuts and 2 washers. A minimum of one foot of the threaded end of each anchor bolt and all nuts and washers shall be hot dipped galvanized and meet the requirements of ASTM A-153. All anchor bolts shall be covered with corrosion resistant metal nut covers or acorn nuts. A 1/4 inch thick steel template ring or welded cross member shall be furnished with each mast arm assembly. The template ring or cross member shall have a bolt circle of the same size as the bolt circle for the anchor bolts and it shall rest upon the right angle hooks of the anchor bolts when permanently installed in the mast arm's concrete base. The use of a solid disc or plate as a template for the installation of anchor bolts will not be permitted.

(j) Excluding anchor bolts, all fasteners with a bolt diameter of 1/2 inch or greater shall conform in material to ASTM A-325 and be hot dipped galvanized and meet the requirements of ASTM A-153. All fasteners with a bolt diameter less than 1/2 inch shall conform in material to ASTM A-307 and be electro zinc plated or conform in material to AISI 300 series and be stainless steel.

(k) Each signal head installation on a mast arm, oriented as shown on the plans, shall be by one of the following methods:

(1) Each signal head installed vertically on a mast arm shall be mounted using a bracket described in Sec 902.4.1.2 (f). A hole for wiring access shall be field drilled in the mast arm for each bracket, the location of which shall be determined by the design plans or as modified by the Engineer, most often for making field adjustments. The bracket shall be banded onto the mast arm with stainless-steel strapping or cable. The area between the bracket and mast arm shall be sealed with a silicon caulk. An 1/8 inch drain hole shall be drilled into each signal head terminal compartment.

(2) Each signal head installed horizontally on a mast arm shall be assembled using a bracket described in Sec 902.4.1.2 (f). This signal head assembly shall be configured and mounted in accordance with the plans and standard detail drawings. A hole for wiring access shall be field drilled in the mast arm to the bracket providing access to the terminal compartment. The location of the hole shall be determined by the plans or as modified by the Engineer.
(l) The cantilever mast arm assembly shall be handled in a manner to avoid damage to the galvanized surfaces. Any galvanized material on which the coating has been damaged shall be rejected or may, with the approval of the Engineer, be repaired in accordance with Sec 1080.

(m) The Contractor shall submit to the Engineer 4 copies of the manufacturer’s steel mast arm assembly shop drawings, with wind load calculations shown signed by and sealed by a Missouri professional Engineer. The shop drawings shall identify the project name and show all details which are required to adequately meet all specifications and to control the mast arm assembly fabrication. All shop drawings must be approved by the Engineer prior to fabrication; however, such approval shall not relieve the Contractor of its responsibility under the contract for successful completion of the work in accordance with these specifications. The shop drawings shall be submitted at least two weeks in advance of the Contractor’s need for approval. This time requirement for approval does not relieve the Contractor of its responsibility for delivery of each mast arm assembly within the time specified on the bid forms.

902.4.4 Wood Poles, Guys and Span Wire Assembly.

(a) Wooden poles, as specified in Sec 1050, shall be Class II wood poles or better. The length of wood poles shall be as shown on the plans. Guy wires, clamps, guards, standoff pipe, fittings, anchors, rods, concrete embedment and other items used for the installation and support of wood poles shall be included as part of the installation of Class IV wood poles:

(1) Guy wire shall be 3/8-inch, high strength, 7 strand, and double galvanized wire conforming to the requirements of ASTM A 475.

(2) Standoff guys, when specified, shall include a 2-1/2 inch diameter galvanized pipe with galvanized end fittings. The pipe shall be of enough length to allow positioning of the guy anchor at the location shown on the plans or at the location spotted in the field by the Engineer.

(3) Plastic guy wire guards shall meet the current requirements of the National Electrical Safety Code. Guy wire guards shall be yellow and made of high-density polyethylene or polyvinyl chloride (PVC) material. The material shall have excellent color retention, be ultraviolet stabilized, and have non-brittle properties. Guy wire guards shall be 8 feet long and be a full round design to cover the guy wire all around (360 degrees). The plastic guards shall be designed to resist upward movement when installed. If clamps are utilized to resist movement, they shall be hot dipped galvanized.

(4) Guy wire anchors in soil shall be 4-way, 10 inch diameter, and have expanding anchors with 3/4-inch galvanized thimble eye anchor rods which extend a minimum of 5 feet into the soil. Guy wire anchors in rock shall be 1-3/4 inch expanding anchors with 3/4-inch galvanized thimble eye anchor rods which extend a minimum of 2-1/2 feet into rock.

(b) Each span wire assembly shall include a 3/8 inch steel span wire from which signal heads and cable are to be suspended and an 1/4 inch steel tether wire for restraining bottom movement of signal heads. Also included shall be all clamps, cable straps, insulators and other items used for a span wire assembly installation, as shown on the standard detail drawings. The span wire and tether wire shall be high strength, 7 strand, double galvanized wire conforming to the requirements of ASTM A 475. All clamps shall be fabricated from low alloy steel.

902.4.5 Power Supply Assemblies. Each type of power supply assembly shall consist of a rainproof circuit breaker cabinet/panel, meter socket and all other necessary appurtenances except those furnished by the utility company or those separately listed in the contract. Each assembly shall meet the approval of Ameren Missouri or Cuivre River Electric Cooperative, Saint Charles County, and the electrical code of the local municipality. All bi-metal connections shall be covered with a non-curing silicon paste used for sealing, lubricating, protecting and insulating
against water infiltration and arcing. Installation of power supply assemblies must be done in accordance with MoDOT’s standard drawing 902.15k “Power Supply Assembly”, unless otherwise shown on the plans.

902.4.5.1 Type 1 (Pole) Overhead Service. The overhead pole type power supply assembly shall consist of a circuit breaker cabinet mounted below a meter socket on the side of a utility pole or wood span wire pole as shown on the plans or as specified in the contract. The circuit breaker cabinet shall be a 70 ampere minimum, single phase, three (3) wire, 120/240 volt enclosure, with 2 single pole 50 ampere circuit breakers. The circuit breaker cabinet shall be a suitably finished type 3R rainproof metal enclosure. The meter socket shall be aluminum, 120/240 volt rated, ringless, 5 terminal, 5 jaw, 100 amperes minimum, and have an overhead socket with a clamped jaw manual by-pass. The bottom of the meter socket glass shall be a maximum of 5-1/2 feet above finish grade, except over walkways where the bottom of the meter socket shall be 6-1/2 feet above the walkway. The power supply assembly shall include all conduits on the pole as shown on the plans or standard drawing, ground rod, bare No. 6 AWG ground wire in 3/4-inch PVC, aluminum service entrance cable of enough length to reach utility company secondary and form a drip loop, and all power supply hardware.

902.4.5.2 Type 2 (Pedestal) Underground Service. The steel post type power supply assembly shall consist of a circuit breaker cabinet mounted opposite a meter socket on the web side of a W6x9 galvanized steel post embedded in concrete. The circuit breaker cabinet shall be a 70 ampere minimum, single phase, 3 wire, 120/240 volt enclosure, with 2 single pole 50 ampere circuit breakers. The circuit breaker cabinet shall be a suitably finished type 3R rainproof metal enclosure. The meter socket shall be aluminum, 120/240 volt rated, ringless, 5 terminal, 5 jaw, 100 amperes minimum, and have an overhead socket with a clamped jaw manual by-pass. The bottom of the meter socket glass shall be a maximum of 5-1/2 feet above finish grade, except over walkways where the bottom of the meter socket shall be 6-1/2 feet above the walkway. The power supply assembly shall also include all conduits mounted on the W6x9 galvanized steel post, concrete embedment, ground rod located in the nearest pull box, bare No. 6 AWG ground wire, all power supply hardware, power cables, and the rigid steel conduit to the utility companies power source. The Contractor may substitute a Type 3 underground service as described in Sec 902.4.5.3 as a replacement for a Type 2 underground service at no additional cost.

902.4.5.3 Type 3 (Pedestal) Signal/Lighting Underground Service. The signal/lighting cabinet shall contain a control panel constructed of the same material as the cabinet. Circuit breakers, the photoelectric switch, a contactor if specified, and any other specified equipment for luminaire control shall be installed on the panel. Control cabinets shall be of enough size to house all equipment shown on the plans. Cabinets shall be dust tight, watertight, NEMA 4, constructed of aluminum or stainless steel. All hinges, catches, and other hardware shall be stainless steel. Cabinets shall have a No. 2 Corbin lock. Photoelectric switches and contactors shall be in accordance with Sec 901 and Sec 1091. Circuit breakers shall be Type B. Two keys for each type of lock shall be provided.

902.4.6 Traffic Actuated Controller Assembly as per plans. A traffic signal controller assembly as per plans is defined as the complete assembly of all required equipment and components as shown on the plans for actuated control of traffic signal indications as shown on the plans for all approaches to an intersection. Its Malfunction Management Unit (MMU) must be MMU2 compliant, have an Ethernet port that is IP addressable, and contain an LCD display surrounded by a black colored front panel. Flashing yellow arrows will be accomplished by way of using the MMU2 mode B programing option. The assembly must meet the latest edition and revision of NEMA Standards Publication No. TS2 Type 1, Traffic Control Systems including the latest NTCIP protocol requirements specified by the County’s Gateway Green Light (GGL) ongoing projects. The traffic controller provided and installed-programmed by the Contractor, as required by the County, will be an unused NTCIP version of an ATC controller compliant with ATC standard version 6.10 or newer. It must be made fully compatible the Gateway Green Light Project TMC infrastructure and TransCore TransSuite software. Integration of this equipment into the Traffic Management Center (TMC) system will be the responsibility of the Contractor and must be proven to be reliable during the 15 continuous day test period. Its interior light(s) shall be a bright LED type to conserve energy and provide longevity. LED lighting shall be placed on the cabinet interior ceiling and under the bottom shelf od three provided at its left and right ends to illuminate backpanel wiring. The traffic controller assembly complete shall be warranted to the
County for the common industry standard for each type of equipment contained within from date of acceptance, except for any provided reused County equipment.

902.4.6.1 BIU. The BIU provided shall meet or exceed the following requirements:

902.4.6.1.1 Introduction. This specification sets forth the minimum requirements for a rack-mountable solid-state Bus Interface Unit (BIU). The BIU shall meet, as a minimum, all applicable sections of the NEMA Standards Publication No. TS2-2003 (clause 8.3) for BIU2 configuration. Where differences occur, this specification shall govern.

902.4.6.1.2 Operational Functions. The following functions shall be provided in addition to those required by the NEMA TS2-2003 Standard Section 8.

902.4.6.1.2.1 The BIU shall pass all tests provided by the BIUT-820 Automatic BIU Tester manufactured by Athens Technical Specialists, Inc.

902.4.6.1.2.2 The following display functions shall be provided in addition to those required by the NEMA TS2-2003 Standard Section 8.

(a) Power Indicator. The POWER indicator shall illuminate to indicate proper DC supply voltage is applied and internal logic is operating properly.

(b) Port 1 Receive Indicator. The RECEIVE indicator shall illuminate for a 40 millisecond pulse each time a Port 1 message is correctly received from the Controller Unit.

(c) Port 1 Transmit Indicator. The TRANSMIT indicator shall illuminate for a 40 millisecond pulse each time a Port 1 message is transmitted from the BIU.

902.4.6.1.3 Hardware.

902.4.6.1.3.1 Front Panel. The front panel shall be constructed of sheet aluminum with a minimum thickness of 0.090” and shall be finished with a black or blue anodized coating to eliminate corrosion. The model information shall be permanently displayed on the front surface.

902.4.6.1.3.2 Electronics. In the interest of reliability, only the PROM memory device for the microprocessor firmware shall be socket mounted. The PROM Memory socket shall be a precision screw machine type socket with a gold contact finish providing a reliable gas tight seal. Low insertion force sockets or sockets with “wiper” type contacts shall not be acceptable. All electrical components used in the BIU shall be rated by the component manufacturer to operate over the full NEMA temperature range of -34°C to +74°C. All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:

(a) All plated-through holes and exposed circuit traces shall be plated with solder.

(b) Both sides of the printed circuit board shall be covered with a solder mask material.

(c) The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin #1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards.

(d) All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.
902.4.6.2 Controller Cabinet. Each controller shall be furnished in a weatherproof cabinet conforming to the following requirements.

902.4.6.2.1 Basic Construction.

(a) Controller cabinets shall be 1/8 (0.125) inch reinforced sheet aluminum alloy (5052-H320). All controller cabinets shall be neat in appearance and sufficiently rugged to withstand normal usage.

(b) All controller cabinets shall have all exterior and interior surfaces solvent cleaned.

(c) A hinged main door shall provide complete access to the interior of the cabinet. A rain tight gasket shall provide a tight fit between the door and the cabinet (Foam Rubber Gaskets will not be accepted). The door shall be provided with a No. 2 cabinet lock. An auxiliary door, positioned on the main cabinet door, equipped with a rain tight gasket, shall allow access to a switch panel and shall be equipped with a lock whose key will not unlock the main door. Two keys shall be provided for each type of lock used.

(d) The door hinges and pins shall be of corrosion resistant metal. Each pin shall be a solid rod, at least 1/8 inch in diameter. If continuous hinges are furnished, the pins shall be continuous the full length of the hinges and shall not be less than 1/16 inch diameter. Each door hinge shall be rigidly fastened to both the cabinet and the door. Fastening of hinges with sheet metal screws shall not be acceptable.

(e) The main cabinet door shall be equipped with at least a two position stop and catch arrangement to hold the door open at positions of 90 degrees and 180 degrees, plus or minus 10 degrees.

(f) The cabinet shall contain a minimum of 3 strong reinforced mounting shelves to adequately accommodate the mounting sizes and weights of the; controller unit, MMU2, Uninterruptible Power Supply (UPS) control unit for the battery backup system, video detection system, Ethernet-Fiber switch, a hereby required TS2 detector rack including a BIU, and all necessary ancillary equipment. The mounting facilities shall permit the controller unit and/or ancillary equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connections or disrupting operation of the intersection. The interior lighting of the cabinet shall be a bright LED strip mounted on the cabinet ceiling as approved by the Engineer. A battery backup side mounted cabinet shall be attached to the main controller cabinet to hold its four batteries (48v), switch, and UPS inverter control unit. Screws used for mounting shelves or other mounting purposes (i.e., panels, wiring terminals, etc.) shall not protrude beyond the outside wall of the cabinet.

902.4.6.2.2 Size and Mounting. The controller cabinet shall provide space for housing all equipment and components. The size of the controller cabinet shall be as shown on the plans or as specified in the contract. The controller cabinet shall be either ground mounted or mounted on a pole. The type of cabinet mounting shall be as shown on the plans or as specified in the purchase order.

(a) Mounting flanges for bolting each ground mount cabinet to its concrete base shall be located inside the cabinet along the bottom perimeter. Mounting flanges located outside a ground mount cabinet shall not be acceptable.

(b) Anchor bolts for ground mount cabinets shall conform to ASTM A-307 and have a minimum yield strength of 36,000 psi. The bolts shall have a diameter of either 5/8 inches or 3/4 inches and be 18 inches long, plus a right angle hook having a minimum length of 2 inches. The bolts shall extend a maximum of 2-1/2 inches above the cabinet base and be threaded. Each bolt shall be furnished with a hex nut and washer. All anchor bolts, nuts and washers shall be hot dipped galvanized and meet the requirements of ASTM A-153.

(c) Each controller cabinet mounted on a pole shall be bolted to two 4 inch x 4 inch pressure treated wood cross members using four 5/8 inch diameter carriage bolts. One 5/8 inch diameter hex head bolt shall be used to
mount each cross member to the wood pole. Each bolt furnished shall be corrosion resistant and secured with a corrosion resistant hex nut and washer.

902.4.6.2.3 Ventilation.

(a) Each controller cabinet shall have a minimum of two adjustable thermostatically controlled ventilating fans installed in the top of the cabinet. The fans shall have an exhausting capability, in an enclosure, of at least 150 cubic feet per minute. A 1/4 inch mesh screen shall be installed inside the cabinet as a guard covering the vent fan blades. The thermostat controlling the fan shall be manually adjustable to turn on between 90°F to 150°F with a differential of not more than 10°F between automatic turn-on and turn-off. An easy to read dial setting calibrated in degrees shall be provided.

(b) Each controller cabinet shall be supplied with a replaceable furnace type fiberglass filter mounted behind louvers and in the lower one fourth of the cabinet door or sides. The acceptable standard size filter to be provided shall depend upon the type of controller cabinet mounting and be as described below:

   (1) In a ground mount controller cabinet, a 12 inch x 16 inch x 1 inch replaceable furnace type fiberglass filter shall be provided.

   (2) In a controller cabinet mounted on a pole, a 12 inch x 12 inch x 1 inch replaceable furnace type fiberglass filter shall be provided.

902.4.6.2.4 Special Switches, Sockets and Outlets. All switches shall be permanently marked so that their identity and operation shall be readily apparent.

(a) Each cabinet shall have two 2 position signal-flash and manual-normal/auto switches mounted on the switch panel behind the auxiliary door (emergency access) to the main cabinet door. The two positions of the switches and their functions are as described below:

   (1) Switch #1 - Signal/Flash

   - Signal - Power is supplied to the signal lights and their operation is controlled by the timer.
   - Flash - Signal lights are controlled by the flasher unit. The timer is operating with stop time introduced. This stop time shall be removed by either setting. This switch back to signal position or as specified in Sec 902.4.6.2.4(b). An input shall be put into the controller unit to show a local flash alarm.

   (2) Switch #2 - Manual Pushbutton Hand Control – Normal/Auto

   - Manual – This switch position will activate the manual hand control push button with coiled connecting cable, to be included, to allow emergency services to control manually each interval of each active phase step by step, with amber minimum timing overriding vehicular clearance intervals.
   - Normal/Auto - Operation is controlled by the controller unit or emergency flasher unit.

(b) Each cabinet shall have a switch provided inside the cabinet to put the signal lights into flashing operation with the controller unit remaining in operation without stop timing being introduced. Access to this switch shall be attainable only by opening the main cabinet door. This switch shall remove stop timing if it was previously introduced by the FLASH switch behind the emergency access auxiliary door.

(c) Each cabinet shall have a switch inside the cabinet to remove power from the timer without interrupting power to the controller features. Access to this switch shall be attainable only by opening the main cabinet door.
(d) Each cabinet shall have a three-position switch to control stop timing to the timer. The three positions are as follows: Stop Time On/Stop Time Off/Normal. Access to this switch shall be attainable only by opening the main cabinet door.

(e) Separate push button momentary switches, with normally open contacts, shall be provided inside the cabinet to put calls into timer for each actuated vehicle and pedestrian phase. If preemption phasing is shown on plans or purchase order, then a push button shall be provided for each preemption sequence.

(f) Each controller cabinet shall have a ground fault circuit interrupter duplex outlet inside the cabinet. An LED light-fixture shall be provided inside on the top side cabinet wall with a switch mounted so that the light will be turned off when the main door is closed. The AC power distribution panel shall be covered with a plastic shield. The controller door shall have three switches; one to activate a door open/close alarm, one to turn off the video detection monitor and one to turn on the LED lighting. The cabinet shall have three shelves. The bottom shelf will have a slide out laptop holding platform attached underneath. The bottom shelf shall also have LED lighting on its right and left bottom sides to illuminate the backpanel. One electric heater controlled by a variable switch inside the cabinet to reduce humidity and keep the electronic warm shall be provided. The 200 watt minimum heater controlled by a thermostat which turns on heat at 40°F and off at 60°F shall be provided. One 10 outlet power strip will be provided on the left side wall which is IP addressable and each individual outlet can be turned on and off remotely through the GGL network.

(g) Each controller cabinet mounted on a pole shall have a ground fault circuit interrupter (GFCI) duplex outlet and a switched LED light in an unobstructed area inside the cabinet. The GFCI outlet shall be near the cabinet’s right side breakers. One electric heater controlled by a variable switch inside the cabinet to reduce humidity and keep the electronic warm shall be provided. The 200 watt minimum heater controlled by a thermostat which turns on heat at 40°F and off at 60°F shall be provided.

902.4.6.3 Panel Wiring, Circuit Breakers and Relays.

(a) All wiring inside the cabinet shall be stranded and shall be neatly bundled and secured with plastic cable ties. Copper barrel lugs shall be provided for all field connections inside the controller cabinet. Insulated crimped-on connectors, one per wire, of an approved type shall be used for all other panel connections. The outgoing signal circuits shall be the same polarity as the line side of the power supply, and the common return of the signal circuits shall be the same polarity as the ground side of the power supply. The power supplied shall be provided through two single conductor cables unless otherwise indicated. The ground side of the power supply shall be carried throughout the controller in a continuous circuit and shall be secured to a ground bus bar in an approved manner. Enough terminals shall also be provided on the ground bus bar for the common return of all field and panel connections.

(b) Each cabinet shall be furnished with easily accessible wiring panel(s) of all metal construction sufficiently rugged to withstand normal usage. Unless otherwise approved by the Engineer, the back panel shall be so constructed, mounted, and wired to allow the panel to be swung forward and down to facilitate access to back wiring, without removing equipment or shelves. As a minimum, the following barrier type terminal strips shall be provided on the panel(s):

(1) Terminals for all incoming power lines.

(2) Terminals and bases for signal load switches and outgoing field circuits. The minimum number of load switch bases for an eight-phase controller shall be sixteen.

(3) Terminals for all sensor and detector cables.

(4) Terminals for all required auxiliary equipment.
(5) One additional SLDC port 1 connector cable for a future use such as a Video Detection System regardless whether that future use is being installed now or later.

(c) All terminals shall be permanently marked so that their identity may be readily apparent.

(d) A surge arrester shall be provided to block high speed transients and remove high energy surges from the incoming AC lines. The arrester shall be designed for a peak current of 26 KA/Mode, 32.5 KA/Phase, 45.5 KA/Total, and a clamping voltage not to exceed 340 volts during surge. The arrester shall provide protection from main neutral to ground as well as main line to ground. The surge arrester shall incorporate two LEDs for failure indication in a modular package that can easily detach and attach from its hard-wired base for quick replacement.

(e) A minimum 30 ampere line filter shall be installed on the incoming power line after the 30 ampere circuit breaker.

(f) The minimum of 16 flashing field circuits complete with a minimum of 8 flash transfer relays shall be provided.

(g) The transfer relays that control the switching operation between the control mechanism and the flasher unit shall be designed to carry 10 amperes (tungsten filament load) per contact set. The socket for each flash transfer relay shall be equal to BEAU 5400 Series socket or TRW Cinch 2400 Series socket. All wiring must be soldered to sockets; push-on terminal lugs are not permitted.

(h) The signal bus shall be connected to the incoming AC+ through a signal bus mercury contactor and be designed to carry a 30 ampere load. The current ratings specified are computed with a tungsten filament load. The signal bus mercury contactor shall be energized to provide power to the signal bus.

(i) Controller assembly incoming and outgoing power carrying wires/cables must be surge protected. If induction loops are used: a three-terminal surge arrester shall be provided for each vehicle detector input. Two terminals are connected across the signal inputs of the detector and the third terminal is grounded. A series surge arrester shall be provided for each pedestrian signal input. The outgoing line to the pedestrian push button detector shall come from safety ground. Logic common shall be connected to safety ground to provide the same potential energy. A three-circuit surge arrester shall be provided for each load switch field circuit. The surge arrestors shall be rigidly installed just below the main back panel and auxiliary signal panel. Camera cables, if used, shall be properly surge protected. Power over Ethernet shall be protected when Ethernet cables are used. NEMA TS-2 port 1 15 pin surge protection must be provided to protect each device connected to a port 1 Synchronous Data Link Control (SDLC). Each SDLC plug must have surge protection meeting or exceeding the following specifications:
General Technical Specifications, SDLC Surge Protection

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<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>5 VDC</td>
</tr>
<tr>
<td>Clamping Voltage</td>
<td>8 VDC</td>
</tr>
<tr>
<td>Operating Current</td>
<td>1.5A</td>
</tr>
<tr>
<td>Peak Surge Current</td>
<td>47A (10 x 1000μs)</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>0 to 20 MHz</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>&lt; 0.1 dB at 20 MHz</td>
</tr>
<tr>
<td>SPD Technology</td>
<td>SAD</td>
</tr>
<tr>
<td>Connection Type</td>
<td>DB-15</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Dimensions (Inches)</td>
<td>1.5H x 0.625W x 2.25L</td>
</tr>
<tr>
<td>Weight</td>
<td>1.25 oz</td>
</tr>
</tbody>
</table>

(j) The electrical connection(s) to the controller unit shall be as specified in the latest edition and revision of NEMA Standards Publication No. TS 2 Type 1, Traffic Control Systems, as modified herein.

(k) A 15 ampere circuit breaker shall be provided to remove power from the cabinet light and ground fault circuit interrupter (GFCI) duplex outlet. A 30 ampere circuit breaker, with input in parallel with the above 15 ampere circuit breaker, shall be provided to remove all other incoming power. Each circuit breaker shall have an "On-Off" switch.

(l) Four sets of drawing(s) of the controller wiring diagrams for each signal installation and the electronic files of these drawings in both a *.PDF and a *.DWG format, compatible with AutoCAD 2020+ and Adobe software shall be provided. The controller wiring diagrams shall be provided on neat and clean 24 x 36 inch sheet(s) and on a computer DVD or removable thumb drive. The diagrams shall be easy to read and match the cabinet wiring. All controller wiring diagrams shall be double referenced.

902.4.6.4 Controller Phase Requirements. The phasing and interval sequence to be provided shall be as shown on the plans or as specified in the purchase order, unless modified by the Engineer.

902.4.6.5 Actuated Traffic Controller, NTCIP, ATC 6.1, NEMA TS2 Type 2. This specification sets forth the minimum requirements for a shelf-mounted sixteen phase fully-actuated digital solid-state traffic controller. The controller shall be configurable to meet, as a minimum, all applicable sections of the NEMA Standards Publications for TS2 and NTCIP 1202 and ATC standard 6.10. Where differences occur, these specifications shall govern. Controller versions shall be available to comply with NEMA TS2 Types 1 and 2. Type 2 versions of the controller shall be capable of operating as a Type 1 controller. The controller unit shall have menu driven programming, front panel keyboard entry, a liquid crystal status display, digital timing, be capable of uploading and downloading from an Ethernet port to a computer, using software compatible with Windows 10 or newer.

902.4.6.5.1 Traffic Controller Hardware:

(a) Enclosure

The controller shall be compact to fit in limited cabinet space. It shall require no more than 7” shelf depth. External dimensions shall not be larger than 8.5” x 15.25” x 6.375” (H x W x D). The top and bottom of the chassis shall be made from extruded aluminum and include an integral handle on the back for easy transport. Its sides shall be constructed of injection-molded polycarbonate. The front panel shall meet specifications set forth in Section 2.5 (Front Panel). The model, serial number, and program information shall be displayed on the outside of the controller. The model, serial number, and program information shall be displayed on the outside of the controller.
(b) Electronics

(1) The electronics shall be modular in design and shall consist of vertical circuit boards. Horizontal circuit boards shall not acceptable.

(2) In the interest of reliability, no sockets shall be used for any electronic device. All devices shall be directly soldered to the printed circuit board. Surface mount parts shall be used for most of the electronic components in the controller.

(3) A built-in, high-efficiency switching power supply shall generate the primary, +5VDC internal voltage, an isolated +24 VDC for internal and external use, VSTANDBY, LINESYNC, POWERUP and POWERDOWN signals. All voltages shall be regulated.

(4) The 120 or 220VAC fuse shall be mounted on the front of the controller. Protection for the 24VDC supply shall be provided by a re-settable electronic fuse.

(5) All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:

- Both sides of the printed circuit board shall be covered with a solder mask material.
- The circuit reference designation for all components and the polarity of all polarized capacitors and two-leaded diodes shall be clearly marked adjacent to the component. Pin 1 for all integrated circuit packages shall be designated on all printed circuit boards.
- All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

(6) Timing of the controller traffic application shall be derived from the AC power line.

(7) To facilitate the transfer of user-programmed data from one controller to another, a Datakey receptacle for using a separate 2070-style, serial flash memory device shall be an available hardware option. In addition, two USB sockets and one SD Card socket shall be provided for memory devices that can be used for data transfer. These data transfer devices shall be easily removable and directly accessible from the outside of the controller. The controller will not require this Datakey, USB memory thumb drive or SD Card to be present for proper operation.

(8) All controller software shall be stored in Flash Memory devices. The controller software shall be easily updated without the removal of any memory device from the controller. The use of removable PROMS or EPROMS from the controller shall not be acceptable. The controller shall include an option that allows updating software using a Windows based computer, a USB memory thumb drive or an SD card.

c) ATC Engine Board

(1) The controller shall include an ATC engine board compliant to ATC standard 5.2b and proposed version 6.10.

(2) The engine board shall include a PowerPC 83XX family processor with QUICC engine.

(3) The engine board shall have a minimum of the following memory:
- 128Mbytes of DDR2 DRAM memory used for application and OS program execution.
- 64 Mbytes of FLASH memory used for storage of OS Software and user applications.
- 2MB of SRAM memory used for non-volatile parameter storage.

(4) The engine board shall provide the seven ATC serial ports, Ethernet, USB and all other control signal required by ATC standard.

(5) The operating system shall be Linux 2.6.35 or later.

(d) User Interface

Program values shall be capable of entry through the keypad or by way of download through the Ethernet port. Menu selections shall be capable of entering the numerical value of the desired option.

(e) Front Panel

(1) The front of the controller shall consist of a panel for the display, keyboard and connectors for all necessary user connections.

(2) The display shall be a 7”, TFT (Thin Film Transistor) LCD (Liquid Crystal Display) with high brightness. It shall be readable in direct sunlight. The display shall perform over the NEMA temperature range and shall have a resolution of 800 x 480. The luminous intensity shall be a minimum of 800 nits. The display shall not be affected by condensation or water drops.

(3) Front-panel operator inputs shall be via clearly labeled elastomeric keypad. These shall include a 10-digit numeric keypad, Main and Sub keys, toggle keys, special function and enter keys, six function keys, status and help keys and a large, four-direction cursor control key.

(4) The front panel shall include a built-in speaker for enhanced controller audio feedback.

(5) The front panel shall include a tri-color status LED.

(f) Ethernet Ports

(1) The controller shall have the capability of supporting Ethernet communications, using TCP/IP communications protocols.

(2) The controller shall provide four front-panel Ethernet ports

(3) Two of the ports shall be connected to Ethernet switch ENET1 and the other two shall be connected to Ethernet switch ENET2

(g) USB Ports

(1) The controller shall provide two USB 2.0 ports.

(2) USB ports shall be used for USB thumb drives to update software, upload or download configuration or uploading logged data.

(h) Connectors
(1) All non-optional interface connectors shall be accessible from the front of the controller in the NEMA Configured Controller models. Configurations shall be offered to accommodate different versions, as follows:

- NEMA TS2 Type 1
- NEMA TS2 Type 2
- NEMA TS1

(2) The D connector shall be compatible with the traffic controller unit.

(3) To facilitate special applications the controller shall have the capability of assignment of any input or output function to any input or output pin respectively on the interface connectors, except for Flashing Monitor, Controller Voltage Monitor, AC+, AC-, Chassis Ground, 24VDC, Logic Ground and TS2 Mode bits.

(4) The controller shall as a minimum have the following communications ports:

a. Port 1 SDLC for communications to other devices in the cabinet.

b. Port 2 serial port for systems communications.

c. Console serial port for local communications.

d. An optional telemetry module shall utilize TDM/FSK data transmission at 1200 baud or 9600 baud over two pairs of wires.

e. Ports on optional ATC-2070 communication modules – see section 2.10.2.

(5) RS-232 Serial communications shall operate at from 1200 to 115.2 K baud.

(i) Serviceability

All electronic modules including the power supply shall be easily removable from the controller using a screwdriver as the only tool. All power and signal connections to the circuit boards shall be via plug-in connectors.

(j) Hardware Options

(1) Optional Data Key

- A Datakey and receptacle shall be available for use as a database storage device (backup) or as a database transfer module. It shall be capable of storing a minimum 2MB of data.

- The Datakey shall be hot swappable, so that it can be inserted and removed without powering down the controller.

- The Datakey shall be capable of storing the entire controller database and shall retain the information without use of battery or capacitor backup.

- The controller shall not require this key to be present during normal operation.
- If the Datakey is present the controller shall automatically backup the database to the data key 20 minutes following the last data change.

(2) Optional ATC-2070 type communications slot

- The controller shall provide support one ATC-2070 Type communications slot that can be added, if needed, providing access to ATC communications ports.

902.4.6.6 Malfunction Management Unit. An external solid-state malfunction management unit (MMU) MMU2 compliant shall be provided as a standard cabinet feature and be capable of handling all circuits provided. The MMU shall be programmed by soldering jumpers on a printed circuit board for those inputs which are considered compatible. The MMU shall have an LCD front face display, a black colored front panel with an optional Ethernet port provided and meet the minimum requirements of the latest revision of NEMA Standards Publication No. TS 2 Type 1, Traffic Control Systems.

902.4.6.7 Solid State Load Switches.

(a) The Contractor must provide a separate load switch for each vehicular phase socket whether it is shown on the plans to be used or not. They also must be provided for any overlap and/or pedestrian phase to switch power to all signal indications required for the signal phasing shown on the plans or as specified in the purchase order. All load switches shall comply with the triple-signal solid-state type load switch as specified in the latest edition and revision of NEMA Standards Publication No. TS 2 Type 1, Traffic Control Systems. The load switches shall be capable of handling a tungsten-lamp load of 10 amperes per circuit. All load switches shall have optically isolated solid-state relay outputs. Dual signal type load switches shall not be allowed.

(b) The number of load switch bases to be provided shall be sixteen.

(c) Light emitting diode indicators shall be provided on the load switches to display the load switch inputs.

902.4.6.8 Flash Operation.

(a) Each controller shall be capable of dual flash operation. Dual flash is defined as follows:

(1) Internal time base or interconnect flash operation, which flashes Yellow-Red.

(2) Emergency flash operation (MMU, police door, etc.), which flashes as follows:

Intersection Signal - Flashes Red-Red
Pedestrian Signal - Flashes Yellow
Fire Station Signal - Flashes Yellow-Red

*Emergency flash operation shall override time base or interconnect flash operation.*

(b) Each controller shall be capable of being placed in flash operation by either an interconnect line or an internal time base.

(c) The transition from normal operation to interconnect or internal time base flashing operation, and vice versa, shall be in accordance with the current edition and latest revisions of the Manual on Uniform Traffic Control Devices (MUTCD).

(d) In each controller the above transitions to and from interconnect line or internal time base flash operation shall be accomplished internally to the controller unit. Programmed flash is Yellow-Red.
(e) Flash operation shall also be obtained manually by utilizing either one of the three switches specified in Sec 902.4.6.2.4. The flash transfer shall occur immediately and override the interconnect line or internal time base flash.

902.4.6.9 Solid State Flasher Unit. The flasher unit shall be provided as a standard cabinet feature and be completely solid state and utilize digital design techniques. The flasher shall comply with the latest edition and revision of NEMA Standards Publication No. TS 2 Type 1, Traffic Control Systems.

(a) Each flasher shall be a Type 3 dual circuit flasher, capable of handling a tungsten-lamp load of 15 amperes per circuit at a temperature of 165°F.

(b) The design shall be such as to simplify repair, utilizing only standard electronic components.

902.4.6.10 Traffic Signal Battery Backup System. The battery backup unit (BBU) shall be provided as a standard cabinet feature with all controller assemblies required by the design plans. It shall be capable of providing power for signal operation for three hours and when 40% battery capacity is reached it will be capable of putting the signal into emergency flash operation. The system shall be mounted onto the right (power-breaker) side of the main controller assembly cabinet. The entire system shall be self-contained in a side mounted aluminum cabinet using a rack mounted inverter, switch and contain shelves holding 4 batteries.

(a) The BBU shall have a minimum output rating of 1100 VA at 1100 watts. The output voltage shall be no less than 115 VAC and no more than 125 VAC and the output frequency shall be a pure form regulated 60-hertz sine wave. The BBU shall operate in a temperature range of -22°F to 165°F. Each of the four required batteries shall sit on a heater mat to keep the battery warm during cold weather, as controlled by the inverter temperature probe, with each heater mat turning off when the signal is operating from battery power or during warm temperatures. Each Gel Cell and/or (AGM) type battery must meet or exceed the following specifications:

<table>
<thead>
<tr>
<th>Battery Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Runtime @ 25A constant Current Load</td>
<td>196 Minutes</td>
</tr>
<tr>
<td>Rated and labeled as 105Ah each, measured at 20 degrees Centigrade Voltage Per Unit</td>
<td>12.8</td>
</tr>
<tr>
<td>Conductance Value</td>
<td>1100</td>
</tr>
<tr>
<td>Max. Discharge Current (A)</td>
<td>900</td>
</tr>
<tr>
<td>Short Circuit Current (A)</td>
<td>2600</td>
</tr>
<tr>
<td>10 Second Volts @ 100A</td>
<td>11.3</td>
</tr>
<tr>
<td>Ohms Impedance 60Hz</td>
<td>0.0050</td>
</tr>
<tr>
<td>Nominal Capacity at 20hrs</td>
<td>(to 1.75VPC) 100Ah</td>
</tr>
<tr>
<td>Nominal Capacity at 20hrs</td>
<td>(to 1.70VPC) 102Ah</td>
</tr>
<tr>
<td>Terminal Type C (Insert w/ 1/4&quot; - 20 round hole)</td>
<td>-40 to 71°C (-40 to 160°F)</td>
</tr>
<tr>
<td>Operating Temperature Range Discharge</td>
<td></td>
</tr>
<tr>
<td>Charge (with temp compensation)</td>
<td>-23 to 60°C (-9.4 to 140°F)</td>
</tr>
<tr>
<td>Float Charging Voltage (Vdc)</td>
<td>13.5 to 13.8</td>
</tr>
<tr>
<td>AC Ripple Charger</td>
<td>0.5% RMS or 1.5% of float charge voltage recommended for best results. Maximum allowed = 4% P-P</td>
</tr>
</tbody>
</table>

(b) The minimum battery voltage will be greater than 48 VDC using four 12VDC 105 amp hour batteries. The battery charger shall be temperature compensated. Batteries shall be charged utilizing a charge manager device.
to individually charge each battery in a string to extends battery life by minimizing charge differences between batteries.

(c) When the AC line has failed, the BBU will supply power to keep the signal in operation for three hours minimum until a programmable time has been reached or 40% battery capacity is reached before putting the signal into emergency flash. Flash shall be triggered by use of a hardwired and programmed relay contact (C4 or C5). The three hour set point and the 40% battery power set point shall be user programmable using the Ethernet port in the field or from the TMC. When the unit is running on battery operation, power will still be supplied to all equipment in the controller cabinet powered by the 30 amp circuit breaker.

(d) The front panel shall display the current line voltage, battery charging, low battery or battery fault, unit processor fault, and unit running on battery. There will be dry contact outputs that mimic the front panel display. The output for battery on will be C1 will be wired to put an alarm into the TS2 backpanel alarm 2 input. Low battery will be C2 and connected to alarm 3. Alarm 1 is the door opened closed alarm.

(e) The Uninterruptible Power Supply (UPS) inverter control unit shall have both a LAN Ethernet port and have either a RS232 serial port or USB port, to allow a technician to connect to and program/monitor the BBU. All the information available on the local displays will also be available through the Ethernet port. These ports will also be used to adjust operating parameters of the unit as needed, with any software required to do so provided to the County at no additional cost. The port connections and terminal set up shall be included in the Operators Manual. The UPS control unit shall be programmed with assigned IP addresses for communicating through an Ethernet cable connected to the switch. Alarm 1 shall be programmed to indicate “battery power on”. Alarm 2 shall be programmed to indicate “low battery”. Alarm 3 shall be programmed for “timer to auto flash” and shall occur 3 hours after continuous battery power due to the lack of available utility power. The side mounted cabinet shall be large enough to house the UPS control unit, all four batteries placed upon their heater mats, the BBU bypass switch, and their connecting cabling between the battery backup system and the new or existing controller assembly. Warranty; Obtain, assign and furnish to the County any written manufacturer's warranties for all provided electronic equipment consistent with those provided as the normal customary trade practice.

(f) An automatic bypass switch shall be installed to keep power supplied to all equipment should the unit require service. Power to the bypass shall come from the output of the 30 amp circuit breaker.

902.4.6.11 Approval of Controller Equipment. In order for manufacturers’ controller equipment, including panel wiring, to be approved, the following requirements must be fulfilled, unless otherwise approved by the Engineer.

(a) The manufacturers' equipment within the controller cabinet, including panel wiring, must satisfactorily meet the specifications as described herein.

(b) The manufacturers' equipment within the controller cabinet must have been previously tested with satisfactory results by a County approved agency. It shall be the prerogative of the Saint Charles County Highway Department to determine whether a current or new model of previously approved equipment will be accepted.

(c) Prior to approval of equipment within the controller cabinet, the Engineer shall be provided with a certification(s) by an independent testing laboratory stating that the equipment complies with the latest edition and revision of NEMA Standards Publication No. TS 2 Type 1, Traffic Control Systems.

(d) The manufacturers' equipment within the controller cabinet, including panel wiring, must meet the subjective approval of the Saint Charles County Highway Department concerning the following:

(1) Appearance (suitable size of equipment, ease of reading functions and displays, neat arrangement of wiring panels).
(2) User friendly (ease of programming, accessibility for monitoring).

(3) Technician compatibility (ease of maintenance, convenient board testing and removal, state of the art board layout and design, accessible wiring panels).

902.4.7 Auxiliary Equipment for Controllers. Auxiliary equipment shall consist of separate devices used to add supplementary features to a controller assembly. Each auxiliary unit mounted inside the controller cabinet shall be enclosed in a suitable finished case that is neat in appearance and sufficiently rugged to withstand normal usage. The function of each auxiliary unit shall be permanently marked by an identification plate on the case. All auxiliary equipment shall be designed to operate satisfactorily between 95 volts AC and 135 volts AC and \(-30^\circ\text{F}\) to 165\(^\circ\text{F}\) ambient temperature. Approval of auxiliary equipment shall be in accordance with the requirements of Sec 902.4.6.1.

902.4.8 Detectors.

902.4.8.1 Pedestrian Push Button Detector.

902.4.8.1.2 Pedestrian push button detectors shall be a touch activated pressure sensitive type, requiring no more than 3 pounds of force to activate, and shall meet or exceed current ADA requirements. They shall be round, black in color except for the touch pads, and shall NOT have an LED light. The operating voltage capability of the pushbutton shall be within the ranges of 12-36 VDC (18 VDC typical) and 9-25 VAC RMS. The operating button shall be sturdy and waterproofed. A 1/2-inch opening for cable shall be provided in the back of each housing case. The entire assembly shall be weatherproof, secure against electrical shock to the user, and of such construction as to withstand continuous hard usage. Push buttons shall be mounted 38 inches above the ground and/or meet current ADA requirements.

902.4.8.1.3 When the plans request a compact pushbutton pedestal, it shall meet the following requirements, as approved by the Engineer:

(a) Four 5/8" x 12" galvanized steel bent anchor bolts with grade A nuts and USS flat washers.

(b) A 4 inch National Pipe Thread (N.P.T.) pedestal post mounted to the top of an anodized aluminum pedestal base shall be secured with a 5/16" X 7" stainless steel bolt passing through the base, pedestal post and stainless steel cable rope tether, secured with a washer, lock washer and lock nut. A stainless steel 1/8" rope tether shall be looped at both ends with stainless steel fasteners tethering the 5/16" bolt to one of the base anchors with a 5/8" washer and nut.

(c) During a vehicle collision the pedestal base shall yield (breakaway) before the schedule 40 aluminum shaft that is secured into the top of the base fails.

(d) The pedestal base shall have a grounding lug installed which supports 14 AWG thru 4 AWG conductors.

(e) The compact pushbutton pedestal shall meet or exceed the requirements illustrated by the generic drawing on the next page.
Compact Pushbutton Pedestal

1" Diameter "C" base, sidewalk or pier

Grade

(4) Hooked Anchor Bolts 5/8" X 12"

10" Support Post

PEDESTAL BASE, Anodized Aluminum

5/16" bolt/lock nut for cable tether

Cable Tether Anchor Attachment Assembly (Required)

6" Bolt Circle

Access Door

Approx. 7"

Approx. 7" BASE BOTTOM VIEW

Approx. 7"

Approx. 7"

BASE SIDE VIEW

Approx. 7"

Approx. 7"

4 1/4"

Access Door

Ground Terminal

6" Bolt Circle

Grade

(4) Hooked Anchor Bolts 5/8" X 12"

1" Diameter "C" base, sidewalk or pier

BASE MOUNTING

PUSHBUTTON PEDESTAL ASSEMBLY

Plan Specified Sign

Center of Push Button

4"x48" Schedule 40 Al. Post

5/16" bolt/lock nut for cable tether.

Cable Tether Assembly

Access Door

Ground Terminal

GRADE

Top Cap

Approx. 10"
902.4.8.1.4 When the plans request an automated pedestrian presence sensor, it shall meet the following requirements, as approved by the Engineer: One sensor shall be able to detect the presence of pedestrians automatically for two directions at one ADA ramp while offering the detection mode choices of approach-only, depart-only, and bidirectional motion. Its power requirements shall range 12-24 V AC or DC ± 10%. Power consumption shall be 2 W maximum while its output power shall be 5mW typical, 2mW minimum. Its relay output shall be form C rated at 1 Amp at 24 VDC (N.O. and N.C.). Its detection method shall be a microprocessor analyzed Doppler microwave with the operating frequency of 24.125 GHz (K-band). It shall be provided with any necessary power converting transformer and mounting hardware to mount it to a standard signal post, allowing easy aiming adjustments. Its enclosure shall be powder coated grey aluminum.

902.4.8.2 Vehicle Inductive Loop Detection System.

902.4.8.2.1 Card Rack Mounted Detectors (if used). The supporting and connecting rack for this type detector shall contain space for a minimum of eight card positions for two channel detector units. Upper and lower slide guide shall be provided for each detector card. The card mounting rack shall be rigidly attached to the middle shelf of three provided. Each channel on each detector card shall be self-tuning. Adjustable frequencies, digital timed delay capability with delay override and call extension shall be incorporated on each channel of each detector card. It shall meet current NEMA TS 2 Type 1 standards. Unless shown otherwise on the plans, each detector in the card rack shall be associated with the appropriate phase as follows:

<table>
<thead>
<tr>
<th>Channel</th>
<th>Card Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ø 1</td>
</tr>
<tr>
<td>2</td>
<td>ø 2</td>
</tr>
<tr>
<td>3</td>
<td>ø 1 or 6</td>
</tr>
<tr>
<td>4</td>
<td>ø 6</td>
</tr>
<tr>
<td>5</td>
<td>ø 3</td>
</tr>
<tr>
<td>6</td>
<td>ø 3 or 8</td>
</tr>
<tr>
<td>7</td>
<td>ø 8</td>
</tr>
<tr>
<td>8</td>
<td>ø 8</td>
</tr>
</tbody>
</table>

*Each detector channel shall be clearly labeled with phase and direction.

902.4.8.3 Video Vehicle Detection System

902.4.8.3.1 Detection System. The number of cameras to be provided for each intersection overhead vehicle video detection system shall be as specified in the contract or shown on the plans. This detection system must be NEMA TS 2 Type 1 compatible. The system shall be capable of producing accurate adjustable detection zones for video detection of vehicles, bicycles, and motorcycles where they travel in all weather and lighting conditions. The system shall be able to determine vehicle presence, traffic flow data (counts and speeds), event alarms, and full-motion live video for real-time traffic control and analysis using current GGL TMC software management systems. The system shall meet or exceed the specifications below this section, as approved by the Engineer. The Contractor shall be responsible for its programming as indicated on the plans to the satisfaction of the Engineer. No separate payment will be made for programming. The unit bid cost for this system shall be lump sum complete installed including all cameras, camera housing units, communications cable, mounting hardware, a cabinet field monitor for viewing live detection, and accessory equipment necessary for proper operation including those listed below.

(a) Camera and Processor.

(1) The camera shall be a color CMOS imaging array.

(2) The camera shall have HD resolution of at least 720p (1280x720 pixels).

(3) The camera shall include a minimum 10X optical zoom.

(4) It shall be possible to zoom the lens as required to satisfy across-the-intersection detection objectives, including stop line and advance detection.
(5) It shall be possible to zoom the lens remotely from the TMC for temporary traffic surveillance operations or to inspect the cleanliness of the faceplate.

(6) The camera shall have direct, real-time iris and shutter speed control by the integrated processor.

(7) The processor shall support H.264 video compression for streaming output.

(8) Video Sensor Enclosure Assembly

(9) The camera and processor shall be housed in a sealed IP-67 enclosure.

(10) The faceplate of the enclosure shall be glass and shall have hydrophilic coating on the exterior surface to reduce debris accumulation and maintenance.

(11) The faceplate shall have a thermostatically-controlled indium tin oxide (ITO) heater applied directly on the interior surface to keep the faceplate clear of condensation, snow, ice and frost.

(12) An adjustable aluminum visor shall shield the faceplate from the sun and extraneous light sources.

(13) An integral aiming sight shall assist in aiming the camera for the detection objectives.

(14) A removable rear cap and cable strain relief shall seal the power connection.

(15) The rear cap shall be tethered to the enclosure to avoid dropping the cap during installation.

(16) The rear cap shall be fastened to the body of the video sensor with a single, captive bolt.

(17) The rear cap and enclosure shall include Gore breathers to equalize internal and external pressure.

(18) The sensor shall be self-supporting on manufacturer’s mounting brackets for easier fastening during installation.

(19) It shall be possible to rotate the field-of-view 360° without changing the angle of the visor.

(b) Power and Communications.

(1) Power and communications for the video sensor shall be carried over a single three-conductor cable.

(2) Termination of the three-conductor cable shall be inside the rear cap of the enclosure on a three-position, removable Phoenix terminal block. Each conductor shall be attached to the Phoenix plug via a screw connection.

(3) The video sensor shall operate normally over an input voltage range of 89 to 265 VAC at 50 or 60 Hz.

(4) Power consumption shall be no more than 16 watts typical.

(5) No supplemental surge suppression shall be required outside the cabinet.

(6) All communications to the video sensor shall be broadband-over-power via the same three-conductor cable that powers the unit. Coaxial cable shall not be required.

(c) Communications Interface Panel.
The video detection system shall include two communications interface panels, one in the cabinet assembly and one spare for future use. It will manage communications between the video sensors, the traffic management center, a maintenance technician, and the traffic cabinet itself. System connections via the communication interface panel shall include an Ethernet RJ-45 WAN Port for TMC communications, video display to the provided LCD panel and for installation/maintenance. A spare second Ethernet RJ-45 shall be provided. This interface panel shall provide Wi-Fi 802.11ac communications for nearby installation/maintenance and video streaming within 20 feet of its location.

(d) Video Sensor Connection.

(1) The communications interface panel shall provide connection points for four video sensors.

(2) Each sensor connection shall be a 3-pole terminal block, which supplies power and broadband-over-power communications to the sensor.

(3) The broadband-over-power communications shall provide a throughput of 70 to 90 Mbps.

(4) The broadband-over-power connection shall support at least 1,000 feet of cabling to the video sensor.

(5) Each video sensor connection shall include a power switch.

(6) There shall be an LED for each video sensor to indicate the state of the power to the sensor and an LED for each video sensor to indicate the status of communications.

(7) Each video sensor connection shall contain a resettable fuse.

(8) Each video sensor connection shall provide high-energy transient protection.

(e) Traffic Management Center (TMC) Communications.

(1) An Ethernet port shall be provided to connect to a remote Traffic Management Center (TMC).

(2) The TMC connection shall support 10/100/1000 Mbps Ethernet communication.

(3) The communications interface panel shall proxy all network requests that arrive on the TMC connection to avoid unwanted network traffic from reaching the broadband-over-power network between the communications interface panel and the video sensors.

(4) All communications to the video detection system through the TMC connection shall be to a single IP address.

(f) Local User Communications.

(1) A wired Ethernet port shall be provided to connect the technician at the cabinet to the video detection system for setup and maintenance purposes.

(2) The maintenance port shall support 10/100/1000 Mbps Ethernet communication.

(3) All communications to the video detection system through the maintenance port shall be to a single IP address.
(4) The maintenance port shall support DHCP to automatically assign an IP address to the user’s computer, if desired.

(5) An 802.11g Wi-Fi access point shall allow wireless connection to the video detection system at the cabinet for setup and maintenance purposes.

(6) All communications to the video detection system through the Wi-Fi access point shall be to a single IP Address.

(7) The Wi-Fi access point shall support DHCP to automatically assign an IP Address to the user’s computer.

(8) The Wi-Fi access point shall include a dipole, omnidirectional antenna.

(9) A momentary pushbutton shall allow the user to turn the Wi-Fi access point on or off.

(10) The Wi-Fi access point shall turn itself off automatically after a period of inactivity from connected devices.

(11) An LED shall indicate when the Wi-Fi access point is enabled.

(12) The Wi-Fi access point shall operate simultaneously with the wired maintenance port and with the TMC connection.

(g) Traffic Controller Connection.

(1) The communications interface panel shall provide one connection to communicate to the traffic controller through the cabinet.

(2) The traffic controller connection shall support a TS2 Type 1 compatible SDLC interface.

(3) The traffic controller connector shall be a 15-pin female metal shell D sub-miniature type connector to support a standard NEMA TS2 or TEES SDLC cable.

(4) The traffic controller connection shall support a protocol interface to SDLC-capable traffic controllers (NEMA or TEES).

(5) The traffic controller connection shall support the NEMA TS2 SDLC protocol to include up to 64 detector outputs and 32 inputs.

(6) The traffic controller connection shall be able to connect to a wired input/output card, which supports wired I/O in cabinets without a SDLC-capable controller.

(7) The wired I/O data communications link shall support at least 24 outputs and 16 inputs.

(8) It shall be possible to connect and use both SDLC communications and communication to the wired input/output card simultaneously.

(h) USB Ports.

(1) The communications interface panel shall include two USB 2.0 ports.
(2) If a communications interface panel fails to start and run due to a software or operating system failure, it shall be possible to reinstall all system and application software from a USB memory stick without necessitating removal of the communications interface panel from the cabinet.

(j) Power.

(1) The communications interface panel shall accept input voltage in the range of 89-265 VAC, 50/60 Hz power from the transient-protected side of the cabinet.

(2) The communications interface panel shall be protected by two slow blow fuses. Spares shall be attached to the panel.

(j) Wired Input/Output Card.

(1) The video detection system shall support an optional wired input/output card that communicates with the communications interface panel for real-time detection states and other I/O to the traffic controller. The card may reside in a standard detector rack or shelf-mount enclosure with power module.

(2) The optional wired input/output card shall comply with the form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack or Caltrans TEES Input File.

(3) The card shall occupy two slots of the detector rack.

(4) The card shall provide four detector outputs on its rear-edge connector.

(5) A front connector shall provide communication to the communications interface panel.

(6) A front connector shall allow 16 inputs and 24 contact-closure detector outputs for wiring into the cabinet.

(7) A front panel LED for each of the 16 inputs and 24 outputs shall indicate the state of the input or output.

(8) The wired input/output card shall support optional expansion cards in other slots. Each expansion card shall support 4 outputs to the back edge of the card.

(9) The wired input/output card shall support optional harnesses for connection to Input Files or C1, C4, C11, and C12 ports to support Type 170 or Type 2070 controllers.

(k) System Software.

The video detection system shall include management software for configuration, monitoring and data collection purposes.

(l) Management Software.

(1) Management software shall be a Windows-based application.

(2) The software shall be compatible with Windows 10 PC operating systems and GGL TMC server software.

(3) The software shall communicate with the video detection system via Ethernet.
(4) The management software shall automatically determine all video sensors and communications interface panels available on the local network and populate a list of all devices.

(5) The management software shall provide the user a means to name individual video sensors and communications interface panels.

(6) The management software shall provide a means for the user to zoom the camera optics while viewing a live video stream.

(7) The management software shall provide a means for the user to calibrate distances in the field of view.

(8) The management software shall provide the user a means to create 4-sided detection zones in the field of view using either a still snapshot or live video.

(9) The management software will overlay an outline of each detection zone over the background image.

(10) It shall be possible for the user to place detection zones anywhere in the field of view for stop line detection and/or advance detection.

(11) It shall be possible for the user to set the desired color of both the on and off states of the detection zone overlay.

(12) It shall be possible for the user to alter the size and shape of any previously created zone.

(13) It shall be possible for the user to overlap zones, either partially or fully.

(14) It shall be possible for the user to name each zone uniquely.

(15) It shall be possible for the user to assign each zone to detect vehicles, to detect bicycles, or to detect both, and to specify different outputs for each type.

(16) It shall be possible for the user to assign the same output to multiple zones such that the output will be on if any of the zones are detecting a vehicle or bicycle.

(17) It shall be possible for the user to assign a single zone to more than one output such that if a vehicle or bicycle is detected, all the assigned outputs shall be turned on.

(18) The management software shall be capable of creating at least 99 detection zones per video sensor.

(19) It shall be possible for the management software to retrieve all configuration parameters from video sensors or communications interface panels.

(20) It shall be possible for the user to save all the settings for a video sensor or a communications interface panel to a laptop file.

(21) The management software shall provide a means to read or import all the settings from a previously saved configuration file for a video sensor or a communications interface panel.

(22) The management software shall be able to download a new version of the application software into a communications interface panel and its attached video sensors.

(23) The management software shall provide a screen to monitor operation of a video sensor.
(24) The monitoring screen shall include a live video stream from the video sensor with at least HD 1280x720 pixel resolution.

(25) The monitoring screen shall show indications of detection in real time by changing the color of the detection zone.

(26) It shall be possible for the user to configure different indications for vehicle detections vs. bicycle detections when both are configured for the same zone.

(27) The monitoring screen shall include the following optional, configurable objects. It shall be possible for the user to size and position them anywhere on the screen and to change the color and size of text.

(28) An indication of when an output is on or off, along with a user-configurable name for that indicator.

(29) The current time in the video sensor.

(30) A user-configurable title or name.

(31) The version number of the video sensor software.

(32) It shall be possible for the user to turn the overlay graphics on or off with a single setting.

(33) The management software shall provide a screen to monitor operation of the intersection with a quad-view video stream from the communications interface panel.

(34) The quad-view video stream shall have a resolution of at least HD 1280x720 pixels, where each of the sensor videos comprising the quad-view shall be at least 640x360 pixels.

(35) It shall be possible for the user to configure the order that the sensor videos appear in the quad-view.

(36) The real-time quad-view video stream shall be capable of displaying the overlay graphics for all four sensors simultaneously.

(37) While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to request a “snapshot” or single-frame image to save to a named file on a laptop.

(38) While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to record a period of the video to save to a named file on a laptop.

(m) System Functionality.

The video detection system shall provide the following features and functionality.

(n) Detection Performance.

(1) The video detection system shall detect the presence of vehicles in defined zones and turn on the assigned output when the vehicle is present in the zone.

(2) Stop Line Detection
- For detection zones placed at the stop line, the probability of not detecting the presence of a vehicle shall be 1% or less under all operating conditions when the video sensor is installed and configured properly.

- For detection zones placed at the stop line, the probability of falsely detecting a vehicle that is not present shall be 3% or less under all operating conditions when the video sensor is installed and configured properly.

(3) Advance Detection

- It shall be possible to place advance detector zones such that the farthest point of the zone is up to 600 feet from the video sensor. Advance detector zone placement shall include 2-3 car lengths of field-of-view beyond the farthest point of the zone.

- To ensure statistical significance for the above detection performance specifications, the data shall be collected over 24-hour time intervals (to avoid a single lighting condition) and will contain a minimum of 100 vehicles per lane. The calculations of detection performance will not include turning movements where vehicles do not pass through the detectors, vehicle lane-change anomalies, or where they stop short or stop beyond the combined detection zones.

(o) Failsafe Mode.

(1) The video detection system shall provide 3 failsafe options during optical contrast loss. The default shall be maximum recall. The end-user may choose to use minimum recall or fixed recall in which a user-defined number of seconds may be implemented to hold call during green.

(2) The video sensor shall continuously monitor the overall contrast in the video. If the overall contrast falls below a preset level (such as caused by dirty faceplate, severe glare, extreme fog, or temporary ice/snow on the faceplate), the sensor shall enable the chosen failsafe mode. When enough contrast is restored in the video, the sensor will exit the failsafe mode.

(3) The communications interface panel shall continuously monitor the connectivity status of the attached video sensors. If any video sensor goes offline due to either electrical failure or internal software failure, the communications interface panel shall enable the failsafe mode for that video sensor. If the video sensor comes back online, failsafe mode shall end.

(p) Data Collection.

(1) The video detection system shall automatically collect and store traffic flow data in non-volatile memory for later retrieval and analysis. No additional hardware or software shall be necessary. The data shall include Vehicle counts and Vehicle average speeds.

(2) The management software shall be able to retrieve collected data for a specified time period or for all currently stored data and save into a standard CSV file.

(q) Operations Log.

The communications interface panel and each video sensor shall maintain a time-stamped operation log of routine and special events in non-volatile memory for later retrieval and analysis.

(r) Time Synchronization.
The video detection system and management software shall provide three methods to synchronize the time of day clocks in the communication interface panel and the video sensors, as follows:

- Manual time synchronization operation by the user, which sets the time to the current time on the laptop where the management software is running.

- A configuration setting to allow the communications interface panel to automatically obtain time from the NEMA TS2 protocol on the SDLC channel and broadcast it to the video sensors.

- A configuration setting to allow the communications interface panel to automatically obtain time from up to five Network Time Protocol (NTP) sources and broadcast it to the video sensors.

(s) Video Streaming.

(1) In addition to the ability to view video streams in the management software, it shall be possible to view video from individual sensors or to view the quad-view from the communications interface panel using a third-party video player application on a tablet, smartphone or laptop computer.

(2) Video bitrate is user-definable between 100 Kbps-5000 Kbps. The default shall be 2048 Kbps. All bitrates shall provide 30 fps.

902.4.8.3.1.1 Installation and Setup. The video detection system hardware shall be designed for flexible, fast and easy installation and setup. It shall be possible to mount the video sensor on an intersection pole, mast arm, or luminaire arm. No special tools or extra equipment, other than a laptop for configuration, will be required. Once all hardware is installed, connected and functional, it shall be possible to configure the video detection system for a typical 4-approach, 8-phase intersection in 15 minutes or less.

902.4.8.3.1.2 Warranty, Service and Support. The video detection system shall be provided with the following warranty, service and support options.

902.4.8.3.1.2.1 Warranty. The manufacturer shall warrant the video detection system to be free of defects in material and workmanship for a minimum of 3 years. An option for up to 6 years of warranty shall be available. During the warranty period, technical support from factory certified personnel or factory certified installers shall be available from the supplier. Ongoing software support by the supplier shall include updates for the video firmware and computer programming/monitoring software and shall be provided at no cost to the County during the warranty period.

902.4.8.3.1.2.2 Service. Ongoing software support by the manufacturer will include software updates of the video sensor, communications interface panel, and management software. These updates will be provided free of charge during the warranty period. The manufacturer will maintain a program for technical support and software updates following expiration of the warranty period. This program will be available to the contracting agency in the form of a separate agreement for continuing support.

902.4.8.3.1.2.3 Support. A quick-start guide, installation guide, application notes, and other materials shall be available from the manufacturer to assist in product installation and setup for various applications. In addition, training online or in person shall be available. The supplier of the video detection system shall provide two days of training to maintenance and Engineering personnel of the contracting agency in the application, design, operation, setup, and maintenance of the video detection system. Manufacturer shall provide a tech support website and an 800 number for technical support.
902.4.8.3.1.3 Basis of Payment. The work will be paid for at the contract unit bid price each for a VIDEO VEHICLE DETECTION SYSTEM, which price shall be payment in full for furnishing, installing, and placing into operation the equipment specified to the satisfaction of the Engineer.

902.4.9 Closed Loop System Equipment.

(a) The closed loop master controller shall manage, control, monitor and collect data for a minimum of 32 intersections. It shall be able to compute, control and supervise the program selection for two independent groups. It shall provide monitoring and reporting of conditions for each new and/or existing local controller and be compatible with said local controllers. It shall allow for master and local programming from remote locations. It shall be capable of handling 64 system detectors, 48 coordination patterns, and 16 timing plans with 3 offsets per timing plan. It shall be capable of providing traffic responsive plan selection. It shall include one internal fiber optic modem, or FSK modem, as specified. The use of two or more masters to accomplish these features shall not be allowed.

(b) Each closed loop local controller shall include one internal fiber optic modem, or FSK modem, as specified.

(c) The closed loop master monitor shall be capable of monitoring multiple systems. It shall receive and log data reports. It shall receive reports of critical alarms via modems from system masters. It shall interpret and relay to a paging system the master location, local intersection location, type of alarm and time of alarm. It shall be capable of printing the alarms at a central location.

(d) An external modem shall be provided. This modem shall be compatible with Windows: XP, NT 4.0, 2000, ME, and 98. It shall be of the type shown on the and/or as approved by the Engineer.

902.4.10 Fiber Optic Termination Housing. The housing shall be suitable for wall mounting and be capable of mounting a minimum of 24 hub ST type connectors. A minimum of 24 single-mode ST type connectors shall be installed in the housing. The housing shall have a splice tray kit capable of a minimum of 30 splices. It shall be capable of housing up to 48 fibers and provide for the stacking of fibers. It shall also have ample room for feed through cable and provide strain relief for multiple cables within the unit. It shall be compatible with Corning Cable Systems # WCH-04P, unless otherwise indicated on the plans.

902.4.11 Video Camera Mounts.

902.4.11.1 Camera Mount on Luminaire Arm. Each steel luminaire arm assembly for mounting a camera out from an extended height pole shall consist of a galvanized steel cantilever arm of a plan specified length. This assembly shall include a plastic or metal end cap bushing and a steel bolted clamp for attachment to a pole. A camera manufacturer recommended bracket, for mounting a camera to the luminaire arm, shall be furnished with each camera.

902.4.11.2 Camera Mount on Post Extension. Each post extension assembly for mounting a camera higher than a mast arm or lighting pole shall consist of a 16-foot straight continuous Schedule 80 extruded aluminum pipe, with a 4-1/2 inch nominal outside diameter. The post shall be equal to aluminum alloy 6063-T6 and have a spun finish. This assembly shall include a removable aluminum post cap with stainless steel set screws and mounting brackets for attachment to a pole. A camera manufacturer recommended bracket, for mounting a camera to the post extension, shall be furnished with each camera.

902.4.11.3 Camera Mount on Mast Arm. Each pipe assembly for mounting a camera to a mast arm shall consist of a 6-foot straight continuous Schedule 40 extruded aluminum pipe, having a 1-1/2 inch nominal pipe size. The pipe shall be equal to aluminum alloy 6063-T6 and have a natural aluminum finish. This assembly shall include a plastic end cap, a bracket similar to the one described in Sec 902.4.1.2 (f) for attachment to a mast arm, and a bracket for mounting a camera to the top of the pipe assembly as recommended by the manufacture of the camera.
902.5 Construction Requirements.

902.5.1 Location of Existing Underground Facilities, Structures and Utilities. Existing underground facilities, structures and utilities, if shown on the plans, shall be considered approximate only. Verification of the locations of all existing underground facilities, structures and utilities, either shown or not shown on the plans, shall be the responsibility of the Contractor, and shall be verified prior to any grading, excavation or construction of improvements. The Contractor/Developer shall contact the Engineer, a minimum of 48 hours in advance of construction work for locating and spotting existing traffic signal utilities. In the event the Contractor/Developer damages existing conduit, cable, or other utilities repairs shall be made at the Contractors cost within 72 hours, as directed by Saint Charles County. Emergency repairs must be made immediately after the damage(s) occur.

902.5.2 Location of New Concrete Bases, Pull Boxes and Detector Loops. The Contractor shall notify Engineer, when ready for the location of new concrete bases, pull boxes, and detector loops. This notice shall be a minimum of 24 hours in advance of construction work. Adequate survey information must be marked in the field prior to this notice to facilitate locating these new traffic signal items. The Contractor shall not proceed with construction until the Engineer has reviewed layout of traffic signal items.

902.5.3 Traffic Signal Construction in Solid Rock. If solid rock is encountered, all conduits, pull boxes, concrete bases and other roadway improvement items requiring excavation shall be installed as required by Sec 901.10, with the approval of the Engineer. All costs for installing these items in solid rock shall be considered incidental to the contract prices bid for these items.

902.5.4 Construction of Concrete Bases. Concrete bases for pedestal posts, mast arm poles, and controller cabinets shall be in accordance with Sec 902.5.2 and conform to dimensions shown on the plans or contract documents.

   (a) The top surfaces of concrete bases shall be constructed to the elevations shown on the plans or the standard detail drawings.

   (b) Excavation for bases shall be made in a neat and workmanlike manner. Each base shall be formed from the top of the base to a minimum of 12 inches below grade. Forms shall be sufficiently rigid to prevent warping or deflection. The forms shall be level and held rigidly in place before and during the placement of concrete.

   (c) Concrete shall be Class B concrete in accordance with Sec 501, or concrete of a commercial mixture as approved by the Engineer. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 703. Anchor bolts and conduit shall be carefully inspected and held rigidly in place before and during the placement of concrete. The placement of anchor bolts and conduit shall be in accordance with the dimensions shown on the plans or contract documents, or as dictated by the manufacturer and approved by the Engineer. Vibration of concrete shall be required to fill all voids. The Contractor shall be required to protect anchor bolt threads during concrete construction. All concrete shall be removed from the threads immediately after finishing has been completed. The tops of all bases shall be finished level in a workmanlike manner. Backfill material shall be compacted around each base in layers not exceeding 6 inches in depth.

   (d) Mast arm concrete bases shall be cured at least 72 hours prior to installing mast arms. Pedestal concrete bases shall be cured at least 48 hours prior to installing pedestal posts and ground mount controller cabinets.

902.5.5 Construction of Concrete Pads. A 4 inch concrete pad shall be constructed in front of each controller cabinet concrete base or wood pole supporting a controller cabinet, when sidewalk is not provided. The size of the concrete pads shall conform to dimensions shown on the plans or standard detail drawings. The top surface of each concrete pad shall be flush with adjacent surfaced areas and be approximately 1 inch above seeded or sodded areas. Concrete pads shall be Class B concrete in accordance with Sec 501, or concrete of a commercial mixture as
approved by the Engineer. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 608.

902.5.6 Installation of Preformed Pull Boxes. Preformed pull boxes shall be in accordance with Sec 902.5.2 and conform to dimensions shown on the plans or standard detail drawings.

(a) A stone drain, consisting of 1 inch clean gravel or crushed stone, shall conform to dimensions shown on the plans or standard detail drawings and be constructed below each preformed pull box. Backfill material shall be compacted around each preformed pull box in layers not exceeding 6 inches in depth.

(b) The top surface of each preformed pull box shall be flush with adjacent surfaced areas. In seeded or sodded areas, a 12 to 6 inch tapered thick concrete apron by 10 inches minimum wide shall be constructed flush around the perimeter of each preformed pull box with #4 rebar inserted. The concrete apron shall be approximately 1 inch above adjacent seeded or sodded areas. Concrete aprons shall be Class B concrete in accordance with Sec 501, or concrete of a commercial mixture as approved by the Engineer. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 608.

902.5.7 Construction of Concrete Pull Boxes. Pull boxes shall be located in accordance with Sec 902.5.2. They shall conform to the dimensions shown on the plans or standard detail drawings.

(a) Each concrete pull box shall be cast in place in a neat and workmanlike manner. Inside and outside surfaces of the pull box walls shall be formed. An outside form shall be installed across trenches leading into the excavation for the pull box. The ends of all conduit through the walls of the pull box shall fit tightly against the inside form. Concrete shall be Class B concrete in accordance with Sec 501, or concrete of a commercial mixture as approved by the Engineer. Concrete shall be placed, vibrated, finished and cured in accordance with the applicable provisions of Sec 703.

(b) The frame, cover, and cable hooks shall be installed conforming to dimensions shown on the plans or standard detail drawings.

(c) A stone drain, consisting of 1 inch clean gravel or crushed stone, shall conform to dimensions shown on the standard detail drawings and be constructed below each pull box. Backfill material shall be compacted around each concrete pull box in layers not exceeding 6 inches in depth.

(d) The top surface of each concrete pull box shall be flush with adjacent surfaced areas and be approximately 1 inch above seeded or sodded areas. The unit bid cost for this work shall include a 4 inch deep by 12 inch wide concrete apron when not located in a paved area, or repair to damaged pavement.

(e) A ground rod shall be placed inside each concrete pull box. The top of the ground rod shall be 1 foot above the top of the stone drain and exothermic welded to the ground wire(s).

902.5.8 Adjustment of Existing Concrete Pull Boxes. This work shall consist of adjusting an existing concrete pull box to finish grade. The existing cast iron frame(s) and cover(s) shall be removed in such a manner so as not to damage the concrete walls of the pull box below the existing frame(s). A concrete collar shall be formed and placed atop the existing pull box walls in a neat and workmanlike manner using Class B concrete in accordance with Sec 501, or concrete of a commercial mixture as approved by the Engineer. Concrete shall be placed, finished and cured in accordance with the applicable provisions of Sec 703. Unless otherwise approved by the Engineer, the concrete collar shall be tied to the existing pull box walls with #3 tie bars equally spaced as directed by the Engineer. The existing cast iron frame(s) and cover(s) shall be placed in the new concrete collar and shall be flush with adjacent surfaced areas and approximately 1 inch above seeded or sodded areas. Any portion of the existing pull box that is damaged shall be repaired or replaced with new materials at the Contractor's expense. The unit bid cost for this
work shall include a 4 inch deep by 12 inch wide concrete apron when not located in a paved area, or repair to damaged pavement.

902.5.9 Installation of Conduit. It shall be the Contractor’s option to install traffic signal conduit by the directional boring method, conventional trenching method, or conventional pushing method. The size of conduit to be installed shall be as specified in the contract or noted on the plans. The top surface of underground conduit shall be placed a minimum of 30 inches below finish grade and at a minimum of 18 inches below subgrade unless; otherwise indicated herein, shown on the plans, or approved by the Engineer. A change in direction of conduit shall be accomplished by bending the conduit uniformly to a radius which will fit the location or by using standard bends or elbows, with approval of the Engineer. All conduit and fittings shall be free from burrs and irregularities. All conduits shall be cleaned and swabbed before cables are installed. All fittings shall be tightly connected to the conduit. Open ends of conduit placed for future use shall be capped or plugged. Conduit placed for future interconnect, current fiber optic cable interconnect, or future traffic signal cable shall contain a blue jacketed No. 12 AWG solid copper trace and pull wire that is labeled as described in Sec 902.5.17. All costs for the pull wire shall be considered incidental with no separate payment being made. Payment for furnishing and installing conduit will be based upon the unit price bid for the size of conduit and quantities shown on the Itemized Bid, regardless of the installation method chosen by the Contractor.

902.5.9.1 Conduit in Trench. All trenches shall be excavated to the width and depth necessary for conduit installation. No dirt or debris shall be placed in the street nor shall it be placed on the sidewalk to leave less than 3 feet of walkway available. Materials which might cause mechanical damage to the conduit shall not be used for backfilling within an elevation of 6 inches below or above the conduit. The bottom of the trench shall be free of such materials before the conduit is placed. No conduit shall be placed without approval of the trench by the Engineer. All trenches shall be backfilled as soon as practicable. Backfill material shall be deposited in the trench in layers not exceeding 6 inches in depth. Each layer shall be compacted to the approximate density of the adjacent material before the next layer is placed. Where excavation is made in parkways, tree lawns or other turfed areas, topsoil shall be replaced as nearly as practicable to its former condition with seeding and sodding operations, unless otherwise indicated on the plans or contract documents. Where excavation is made across planting beds, stabilized shoulders, or rocked areas, these materials shall be replaced in kind to restore the areas to their former condition. Where excavation is made in proposed sidewalk, roadway, or shoulder areas, or wherever prevention of backfill settlement is considered essential by the Engineer, the trench shall be backfilled with granular fill from a level of 6 inches above the conduit to finish subgrade. Granular backfill shall consist of 3/4 inch minus crusher-run limestone (Designation MSD 3 Backfill). The entire area involved in trenching operations shall be left in a neat and presentable condition. All restoration costs shall be included in the unit price bid for the size of conduit installed, unless otherwise provided for as a separate pay item. All couplings, connectors and elbows necessary for installing conduit in trench shall also be included in the unit price bid for the size of conduit installed. Red burial tape imprinted with “CAUTION – BURIED CABLE BELOW” shall be installed in all trenches at approximately one-third to one-half of the depth of trench.

902.5.9.2 Pushed Conduit. All pushed conduit shall be installed without disturbing the existing surface, unless otherwise approved by the Engineer. Pushed conduit may be placed by jacking, pushing, boring, or other approved means. Push pits and receiving pits shall be backfilled in the same manner as described for "Conduit in Trench" in Sec 902.5.9.1. If any existing pavement, shoulders, sidewalk, or curbing is removed and replaced for installing pushed conduit, all restoration costs shall be included in the unit price bid for the size of conduit installed, unless otherwise provided for as a separate pay item. If concrete sidewalk or pavement is broken or removed, full slab replacement will be required. All couplings, connectors and elbows necessary for installing pushed conduit shall also be included in the unit price bid for the size of conduit installed.

902.5.9.3 Directional Boring. Directional boring shall be used to install high-density polyethylene (HDPE) conduit and limit the disturbance of the existing ground surface. The boring machine shall be set up at locations which will minimize damage to existing improvements. An output signal shall be supplied inside the housing of the boring machine drill bit. The output signal shall always be constant to allow a person to track the location of the drill bit.
The directional head shall be capable of accepting a variety of cutting bits for varied soil conditions. The operators of the boring machine shall check the bore path and make the necessary corrections to stay along the intended alignment. The boring machine shall be equipped with either water or a drilling fluid to facilitate drilling operations and the lubrication of the HDPE duct during pull-back. The Contractor shall make the necessary provisions to keep water and soil out of the new HDPE duct. Agents may be added to the water or drilling fluid to assist in holding the tunnel open during duct pull-back. If any existing pavement, shoulders, sidewalk, or curbing is removed and replaced to bore conduit, all restoration costs shall be included in the unit price bid for the size of conduit installed, unless otherwise provided for as a separate pay item. If concrete sidewalk or pavement is broken or removed, full slab replacement will be required.

902.5.9.4 Conduit in Doweled-On Concrete Median. When 3/4 inch conduit in a doweled-on concrete median is specified for detector loop installations, the conduit shall be installed in conformance with the standard detail drawings. Most of the conduit shall be laid on the surface of the pavement prior to construction of the concrete median. One end of the 3/4 inch conduit shall be connected to a pull box in the proposed median. The other end of the conduit shall be installed by embedding a minimum 12 inches of conduit in the pavement below the edge of the proposed median. After constructing the median and removing concrete forms, cut the conduit flush with the face of the median below finish grade and remove the excess conduit. The open end of the conduit located below finish grade at the face of the median shall be cleaned and temporarily sealed with "duct" seal or an equivalent removable sealant.

902.5.9.5 Conduit on Wood Pole. If conduit on wood pole is specified, the conduit shall be PVC or rigid steel as required and installed in a straight, neat, and workmanlike manner. The conduit shall be supported by conduit clamps at a maximum spacing of 4 feet. Conduit extended to near the top of a wood pole shall be capped with an approved entrance head fitting and positioned to allow for formation of a drip loop in the entering cable. Conduit extended to the base of a wood pole for either 1 or 2 detector loops shall include a 6 inch x 6 inch x 4 inch weatherproof PVC junction box with a screw down cover. This box shall be mounted to the wood pole approximately 18 inches above finish grade. All couplings, connectors, elbows, tees, hubs, clamps and access fittings necessary for installing conduit on a wood pole, including the above referenced PVC junction box with a screw down cover, shall be included in the unit price bid for the size of PVC conduit on a wood pole.

902.5.9.6 Conduit Repair. The Contractor shall locate broken conduit (PVC, steel, or HDPE), excavate, remove existing cable, repair/replace conduit, reinstall/replace cable, backfill and restore area. Payment for this work will be as specified in the contract or noted on the plans. If existing pavement, shoulders, sidewalk, or curbing is removed and replaced for a conduit repair, the cost for this work shall be provided for as a separate pay item(s). If concrete sidewalk or pavement is broken or removed, full slab replacement will be required.

902.5.10 Connecting Conduit to Existing Pull Boxes. This work shall consist of connecting new conduit to an existing pull box as indicated on the plans. An opening for the new conduit shall be drilled through the wall of the existing concrete pull box at a minimum of 18 inches below finish grade. The new conduit shall be properly fitted in place and extend a minimum of 2 inches from the inner face of the pull box. After the conduit is in place, the opening around the conduit shall be sealed watertight in an approved manner. Any portion of the existing pull box that is damaged shall be repaired or replaced with new materials, at the Contractor’s expense.

902.5.11 Installation of Signal Posts and Mast Arm Assemblies. Each steel mast arm pole and aluminum post with a square pedestal base shall be securely fastened to a concrete base with anchor bolts.

(a) Aluminum posts with square pedestal bases shall be erected vertically without the use of leveling nuts. Each square pedestal base shall be positioned so the handhole cover is located adjacent to a sidewalk or walkway where such paved areas exist.

(b) Steel poles for cantilever mast arms shall be installed plumb by adjustment of leveling nuts. Poles for cantilever mast arms may be raked only when approved or directed by the Engineer.
(c) All signal posts and mast arm assemblies shall be grounded by a No. 6 AWG, 7 strand, bare copper wire from a grounding lug inside each signal post or mast arm assembly to a common ground provided by a ground rod in the nearest pull box.

902.5.12 Installation of Wood Poles, Guys and Span Wire Assemblies. Wood poles, guys and span wire assemblies shall be installed as shown on the plans and in accordance with the standard detail drawings.

(a) Wood poles shall be Class II or better and installed a minimum of 7 feet below finish grade. The depth shall be increased 1 foot for each 5 foot increase in length above 35 feet.

(b) Upon installation of guy wires, a yellow plastic guy wire guard, as specified in Sec 902.4.4(a.3), shall be installed on each down guy.

(c) Standoff guys, when specified, shall be installed with the standoff pipe a minimum of 10 feet above finish grade. The standoff pipe shall be of enough length to allow positioning of the guy anchor at the location shown on the plans or at a location spotted in the field by the Engineer.

(d) When a wood pole in concrete embedment is required, a 3 foot diameter hole shall be drilled. Loose material at the bottom of the hole shall be either removed or compacted to the approximate density of the adjacent material. A masonry block shall be placed at the bottom of the hole upon which the pole shall be set. Concrete embedment shall be poured around the pole up to a level 24 inches below finish grade. The concrete shall be Class B concrete in accordance with Sec 501, or concrete of a commercial mixture as approved by the Engineer. Concrete embedment around the wood pole shall be cured at least 72 hours prior to the wood pole being subjected to concentrated loads. The remaining 24 inches below finish grade shall be backfilled and compacted in layers not exceeding 6 inches in depth.

(e) Guy wires, clamps, guards, standoff pipe, fittings, anchors, rods, concrete embedment and other items used for the installation and support of wood poles shall be included in the unit price bid for Class II wood poles.

(f) The span wire assembly shall be installed at enough height to provide a minimum clearance of 16' and a maximum clearance of 19' to each signal head assembly.

(g) Span wire, tether wire, clamps, cable straps, insulators and other items used for installation of a span wire assembly shall be included in the lump sum price bid for span wire assembly.

902.5.13 Installation of Power Supply Assemblies. Each power supply assembly shall be installed in accordance with MoDOT’s standard drawing 902.15k, unless otherwise shown on the plans. Any charges imposed by the local utility company for connection, disconnection, or relocation of electrical service shall be borne by the Contractor and included in the contract unit price bid for each power supply assembly. They shall not be installed until the local utility company has determined its source and the Engineer has determined its location.

902.5.13.1 Type 1 (Pole) Overhead Service. Each power supply mounted on a pole shall be installed in accordance with the requirements of the local utility company, the governing municipality who issues electrical permits, and the plans. The bottom of the meter socket glass shall be a maximum of 5-1/2 feet above finish grade, except over walkways where the bottom of the meter socket shall be 6-1/2 feet above the walkway.

902.5.13.2 Type 2 & 3 (Pedestal) Underground Service. Each power supply mounted on a concrete base shall be installed in accordance with the requirements of the local utility company, the governing municipality who issues electrical permits, and the plans. The top of the embedded concrete base shall be constructed to the elevations indicated on the plans or contract documents. The bottom of the meter socket glass shall be a maximum of 5-1/2
902.5.14 Installation of Signal Heads. All signal head assemblies shall be constructed and installed in accordance with this specification and the standard detail drawings, unless otherwise approved by the Engineer.

(a) The vertical clearance to the bottom of an overhead signal head assembly shall be at least 16 feet but not more than 19 feet above the roadway.

(b) Within the limits of normal vertical clearance, signal heads shall have a horizontal clearance of not less than 2 feet from the face of a vertical curb or from the outside edge of a shoulder. In a median, the above 2 foot minimum clearance should be obtained where possible.

(c) Each signal head installation on a mast arm, oriented as shown on the plans, shall be by one of the following methods:

(1) Each signal head installed vertically on a mast arm shall be mounted using a bracket described in Sec 902.4.1.2 (f) with an in-line terminal compartment. A hole for wiring access shall be field drilled in the mast arm for each head mounting bracket, the location of which shall be determined by the Engineer. The head mount bracket shall be banded onto the mast arm using stainless-steel strapping or cables. The area between the bracket and mast arm shall be sealed with a silicon caulk. An 1/8 inch drain hole shall be drilled into each terminal compartment.

(2) Each signal head installed horizontally on a mast arm shall be assembled using a bracket described in Sec 902.4.1.2 (f) with one terminal compartment. This signal head assembly shall be configured and mounted in accordance with the standard detail drawings. A hole for wiring access shall be field drilled in the mast arm to the mounting bracket providing access to the terminal compartment. The location of the hole shall be determined by the Engineer.

(d) Signal head fittings, brackets, terminal compartments and hardware shall be securely tightened and fastened in position. When banding is used to attach a signal head, a 5/8 inch by .030 inch stainless steel band shall be used. Prior to placing signal heads in operation, all signal faces shall be covered or turned away from approaching traffic.

(e) When ready for operation, the signal heads shall be securely fastened in position and face approaching traffic. Signal faces shall be aimed laterally at the approximate center of the lane or lanes they control, unless otherwise directed by the Engineer. They shall be aimed, when not optically limited, at a point back of the stop line a distance corresponding to the following requirements:

<table>
<thead>
<tr>
<th>Approach Speed (M.P.H.)</th>
<th>Distance (Feet)</th>
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<tbody>
<tr>
<td>30</td>
<td>160</td>
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<tr>
<td>40</td>
<td>240</td>
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<tr>
<td>50</td>
<td>330</td>
</tr>
</tbody>
</table>

902.5.15 Installation of Controller Cabinets. Each controller cabinet shall be installed in accordance with MoDOT’s standard drawing 902.10Q, or its latest revision, unless otherwise shown on the plans or directed by the Engineer. The controller cabinet size shall be a NEMA Type R with the minimum dimensions of 44” (W) x 77” (H) x 25.5” (D). The cabinet shall have three shelves and will be mounted onto a new type E concrete bases, except as otherwise directed by the design plans such as when reusing existing bases and matching existing bolt patterns. The bottom shelf will have a slide out laptop holding platform attached underneath.
(a) Each ground mount cabinet location shall be already existing as shown on the plans or as located in the field by the Engineer or authorized representative. The anchor bolt’s spacing and dimensions shall be as specified by the manufacturer of each cabinet. After the controller cabinet is bolted to the existing concrete base, the outside perimeter of the cabinet shall be sealed with 100% silicone caulk.

(b) Each controller cabinet mounted on a wood pole shall be bolted to two 4 x 4 inch pressure treated wood cross members using four 5/8-inch diameter carriage bolts. One 5/8-inch diameter hex head bolt shall be used to mount each cross member to the wood pole. Each bolt shall be corrosion resistant and secured with a corrosion resistant hex nut and washer. Each cabinet shall be mounted so that the main door lock is 4 feet above the concrete pad.

(c) The cost of installing the cabinet will be inclusive of the bid item Traffic Signal Controller Assembly as per Plans.

902.5.16 Installation of Detector Loops.

(a) Detector loops will be marked on the pavement by the Engineer or authorized representative after receiving a minimum 24 hours’ notice from the Contractor in accordance with Sec 902.5.2.

(b) Prior to sawing the detector loops, traffic control protection shall be provided to detour traffic around the work area meeting the minimum requirements of the latest revision of the Manual on Uniform Traffic Control Devices (MUTCD).

(c) Slots for the installation of detector loop cable shall be sawed in the pavement with a power concrete saw. Newly constructed concrete pavement shall not be sawed for 72 hours, unless directed otherwise by the Engineer. All sawed slots shall be thoroughly cleaned using compressed air to blow out dirt and all free water.

(d) Each sawed slot for detector loops shall be 3/8 inch wide and 2 inches deep regardless of the number of detector loop cables to be installed. The intersection of slots shall overlap enough to maintain full 2 inch depth. Where slots intersect, a 1-1/4 inch diameter hole shall be drilled to full 2 inch depth. The practice of sawing diagonal cuts across the corners of a loop shall not be permitted.

(e) One slot for loop leads, 3/8 inch wide and 2 inches deep, shall be sawed from each detector loop to a separate 3/4 inch conduit. The lateral distance between each of the loop lead slots shall be 1 foot minimum. The lateral distance between transverse pavement joints and the nearest loop lead slot shall also be 1 foot minimum.

(f) The 3/4 inch conduits for loop leads shall be located near the edge of pavement or near the face of a curb, median or island. These conduits shall be installed in accordance with the standard detail drawings.

(g) After 3/4 inch conduit is installed for detector loop leads, the face of each median, island or curb above each conduit shall be marked and scored with a concrete saw. If the pavement is ever overlaid, this scoring of concrete faces will provide a permanent mark to aid in locating the end of each 3/4 inch conduit in the event the detector loops must ever be replaced.

(h) Detector loop cable shall be pushed into the sawed slots with blunt tools without damaging the conductor’s insulation or jacket. The number of loop turns required shall be as shown on the plans. The loop leads shall be pushed into the slot leading to a 3/4 inch conduit and pulled through the conduit to a pull box for connection to a shielded lead-in cable. The detector loop wire shall be continuous without splice.

(i) Detector loop leads shall be connected to shielded lead-in cable in a pull box as shown on the plans and in accordance with Sec 902.5.17(d).
(j) Prior to pouring the detector loop sealant, each 3/4 inch conduit opening shall be sealed with "duct" seal or an equivalent removable sealant. This "duct" seal will keep the detector loop sealant from running into the 3/4-inch conduit to prevent future maintenance problems if a loop must ever be replaced.

(k) Prior to pouring the detector loop sealant, wedges shall be inserted into the sawed slots on 3 foot centers to prevent the air space in the tube jacket from causing the detector loop cable to float in the slot when the loop sealant is poured. The wedges shall be 1 inch sections of plastic tubing which are folded before insertion.

(l) After the detector loop cable is connected to a shielded lead-in cable and before the slot is sealed, the resistance of the detector loop and lead-in cable to ground shall be checked. After a satisfactory test, which shows resistance of not less than 10 mega ohms, the slot shall be sealed with detector loop sealant.

(m) The placement of the detector loop sealant shall be in strict accordance with the directions of the manufacturer regarding the preparation of the sealant mix, its application, and the proper curing procedures subsequent to reopening of the road to traffic.

(n) Where a 3/4 inch conduit joins a loop lead slot, loop sealant shall be poured into the space between the pavement and the 3/4 inch conduit causing the conduit to be bonded to the pavement.

(o) Where future detector loops are to be installed, 3/4 inch conduit shall be installed for the future detector loop leads. The ends of the 3/4 inch conduit shall be sealed with "duct" seal or an equivalent removable sealant. This will keep dirt and debris out of the unused 3/4 inch conduit. The face of each median, island or curb above each 3/4 inch conduit shall be marked and scored with a concrete saw to aid in the future locating of each conduit.

902.5.17 Installation of Wiring. Circuits shall be properly labeled in the controller cabinet and all pull boxes by means of round aluminum identification tags with a minimum thickness of 0.1 mils, attached to the cables with a copper wire. Information stamped on the tags shall identify equipment served by the conductor cable in accordance with designations used on the plans.

(a) All signal cable runs shall be continuous without splice from the terminal block of each signal head to a terminal strip in the controller cabinet, or from the terminal block of one signal head to the terminal block of another signal head when a jumper is shown on the plans or directed by the Engineer. All conductor cable combinations to signal heads shall be as shown on the plans or as directed by the Engineer.

(b) Power cable runs shall be continuous without splice from the power supply circuit breaker panel to the traffic signal controller cabinet. Energized power cables shall be black and terminated on circuit breakers inside the power supply circuit breaker panel and the controller cabinet. The neutral cable shall be white and terminated on the ground bus bar inside the power supply circuit breaker panel and the controller cabinet.

(c) Pedestrian push button detectors and vehicle detector loops shall be connected to the controller by separate No. 14 AWG, 2 conductor, shielded lead-in cables which shall be continuous without splice.

(d) Detector loop leads shall be connected in series to shielded lead-in cable. These connections shall be made in a pull box near the loops as shown on the plans. All connections between detector loop leads and shielded lead-in cable shall be made by using a 3M Direct Bury Splice Kit #DBY or compatible connection approved by the Engineer. Shielded lead-in cable runs shall be continuous without splice from a pull box near the loops to the controller cabinet. If more than one shielded lead-in cable is wired to the same loop detector channel, the lead-in cables shall be wired in series in the controller cabinet, and not connected in series in a pull box.
(e) For vehicle detection cameras with an internal processor, the power/communication cable may be connected to the camera's Machine Vision Processor (MVP) cable in the mast arm pole handhole above the mast arm base.

(f) All signal post shall be grounded by using a No. 6 AWG stranded bare copper wire from the ground lug inside the post to an 8 foot minimum length ground rod installed inside the nearest pull box or junction box. The bonding between the grounding conductor and grounding electrode shall be by exothermic welding.

(g) The controller shall be grounded by connecting a No. 6 AWG stranded bare copper wire from the ground bus terminal inside the cabinet to an 8 foot minimum length ground rod installed inside the nearest pull box or junction box. The bonding between the grounding conductor and grounding electrode shall be by exothermic welding.

(h) All wiring connections shall be securely tightened. Copper barrel lugs shall be used for all field connections inside the controller cabinet. Insulated crimped-on connectors of an approved type shall be used for all other terminal connections. All spare field wires shall be capped with closed end insulated terminals of an approved type.

(i) Signal interconnect cable shall be continuous without splice between the terminal strips of interconnected controllers, except when the distance between controllers exceeds 2,000 feet or when otherwise approved by the Engineer. This exception is not applicable to fiber optic cable installations which shall be continuous without splice between controllers.

(j) Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, yellow to yellow, green to green, and white to neutral. The power cables shall be color coded so that black connects to AC (+) and white to neutral. The cable for 7-wire interconnection of one or more controllers to a master controller shall maintain the following color code:

<table>
<thead>
<tr>
<th>7 Conductor Interconnect</th>
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<tbody>
<tr>
<td>Reset 1</td>
</tr>
<tr>
<td>Reset 2</td>
</tr>
<tr>
<td>Reset 3</td>
</tr>
<tr>
<td>Cycle 2</td>
</tr>
<tr>
<td>Cycle 3</td>
</tr>
<tr>
<td>Flash</td>
</tr>
<tr>
<td>Neutral</td>
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(k) At an existing traffic signal installation, where new/existing cable is to be installed/relocated into an existing conduit, all existing cable and wire not used shall be removed from the conduit. All costs for relocating/removing existing cable and wire shall be considered incidental with no separate payment being made.

(l) When existing conduit needs to be repaired/replaced, the existing cable needs to be removed and then reinstalled/replaced through the repaired/new conduit, or as directed by the Engineer.

(m) When existing conduit is to be intercepted with a new pull box, existing cable shall be removed from the intercepted location and replaced after the pull box is installed and conduits are properly angled within the pull box.

902.5.18 Fiber Optic Cable. The fiber optic cable installation shall be supervised by trained and experienced personnel. The Contractor shall, upon request of the Engineer, provide documentation of qualifications and
experience for fiber optic installations. The Engineer shall determine if the Contractor is qualified to perform this work.

902.5.19 Removal of Existing Pull Boxes. Unless otherwise noted on the drawings, existing concrete pull boxes to be removed shall be removed 12 inches below finish grade and backfilled to finish grade with material of the same grade and type as the adjacent surface. Preformed pull boxes are to be hauled away unless otherwise approved by the Engineer for use by either the Contractor and/or the County.

902.5.20 Removal of Existing Concrete Bases. Unless otherwise noted on the drawings, existing bases to be removed shall be removed 12 inches below finish grade and backfilled to finish grade with material of the same grade and type as the adjacent surface.

902.5.21 Relocation or Removal of Existing Signal Equipment.

(a) Traffic signal equipment shall be relocated or removed only with the approval of the Engineer. The Contractor shall exercise care in its dismantling operations so as not to damage traffic signal equipment to be relocated or removed. All traffic signal equipment to be relocated or removed shall be assumed to be in good condition unless indicated otherwise by a previous inspection by the Engineer. It will be the Contractor's responsibility to request and set up an inspection appointment with the Engineer prior to the relocation or removal of equipment to determine the extent of any damage to equipment.

(b) County or maintained traffic signal equipment to be removed shall be delivered to the Highway Department Facility designated by the Engineer. Equipment maintained by another municipality shall be delivered to the location they designate.

(c) State maintained traffic signal equipment to be removed shall be delivered to the Missouri Highway and Transportation Department Signal Shop, 2309 Barrett Station Road, Ballwin, Missouri, 63021, Phone (314) 340-4100.

902.5.22 Modification of Existing Traffic Signals.

(a) Existing traffic signals, including detectors and interconnect, shall remain in effective operation, except during the time when the traffic signal must be shut down for alterations or changeover to new traffic signal equipment. The Contractor shall notify the Engineer 48 hours in advance of any traffic signal shutdown. During the time traffic signals are turned off, "Stop" signs shall always be installed and maintained by the Contractor adjacent to each lane approaching the intersection as directed by the Engineer. The length of time existing traffic signal(s) is turned off for alterations or changeover to new equipment shall be held to a minimum. The times of day and days of week existing traffic signals may be shutdown shall be as specified on the plans or as directed by the Engineer.

(b) Any portion of an existing traffic signal installation or system that is modified shall be maintained by the Contractor in accordance with Sec 902.5.23. In addition, any portion of an existing traffic signal installation that is damaged by construction operations shall be repaired at the Contractor's expense, including portions of an existing signal not modified by the Contractor.

902.5.23 Signal Maintenance During Construction. This maintenance shall include all repairs and/or adjustments to signal materials and equipment, furnished and installed by the Contractor, which the Engineer has determined are necessary due to malfunctions, construction operations, vandalism, knockdowns, and/or acts of God. The Contractor shall be responsible for obtaining recovery of all damages, including replacement of any signal equipment until its acceptance. In any event, if in the opinion of the Engineer and at their sole discretion, immediate repairs and/or adjustments are determined to be necessary to provide for the safe and efficient movement of traffic, and the Contractor is not capable of or willing to making such repairs and/or adjustments to the satisfaction
of the Engineer, the Engineer will order County personnel or other qualified Contractors, Engineers or technicians to make immediate repairs and/or adjustments. The Contractor will be charged the cost of the work performed as determined in Sec 108.9. This cost will be deducted from monies due the Contractor on their next pay request. The work performed by County or other qualified personnel will in no way jeopardize any part of the guarantees as specified in Sec 902.4.1.3.1.2 (g), Sec 902.4.8.3.1.2.1, and Sec 902.10.

902.5.23.1 Daily Cleanup During Construction. All dirt, trash, and other related construction debris shall be removed from the right-of-way before the end of the work day. If in the opinion of the Engineer, the construction site is unclean and presents a hazard to vehicular and/or pedestrian traffic, the Engineer may order County personnel to provide cleanup efforts with the entire cost of the work performed by the County to be deducted from monies due to the Contractor from forthcoming payments.

902.5.23.2 Traffic Handling During Construction. Signal construction should be accomplished with as little interruption to traffic as possible. When interruptions to traffic become inevitable, it will be the Contractor's responsibility to furnish, place, and maintain, standard traffic control devices in accordance with the latest revisions of the Manual on Uniform Traffic Control Devices (MUTCD) or as directed by the Engineer. All costs for traffic handling shall be considered incidental with no direct payment being made, unless otherwise provided for as a separate pay item. The traveled portion of the roadway must be clear of all equipment and materials from 3:30 PM to 9:00 AM, unless otherwise approved by the Engineer.

902.5.24 Restoration. All pavement, shoulders, sidewalk, curbing, embankments, planting beds, and turf areas disturbed by construction shall be restored as directed by the Engineer. All costs for restoration shall be considered incidental with no direct payment being made, unless otherwise provided for as a separate pay item.

902.5.25 Painting and Final Clean Up.

(a) All existing metal parts to be reused as part of the modification of an existing signal installation shall be repainted or touched up in a manner satisfactory to the Engineer.

(b) All signal equipment shall be cleaned in such a manner to be free of grease, oil and excess dust. The lens and reflector of each signal indication shall be wiped clean. All debris or scrap material shall be removed from the inside of each pull box, handhole, signal head and controller cabinet. The final cleaning up of the right-of-way shall meet the requirements of all applicable contract documents.

902.6 Temporary Traffic Signals.

(a) When specified, temporary traffic signals shall be provided for the handling of traffic during construction. The operation period of temporary traffic signals shall be held to a minimum. Unless otherwise provided, a plan of each proposed temporary signal shall be submitted to the Engineer for approval prior to the installation of the signal. When temporary traffic signals are installed, the signal heads shall be covered until the installation is placed in operation. Temporary traffic signals, when required, shall be kept in effective and continuous operation except for shutdowns required for changeover to new equipment.

(b) If an existing traffic signal is to be replaced with a temporary traffic signal installation, the existing traffic signal shall not be taken out of operation until such time as approval is received from the Engineer for a changeover. The downtime for this changeover shall be kept to an absolute minimum. Existing traffic signals taken out of operation shall be covered until removed.

(c) Unless otherwise noted, the Contractor shall be required to furnish and install the necessary materials and equipment for the operation of temporary traffic signals. The maintenance of temporary traffic signals shall be in accordance with Sec 902.5.23. The Contractor shall remove each temporary traffic signal installation when its use is no longer deemed necessary by the Engineer. No direct payment will be made for the removal of the
temporary signal; and the temporary signal equipment will remain the property of the Contractor. The Contractor shall comply with all existing electrical codes, ordinances and regulations of Saint Charles County and municipalities involved. The Contractor shall also comply with the requirements of the local utility company to obtain power for the operation of each temporary traffic signal installation.

902.7 Signal Acceptance Procedures.

902.7.1 Signal Inspection. When the Contractor is certain all traffic signal equipment that was furnished and installed by the Contractor for a new or modified traffic signal installation, is operating properly, they shall make an appointment for inspection with the Engineer. After a thorough inspection of the signal equipment and installation, the Engineer may authorize the Contractor to put the signal into permanent operation. This authorization will be given if all signal equipment is working properly, or if public safety and convenience warrants the operation of the signal before all corrections have been made. If the inspection reveals signal deficiencies, the Contractor shall correct them expeditiously and within the time allowed for the completion of the project. If the signal must be put into flashing operation or completely shut down to make the necessary corrections, the Contractor must receive approval from the Engineer before this action is taken. This inspection procedure shall be repeated until all corrections have been made.

902.7.2 Signal Test Period.

(a) After all deficiencies to signal equipment furnished and installed by the Contractor have been corrected, the signal shall remain in operation for a 15 consecutive day test period. Any failure or malfunction of equipment during the test period shall be corrected by the Contractor. The signal shall then be tested for an additional 15 consecutive day period. This procedure shall be repeated until the signal equipment has operated to the Engineer’s satisfaction for 15 consecutive days. However, it should be noted that if the signal is part of a system within the project, that portion of the signal installation associated with systems operation shall not be tested until all signals in the system within the project are ready to be tested.

(b) After a signal and/or signal system that was furnished and installed by the Contractor has been satisfactorily tested for 15 consecutive days, the County will make emergency repairs and/or adjustments determined to be necessary due to malfunctions. However, prior to final acceptance, the Contractor shall still be responsible for any repairs and/or adjustments which the Engineer has determined are necessary due to construction operations, vandalism, knockdowns and/or acts of God. The Contractor shall be responsible for obtaining recovery of all damages.

902.7.3 Signal Maintenance Information. Before final acceptance of the work, the Contractor shall furnish the Engineer the following information for signal equipment furnished and installed by the Contractor.

(a) One copy each of the manufacturers' instructions for the maintenance and operation of all signal equipment, as well as their bundled software when applicable. Warranty; The Contractor shall obtain, assign and furnish to the County written manufacturer’s warranties for all electronic equipment consistent with those provided as customary trade practice.

(b) Four drawings of controller wiring diagrams for each signal installation and/or signal system, and a DVD computer disc or removable thumb drive containing this information stored in a *.DWG format compatible with AutoCAD software version 2018 or later. The controller wiring diagrams shall be plotted on neat and clean 24 x 36 inch sheet(s). The diagrams shall be easy to read and match the cabinet wiring. All controller wiring diagrams shall be double referenced.

902.7.4 Final Acceptance. Upon presumptive completion of the entire project, including the completion of the signal test period and corrections to all deficiencies, the Engineer will make a final inspection. If all construction contemplated by the contract has been completed to the Engineer’s satisfaction, that inspection will constitute the
final inspection. The Engineer will notify the Contractor in writing of this acceptance, indicating the of the date of the final inspection

902.8 Method of Measurement.

(a) Measurement of conduit will be made to the nearest linear foot as indicated on the plans. Contract quantities will be used in final payment except as provided in Sec 902.8(c).

(b) Measurement of cable and wire will be made to the nearest 10 linear feet as indicated on the plans. Contract quantities will be used in final payment except as provided in Sec 902.8(c).

(c) Field measurements will be made only for authorized changes during construction, or where appreciable errors are found in the contract quantity. Each revision or correction will be computed and added to or deducted from the contract quantity.

902.9 Basis of Payment. Accepted traffic signals will be paid for at the unit bid price for each of the pay items included in the contract. No separate payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract and not specified to be included in a unit bid item.

902.10 Contractor Guarantee.

(a) The Contractor shall guarantee satisfactory in-service operation of all Contractor supplied and installed electrical equipment and related components for a period of 1 year from date of the final acceptance of the entire project.

(b) Upon notice from the Engineer of unsatisfactory in-service operation of Contractor supplied and installed electrical equipment and/or related components, the Contractor shall immediately begin the correction, repair or replacement process. This notice from the Engineer may be given anytime within the guarantee period specified in Sec 902.10(a). The Contractor shall be responsible for having the defective work, materials or equipment corrected, repaired or replaced within 3 working days after notification by the Engineer. Unless otherwise approved by the Engineer, if defective materials or equipment cannot be repaired or replaced within this time, the Contractor shall perform their temporary replacement with similar materials or equipment. In any event, if in the opinion of the Engineer and at their sole discretion, immediate repairs and/or adjustments are determined to be necessary to provide for the safe and efficient movement of traffic, and the Contractor is not capable of making such repairs and/or adjustments to the satisfaction of the Engineer; the Engineer will order County personnel, other Contractors, or other qualified Engineers and/or technicians to make immediate repairs and/or adjustments. The Contractor will be charged the cost of the work performed, as determined by Sec 108.9 by County or other qualified personnel (if paid by the County). The Contractor will be charged for all labor (including benefits and indirect overhead), materials, and equipment furnished by the County in making immediate repairs and/or adjustments. There will be a 3 hour minimum call-up time for overtime. The work performed by County or other qualified personnel will in no way jeopardize any part of this Contractor guarantee or any manufacturer guarantee contained herein.

902.11 Warranty Certificates. The Contractor shall provide warranty certifications to the County Engineer for the Video Vehicle Detection System, Traffic Signal Battery Backup System, Traffic Actuated Controller Assembly and all its major components.
SECTION 903
ROADWAY SIGNING

903.1 Description. This work shall consist of furnishing and installing roadway signs as shown on the plans. All signs shall be installed according to the minimum requirements for the roadway classification affected as indicated by the most recent revision of the Manual on Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration.

903.2 Materials. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
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<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
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<tr>
<td>Highway Sign Material</td>
<td>1042</td>
</tr>
<tr>
<td>Square Steel Perforated Posts</td>
<td>1044.4</td>
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<tr>
<td>Delineator Posts</td>
<td>1044</td>
</tr>
<tr>
<td>Low-Carbon Steel Bolts, Nuts and Washers</td>
<td>1080</td>
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<tr>
<td>Structural Carbon Steel</td>
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<td>Structural Low Alloy Steel</td>
<td>1080</td>
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<tr>
<td>Low-Carbon Steel Anchor Bolts</td>
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<tr>
<td>High-Strength Bolts, Nuts and Washers</td>
<td>1080</td>
</tr>
<tr>
<td>Galvanized Coating of Structural Steel, Tubular Steel Sign Supports, Sign Trusses and Appurtenances</td>
<td>1081</td>
</tr>
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</table>

903.2.1 Sign Posts and Tubular Steel Sign Supports.

<table>
<thead>
<tr>
<th>Item</th>
<th>Section/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Posts</td>
<td>ASTM A 53, Grade B, or ASTM A 500, Grade B</td>
</tr>
<tr>
<td>Galvanizing of Steel Pipe Posts</td>
<td>ASTM A 53</td>
</tr>
</tbody>
</table>

903.2.2 Hardware. Bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with Sec 1081. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. For high strength bolts, the Contractor shall furnish to the Engineer a copy of the manufacturer's inspection test report for each production lot or shipping lot furnished, and shall certify the bolts furnished are in accordance with Sec 1080.

903.2.3 Sheeting. All signs shall be fabricated with High Intensity Prismatic (HIP) reflective sheeting meeting or exceeding ASTM D4956 Type IV, and AASHTO M268 Type B specifications.

903.2.3.1 Signs shall be screen printed unless otherwise approved. Otherwise, they must meet or exceed Sec 1042 requirements unless shown differently on the plans.

903.2.4 Concrete. Concrete shall be of the class specified in the contract. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Sec 501 for the specific class specified. Concrete shall be placed, finished and cured in accordance with Sec 703.

903.2.5 Equipment and Material. Equipment and material shall be of new stock unless the contract provides for relocation of existing units or use of units furnished by others. New equipment and material shall meet the approval of the Engineer.

903.3 Construction Requirements.
903.3.1 Posts for Ground Mounted Signs. All permanent roadway signs shall be mounted onto a 2 inch by 2 inch 12 gauge perforated square galvanized steel tubing post, unless specifically shown on the plans or standard specifications to be mounted using a specific method. These posts shall be bolted to a 2.5 inch by 2.5 inch 12 gauge perforated square galvanized steel foundation tube extending at least 36 inches below the foundation top. Both post types shall comply with Sec 1044.4. This includes relocated signs and their final mounting location shall be on new or undamaged post.

903.3.1.1 Post Lengths. The Contractor shall be responsible for determining post lengths to provide the vertical clearance required by the MUTCD according to the sign type and size. Field cutting of posts will be permitted.

903.3.1.2 Post Alignment. Sign posts shall be vertical. Any post bent or otherwise damaged to the extent that the post is considered unfit for use shall be removed and replaced with an acceptable post at the Contractor's expense.

903.3.1.3 Perforated Square Steel Tube Posts. Perforated square steel tube posts shall be installed at locations shown on the plans. Exposed steel areas and damaged galvanizing shall be repaired in accordance with Sec 1081.

903.3.1.4 Pipe Posts. Pipe posts shall be fabricated as shown on the plans and shall be hot-dip galvanized after fabrication. Welds shall be of full section and sound throughout. Posts with dimensional defects and structural discontinuities will be rejected. All welds shall be cleaned before galvanizing. Exposed steel areas and damaged galvanizing shall be repaired in accordance with Sec 1081. Friction caps for pipe posts shall be of the dimensions shown on the plans and may be galvanized steel or aluminum alloy.

903.3.1.5 Certification. The Contractor shall furnish to the Engineer three copies of the fabricator’s certification that the material supplied is in accordance with the County requirements specified.

903.3.2 Footings for Posts. All signs not shown on the plans to be specifically mounted using a specific type of post shall be embedded according to Sec 903.3.1.

903.3.2.1 Embedded Installations. Class B or B-1 concrete, or concrete of a commercial mixture meeting the requirements of Sec 501 shall be used for the footings for embedded-type sign posts, except as otherwise allowed herein. Posts shall be supported in proper position until the concrete or other approved material has set. Tops of footings shall be finished flush with the slope of the ground. Footings shall be visually inspected for acceptance by the Engineer. Footings shall be cylindrical in shape and have a minimum 12 inch diameter by 36 inch depth, unless otherwise approved by the Engineer.

903.3.2.1.1 In lieu of the concrete material requirements in Sec 903.3.2.1, the Contractor may use a prepackaged dry commercial concrete mixture having a manufacturer’s 28-day compressive strength rating of no less than 4,000 psi for the footings of embedded-type sign posts. The concrete shall be thoroughly mixed in accordance with the manufacturer’s recommendations. Strength requirements shall meet or exceed Class B concrete as specified in Sec 501.

903.3.3 Signs

903.3.3.1 The Contractor shall notify the Engineer as soon as possible and at least one full working day in advance of any required or requested modifications to signage.

903.3.3.2 For all temporary signage see Sec 616 and other contract documents.

903.3.3.3 Existing Signs. Existing signs shall be placed as indicated on the design plan(s) or as directed by the Engineer. They shall be kept and maintained in a condition reasonably close to that in which they were found. Signs
that are shown to be removed and/or replaced that are not quantified shall be considered incidental to the project and shall not be paid for separately.

903.3.4 Permanent Signs. Permanent signs shall be placed as indicated on the design plan(s) or as directed by the Engineer.

903.3.5 Street Identifications Signs. All street identification signs shall be 0.080” minimum thick aluminum covered in high intensity prismatic green reflective sheeting with direct applied high intensity prismatic white letters. The characters of the street identification ground mounted signs must be 6 inch minimum upper-case and 4.5 inch lower-case letters, as directed by the most recent MUTCD revision. They shall be constructed as shown below:

903.3.6 Fabricator’s Certification. The Contractor shall furnish to the Engineer, prior to sign erection, the fabricator’s certification stating, “I hereby certify only material and manufacturing processes in full compliance with the St. Charles County job specification requirements were used in the fabrication of signs for Project ____________”

903.3.7 Storage of Signs. Signs delivered for use on a project shall be stored in a manner meeting the approval of the engineer. Any sign damaged, discolored or defaced during transportation, storage or erection may be rejected.

903.3.4 Permanent Sign Brackets Required For Tubular Mast Arm Mounting. All permanent sign brackets required for tubular mast arm mounting will meet or exceed the criteria in Sec 903.3.4.1 though Sec 903.3.4.5.

903.3.4.1 General. This specification shall describe a mechanical mounting system capable of mounting various traffic control signs utilizing a mast arm design. This unit shall consist of a clamp assembly, extrusion tube, support channels and hardware. The mounting system shall be capable of being mounted either vertically or horizontally and position the sign in either position. The manufacturing and production of this unit shall be of the best commercial practices, and only materials of the finest quality are to be used. Bidders must submit to the engineer for approval the complete specifications and descriptive literature pertaining to the unit they propose to furnish.

903.3.4.2 Clamp assembly. Clamp shall be constructed of cast 356 Aluminum. Serrations shall be cast in the backside of the clamp body to help prevent movement and reduce the tension needed on banding. Attachment of clamp to the mast arm shall utilize two 304 stainless steel bands and buckles. Banding shall be 3/4 inch wide and .035 inches thick. Design shall be such as to permit the use of an industry approved band tensioning device for tensioning the bands. Each clamp assembly shall include 2 sign support channels.
903.3.4.3 **Extrusion tube.** Tube shall be constructed of extruded 6063 Aluminum. Outside diameter of the tube shall be 1-7/8 inch. The tube for long street names shall be less than 48” in length. 1.5’-2’Hx10’L, 11’L & 12’L street names shall include a minimum of three clamp assemblies. 1.5’-2’Hx6’L, 7’L, 8’L & 9’L street names shall include a minimum of two clamp assemblies. Signs less than 6’ long in its longest dimension can be mounted with one clamp assembly.

903.3.4.4 **Support channels.** Channels shall be constructed of extruded 6060 Aluminum. Channels shall be supplied with all standard holes pre-drilled for mounting; installer may add additional holes as required. Each channel shall be between 8 inches and 24 inches in length, depending upon the sign height. The exact length shall be determined by the sign height with the channel being no shorter than 2/3 of its height. Quantity of channels required shall be 2 per clamp specified within the manufacture’s recommendations. Hardware required to attach sign to channels shall be supplied by the Contractor.

903.3.4.5 **Finish.** Castings shall be supplied with mill scale removed. Components shall be supplied with a natural finish.

903.4 **Method of Measurement.** Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. Where required, measurements will be made in the following manner.

903.4.1 Measurement of sign areas will be made to the nearest 1/10 square foot for each sign and to the nearest square foot for the total. The area of each sign will be that of the smallest rectangular, triangular or trapezoidal shape encompassing the sign panel.

903.5 **Basis of Payment.** Payment for signage shall be as indicated and quantified per the unit bid price on the design plan(s) and/or contract documents. Their cost shall include all incidentals including but not limited to post, mounting hardware, labor, materials and site restoration.
Division 1000

MATERIALS
SECTION 1001
GENERAL REQUIREMENTS FOR MATERIAL

1001.1 All requirements of Sec 106 will apply to material hereinafter specified. Material or processes requiring pre-qualification or pre-acceptance shall be in accordance with the applicable sections of these specifications. After approval, the material or process will be placed on either the qualified list or the pre-acceptance list (PAL) maintained on MoDOT’s web site by Construction and Materials. The Contractor shall select materials or processes from the appropriate list for use in St. Charles County work. Final acceptance may be based on field inspection.

1001.2 All packaged material shall be plainly marked showing the quantity and nature of the contents and shall be delivered intact.

1001.3 A description of the classification of deleterious material may be found in MoDOT’s EPG 106.3.2.71 on MoDOT’s web site.

1001.4 Chat will be defined as an aggregate waste material that was formed in the course of milling operations employed to recover lead and zinc from metal-bearing ore minerals.

1001.5 Crushed stone will be defined as the product obtained by the artificial reduction in the size of rock that has been mined or excavated from ledge formation. Chat as defined in Sec 1001.4 is not included.

1001.6 Gravel will be defined as the coarse granular material, generally considered as material retained on the No. 4 or No. 10 sieve, but may include finer sizes, resulting from the natural disintegration and abrasion of rock, or from processing of weakly bound conglomerate. Gravel may include such material that has been further reduced in size by artificial means.

1001.7 Porphyry will be defined as a fine-grained, dense, igneous rock generally occurring in the Missouri counties of Iron, Madison, St. Francois and their adjacent counties.

1001.8 Wet bottom boiler slag will be defined as a hard, angular by-product of the combustion of coal in wet bottom boilers.

1001.9 Sieves specified for gradation requirements shall have openings as prescribed in AASHTO M 92.

1001.10 Storage and Handling of Aggregate. Aggregate shall be produced, handled and stockpiled to minimize segregation, degradation and contamination. Regardless of the method of storage and handling, all aggregate that is segregated, degraded or contaminated to the extent that the aggregate does not meet specifications, will be considered unacceptable. Aggregate may be reconditioned by any method that produces satisfactory material.

1001.11 Approval of Aggregate Sources. All sources of aggregate shall be evaluated by the Engineer for initial approval and source approval as herein prescribed, prior to acceptance of aggregate from that source.

1001.11.1 Sources of crushed stone shall be evaluated for initial approval on a ledge by ledge basis. Each exposed ledge will be identified, and the Engineer will describe the ledge boundaries. Only identified ledges shall be used in the manufacture of the final product. A sample for initial approval will be required from each ledge. Resampling will be required if source approvals indicate a significant change has occurred.

1001.11.2 Source approvals will be required a minimum of every year. Source approval samples will be required for each unique combination or ledges. Resampling will be required at closer intervals if, in the judgment of the Engineer, any significant change has occurred to the source. Samples of aggregate for source approval shall be taken while the Engineer is present.
1001.11.3 Sources approval of natural sand, gravel and manufactured lightweight aggregate shall be evaluated as the final product.

1001.11.4 Sources of aggregate such as chat, slag and other by-products from previously produced material or any other undefined sources will be evaluated on an individual basis.

1001.12 Mining By-Product Aggregate. Chat may be furnished under the following requirements.

1001.12.1 Chat used in hot, warm, or cold mix asphalt, slurry seal, micro-surfacing, or in epoxy seal delivered to St. Charles County projects or property shall have a total lead content less than 4,500 ppm as determined by EPA Method 3050B, Acid Digestion of Sediments, Sludges, and Soils. Testing shall be conducted a minimum of once per year per source/location of chat.

1001.12.2 Chat used in Portland cement concrete, granular road base, flowable fill, stabilized road base, ice control material, or chip seal delivered to St. Charles County projects or property shall have Synthetic Precipitation Leaching (SPLP) testing conducted using EPA SW-846 Method 1312 as required by 40 CFR 278. The leachate testing results shall not exceed the National Primary Drinking Water Standards for lead and cadmium and the fresh water chronic National Recommended Water Quality Criterion for zinc of 120 ug/1. Testing shall be conducted a minimum of once per year per source/location of chat.

1001.12.3 Test reports shall be submitted to the Engineer prior to chat being used on any St. Charles County project or property. The report shall identify the location of the stockpile, date of sample, and specific test results as required in 40 CFR 278. Attached to the report shall be a certification from the supplier stating that the material furnished does not exceed the lead amounts specified in 40 CFR 278. The Engineer will maintain copies of laboratory test results and certifications for a minimum of three years.

1001.12.4 The supplier shall also provide a summary at the end of each calendar year that identifies the quantity and location of chat shipped for use on St. Charles County projects.

1001.13 Dust Suppressants. Approved dust suppressant additives may be used during the crushing or aggregate handling process provided there is no detrimental effect to the aggregate or subsequent products made from the affected aggregate.

1001.13.1 Manufacturer and Brand Name Approval. Prior to approval and use of a dust suppressant additive, the manufacturer shall submit to the Engineer a certified test report from an approved independent testing laboratory showing specific test results when tested in accordance with MoDOT Test Method TM 62. The certified test report shall contain the manufacturer's name, brand name of material, date tested, date of manufacture and dosage rate of the additive used. In addition, the manufacturer shall submit to the Engineer a sample representing the additive tested by the independent testing laboratory and accompanied by a material data sheet, an MSDS showing the brand name, composition or description of the product, the normal and maximum recommended dosage rates, the manner of identification on containers and a copy of the infrared spectrum. The manufacturer shall certify that the material, when used at or below the maximum dosage rate, does not affect the properties of the aggregate or subsequent products made from the treated aggregate. The manufacturer shall also guarantee that as long as the material is furnished under that brand and designation, the material will be of the same composition as originally approved and will in no way be altered or changed. Upon approval of the additive, the manufacturer and brand name will be placed on a list of qualified dust suppressant additives for aggregate.

1001.13.2 The aggregate supplier shall keep the inspector advised of the use of any dust suppressant material and shall provide for the inspection of such facilities. No dust suppressant shall be applied above the manufacturer's maximum recommended rate.
SECTION 1002
AGGREGATE FOR ASPHALTIC CONCRETE

1002.1 Scope. This specification covers aggregate to be used in asphaltic concrete.

1002.2 Coarse Aggregate.

1002.2.1 All coarse aggregate shall consist of sound, durable rock, free from cemented lumps or objectionable coatings. When tested in accordance with AASHTO T 96, the percentage of wear shall not exceed 50. The percentage of deleterious substances shall not exceed the following values, and the sum of percentages of all deleterious substances shall not exceed 8.0 percent.

<table>
<thead>
<tr>
<th>Deleterious Material</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious Rock</td>
<td>8.0</td>
</tr>
<tr>
<td>Shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Other Foreign Material</td>
<td>0.5</td>
</tr>
</tbody>
</table>

1002.2.1.1 The above requirements apply to combined aggregates during production when used in accordance with Sec 401.

1002.2.1.2 Crushed stone shall be obtained from rock of uniform quality. Rock tested from any combination of ledges for source approval, and trial mix samples, shall meet the following criteria.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles Abrasion, AASHTO T 96, percent loss, max</td>
<td>50</td>
</tr>
<tr>
<td>Absorption, AASHTO T 85, percent, max</td>
<td>4.0</td>
</tr>
</tbody>
</table>

1002.2.2 Gravel aggregate shall be washed sufficiently to remove any objectionable coating and shall meet the following criteria for source approval and trial mix samples.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles Abrasion, AASHTO T 96, percent loss, max</td>
<td>50</td>
</tr>
<tr>
<td>Absorption, AASHTO T 85, percent, max</td>
<td>5.5</td>
</tr>
</tbody>
</table>

1002.2.3 Steel slag consisting principally of a fused mixture of oxides and silicates shall be a synthetic aggregate produced as a by-product of basic oxygen, electric or open hearth steel making furnaces. The steel slag shall be aged at least three months after crushing and screening. Steel slag, which has been previously crushed, screened, and aged three months will not be required to receive additional aging. Steel slag from one source shall not be blended with steel slag from a different source.

1002.3 Fine Aggregate.

1002.3.1 Fine aggregate for asphaltic concrete shall be a fine, granular material passing the 3/8 inch sieve, naturally produced by the disintegration of rock of a siliceous nature and/or manufactured by the mechanical reduction of sound durable rock in accordance with Sec 1002.2.1.2 and Sec 1002.2.2. With written approval from the Engineer and compliance with this specification, chat sand produced from flint chat in the Joplin area, dolomite chat as produced in the southeast lead belt area, fines manufactured from igneous rock, chert gravel or wet bottom boiler slag may be used as fine aggregate for asphaltic concrete. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating or injurious material. The percentage of deleterious substances shall not exceed the following values:
<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps and shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Total lightweight (low mass density) particles, including coal and lignite</td>
<td>0.5</td>
</tr>
<tr>
<td>Other deleterious substances</td>
<td>0.1</td>
</tr>
</tbody>
</table>

1002.3.2 The total lightweight particle requirement will not apply to wet bottom boiler slag, angular chert sand or manufactured sand.

1002.4 Mineral Filler. Mineral filler shall be in accordance with AASHTO M 17. Prior to approval and use of mineral filler for SMA mixtures, the manufacturer shall submit to the Engineer a certified test report from an approved independent testing laboratory showing specific test results when tested in accordance with applicable sections of AASHTO M17 and MoDOT Test Method TM-73. The certified test report shall contain the manufacturer's name, product, date tested and date of manufacture. In addition, the manufacturer shall submit to the Engineer a sample representing the mineral filler tested by the independent testing laboratory and accompanied by a material data sheet and an MSDS showing the product and composition or description of the product. The manufacturer shall guarantee that as long as the material is furnished under that brand and designation, the material will be of the same composition as originally approved and will in no way be altered or changed. Upon approval of the mineral filler, the manufacturer and product will be placed on a list of qualified SMA mineral fillers.

1002.5 Hydrated Lime. Hydrated lime shall be thoroughly dry and free of lumps. Hydrated lime shall be in accordance with AASHTO M 303, Type I or II, except the gradation shall be determined in accordance with AASHTO T 37.
SECTION 1003
AGGREGATE FOR SEAL COATS

1003.1 Scope. This specification covers aggregate to be used for seal coat.

1003.2 Aggregate. Aggregate for seal coats shall consist of sound durable rock particles, free from objectionable coatings.

1003.2.1 When tested in accordance with AASHTO T 96, the percentage of wear shall not exceed 50 percent. The sum of the percentages of all deleterious substances shall not exceed 2.0 percent for Grade A aggregate, 4.0 percent for Grade B, or 8.0 percent for Grade C aggregate, and the aggregate shall meet the following criteria:

<table>
<thead>
<tr>
<th>Property</th>
<th>Grade A Aggregate</th>
<th>Grade B Aggregate</th>
<th>Grade C Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious rock, percent by weight, max</td>
<td>2.0</td>
<td>4.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Shale, percent by weight, max</td>
<td>0.5</td>
<td>0.75</td>
<td>1.0</td>
</tr>
<tr>
<td>Other foreign material, percent by weight, max</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Two fractured faces, percent, min</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Thin, elongated particles, ASTM D 4791, 5:1, percent, max(^a)</td>
<td>10</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Micro-Deval, AASHTO TP 58, percent, max</td>
<td>18</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

\(^a\) Test material retained on the No. 4 sieve.

1003.2.2 The aggregate shall be in accordance with the following requirements for the grade specified in the contract:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Grade A1 Aggregate</th>
<th>Grade A2 Aggregate</th>
<th>Grade B1 Aggregate</th>
<th>Grade B2 Aggregate</th>
<th>Grade C Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent Passing by Weight</td>
<td>Percent Passing by Weight</td>
<td>Percent Passing by Weight</td>
<td>Percent Passing by Weight</td>
<td>Percent Passing by Weight</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>97-100</td>
<td>100</td>
<td>95-100</td>
<td>100</td>
<td>95-100</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>--</td>
<td>97-100</td>
<td>--</td>
<td>95-100</td>
<td>--</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-25</td>
<td>--</td>
<td>0-30</td>
<td>--</td>
<td>0-35</td>
</tr>
<tr>
<td>No. 8</td>
<td>--</td>
<td>0-30</td>
<td>--</td>
<td>0-30</td>
<td>--</td>
</tr>
<tr>
<td>No. 200(^a,b)</td>
<td>0-1.0</td>
<td>0-1.5</td>
<td>0-2</td>
<td>0-2.5</td>
<td>0-2</td>
</tr>
</tbody>
</table>

\(^a\) The percent passing the No. 200 sieve may be increased by 1.0 percent provided the aggregate is pre-coated with bituminous material.
\(^b\) These values may be raised by 0.5% at the destination to account for handling provided the material meets this gradation at the source.

1003.2.3 Crushed stone shall be obtained from rock of uniform quality. Rock from individual ledges and gravel tested for initial source approval shall meet the following criteria:

<table>
<thead>
<tr>
<th>Property</th>
<th>Grade A1 &amp; A2 Aggregate</th>
<th>Grade B1 &amp; B2 Aggregate</th>
<th>Grade C Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption, AASHTO T 85, percent, max</td>
<td>2.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>
1003.2.4 Lightweight aggregate shall be in accordance with the following requirements for the grade specified in the contract:

<table>
<thead>
<tr>
<th>Property</th>
<th>Grade A1 &amp; A2 Aggregate</th>
<th>Grade B1 &amp; B2 Aggregate</th>
<th>Grade C Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption, ASSHTO T 85, percent, max</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Los Angeles Abrasion for Lightweight Aggregate, MoDOT Test Method TM 78, percent, max</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
SECTION 1004
GRADED AGGREGATE FOR BITUMINOUS SURFACES

1004.1 Scope. This specification covers aggregate to be used in bituminous surfacing.

1004.2 Coarse Aggregate.

1004.2.1 All coarse aggregate shall consist of sound, durable rock, free from cemented lumps or objectionable coatings. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 8.0 percent.

<table>
<thead>
<tr>
<th>Deleterious Material</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious Rock</td>
<td>8.0</td>
</tr>
<tr>
<td>Mud Balls and Shale Combined</td>
<td>2.0</td>
</tr>
<tr>
<td>Clay, uniformly dispersed</td>
<td>3.0</td>
</tr>
<tr>
<td>Other Foreign Material</td>
<td>0.5</td>
</tr>
</tbody>
</table>

1004.2.1.1 The above requirements apply to combined aggregates during production when used in accordance with Sec 401.

1004.2.1.2 If a density requirement is specified for asphaltic concrete, the total quantity of chert in each size or fraction of produced crushed stone aggregate, including that permitted as deleterious, shall not vary by more than 10 percentage points from the quantity present in the aggregate used in the approved laboratory job mixtures.

1004.2.2 Gravel aggregate shall be washed sufficiently to remove any objectionable coating and shall meet the following criteria for source approval and trial mix samples.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles Abrasion, AASHTO T 96, percent loss, max.</td>
<td>55</td>
</tr>
<tr>
<td>Absorption, AASHTO T 85, percent, max.</td>
<td>4.5</td>
</tr>
</tbody>
</table>

1004.2.3 Steel slag consisting principally of a fused mixture of oxides and silicates shall be a synthetic aggregate produced as a by-product of basic oxygen, electric or open hearth steel making furnaces. The steel slag shall be aged at least three months after crushing and screening. Steel slag, which has been previously crushed, screened, and aged three months will not be required to receive additional aging. Steel slag from one source shall not be blended with steel slag from a different source.

1004.3 The aggregate shall be in accordance with the following requirements for the grade specified in the contract. If grade is not specified, any listed grade may be used.
<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Material</th>
<th>Sieve Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3/4 in.</td>
</tr>
<tr>
<td>1</td>
<td>Crushed Stone or Porphyry</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Gravel</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Chat</td>
<td>100</td>
</tr>
</tbody>
</table>
SECTION 1005
AGGREGATE FOR CONCRETE

1005.1 **Scope.** This specification covers aggregate to be used for concrete construction.

1005.2 **Coarse Aggregate.**

1005.2.1 All coarse aggregate for concrete shall consist of sound, durable rock, free from objectionable coatings and frozen and cemented lumps. The percentage of deleterious substances shall not exceed the following values, and the sum of percentages of all deleterious substances, exclusive of Items 5 and 6, shall not exceed 6.0 percent. For crushed stone, the percentage of wear shall not exceed 50 when tested in accordance with AASHTO T 96.

<table>
<thead>
<tr>
<th>Deleterious Material</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious Rock</td>
<td>6.0</td>
</tr>
<tr>
<td>Shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Chert in Limestone</td>
<td>4.0</td>
</tr>
<tr>
<td>Other Foreign Material</td>
<td>0.5</td>
</tr>
<tr>
<td>Material Passing No. 200 Sieve Gradations D &amp; E</td>
<td>2.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Thin or Elongated</td>
<td>5.0</td>
</tr>
</tbody>
</table>

<sup>a</sup> Value may be raised to 3.0 percent, providing the material passing the #200 sieve in the fine aggregate is less than or equal to 1.0 percent.

1005.2.1.1 The above requirements will apply to each size or fraction of aggregate produced.

1005.2.1.2 Crushed stone shall be obtained from rock of uniform quality. Rock tested for initial approval shall be in accordance with the criteria below. Source approval and production samples shall also meet the following criteria:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles Abrasion, AASHTO T 96, percent loss, max.</td>
<td>50</td>
</tr>
<tr>
<td>Absorption, AASHTO T 85, percent, max.:</td>
<td></td>
</tr>
<tr>
<td>(a) Portland Cement Concrete Pavement</td>
<td>--</td>
</tr>
<tr>
<td>(b) Portland Cement Concrete Masonry</td>
<td>3.5</td>
</tr>
<tr>
<td>Soundness, MoDOT Test Method TM 14, percent loss, max.:</td>
<td></td>
</tr>
<tr>
<td>(a) Portland Cement Concrete Pavement</td>
<td>--</td>
</tr>
<tr>
<td>(b) Portland Cement Concrete Masonry</td>
<td>18.0</td>
</tr>
<tr>
<td>Durability Factor, AASHTO T 161 Procedure B, percent, min.:</td>
<td></td>
</tr>
<tr>
<td>(a) Portland Cement Concrete Pavement</td>
<td>75&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(b) Portland Cement Concrete Masonry</td>
<td>--</td>
</tr>
</tbody>
</table>

<sup>a</sup> Approval will be based on maximum aggregate size produced that meets durability requirements.

1005.2.1.3 Gravel shall be washed and shall be in accordance with the criteria below for initial approval. Source approval and production samples shall also meet the following criteria:
### 1005.2.1.4 The Engineer reserves the right to use additional test methods, such as ASTM C 586, AASHTO T 161 or other appropriate tests, to measure the soundness and durability of aggregate for use in concrete when deemed necessary.

### 1005.2.2 Coarse aggregate for concrete pavement or base course shall be crushed stone or porphyry.

### 1005.2.3 Grade F Aggregate. Coarse aggregate for Portland cement concrete pavement, base and approach slabs for bridges that is not produced from the Burlington, Keokuk, Cedar Valley (formerly Callaway) or Warsaw limestone formations, which is obtained from sources in the following areas shall have a maximum top size of ¾ inch:

(a) State of Kansas, Iowa and Nebraska.


### 1005.2.4 Coarse aggregate for concrete for structures, except as specified in Sec 1005.2.5, may be gravel or crushed stone. Coarse aggregate for Class B, B-1, B-2, MB-2 or Seal concrete shall be in accordance with either Gradation D or E. Coarse aggregate for Class A-1 concrete shall be in accordance with Gradation E.

<table>
<thead>
<tr>
<th>Gradation D</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 inch sieve</td>
<td>100</td>
</tr>
<tr>
<td>Passing 3/4 inch sieve</td>
<td>85-100</td>
</tr>
<tr>
<td>Passing 3/8 inch sieve</td>
<td>15-55</td>
</tr>
<tr>
<td>Passing No. 4 sieve</td>
<td>0-10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gradation E</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 3/4 inch sieve</td>
<td>100</td>
</tr>
<tr>
<td>Passing 1/2 inch sieve</td>
<td>70-100</td>
</tr>
<tr>
<td>Passing 3/8 inch sieve</td>
<td>30-70</td>
</tr>
<tr>
<td>Passing No. 4 sieve</td>
<td>0-20</td>
</tr>
<tr>
<td>Passing No. 8 sieve</td>
<td>0-6</td>
</tr>
</tbody>
</table>

### 1005.2.5 Coarse aggregate for ornamental concrete shall be crushed stone in accordance with Sec 1005.2.4, Gradation E. However, the use of coarse aggregate containing more than 2 percent chert will not be permitted.

### 1005.3 Fine Aggregate.

### 1005.3.1 Fine aggregate for concrete shall be a fine granular material naturally produced by the disintegration of rock of a siliceous nature, or shall be manufactured from an approved limestone or dolomite source as defined in Sec 1005.2. By specific approval from the Engineer, chat sand produced from flint chat in the Joplin area or fines manufactured from igneous rock or chert gravel may be used. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating of injurious material. The percentage of deleterious substances shall not exceed the following values:
<table>
<thead>
<tr>
<th>Deleterious Material</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Lumps and Shale</td>
<td>0.25</td>
</tr>
<tr>
<td>Coal and Lignite</td>
<td>0.50</td>
</tr>
<tr>
<td>Total Lightweight Particles, Including Coal and Lignite</td>
<td>0.50</td>
</tr>
<tr>
<td>Material Passing No. 200 Sieve</td>
<td></td>
</tr>
<tr>
<td>(a) Natural Sand</td>
<td>2.0</td>
</tr>
<tr>
<td>(b) Manufactured Sand</td>
<td>4.0</td>
</tr>
<tr>
<td>Other Deleterious Substances</td>
<td>0.10</td>
</tr>
</tbody>
</table>

1005.3.2 The total lightweight particle requirement will not apply to angular chert sand or manufactured sand.

1005.3.3 Fine aggregate shall produce a mortar having a seven-day compressive strength of at least 90 percent of a control mortar developed at the same proportions, using standard Ottawa sand. Tests shall be performed in accordance with AASHTO T 106. Cement used in the tests shall be Type I, in accordance with Sec 1019. AASHTO T 106 may be waived provided the fine aggregate produces a glass color standard lighter than Organic Platte No. 3, in accordance with AASHTO T 21.

1005.3.4 Fine aggregate for ornamental concrete shall be free from coal and lignite material when tested in accordance with AASHTO T 113. All fine aggregate used for concrete paved approaches, concrete driveways, concrete sidewalk, curb ramps, and steps shall contain only Finish Sand or Meramec Sand.

1005.3.5 All fine aggregate for PCCM shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 3/8 inch sieve</td>
<td>100</td>
</tr>
<tr>
<td>Passing No. 4 sieve</td>
<td>95-100</td>
</tr>
<tr>
<td>Passing No. 8 sieve</td>
<td>70-100</td>
</tr>
<tr>
<td>Passing No. 16 sieve</td>
<td>45-90</td>
</tr>
<tr>
<td>Passing No. 30 sieve</td>
<td>15-65</td>
</tr>
<tr>
<td>Passing No. 50 sieve</td>
<td>5-30</td>
</tr>
<tr>
<td>Passing No. 100 sieve</td>
<td>0-10</td>
</tr>
</tbody>
</table>

1005.4 Lightweight Aggregate.

1005.4.1 Lightweight aggregates shall be prepared by expanding, calcining, or sintering argillaceous material such as clay, shales, and slates.

1005.4.2 Grading The grading shall be uniform and conform to the requirements given in Table I.

1005.4.3 Unit Weight. The unit weight of lightweight aggregates shall not exceed the following:

<table>
<thead>
<tr>
<th>Dry, Loose Weight, Max. lb/cu ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Aggregate</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
</tr>
</tbody>
</table>

1005.4.3.1 Uniformity of Weight. If the unit weight of any shipment of lightweight aggregate when tested in accordance with AASHTO T 19 is found to vary by more than 10 percent from that of the sample submitted for source approval, the aggregate shipment may be rejected.
1005.4.4 Soundness. When tested in accordance with AASHTO T 104, the loss of lightweight fine or coarse aggregate in 5 cycles of the accelerated soundness test shall not exceed 8 percent if sodium sulfate is used or 10 percent if magnesium sulfate is used.

1005.4.5 Drying Shrinkage. The drying shrinkage of concrete specimens prepared and tested in accordance with AASHTO M 195, shall not exceed 0.07 percent.

1005.4.6 Sampling. Samples of fine and coarse aggregate shall be furnished by the Contractor for source approval. Other samples shall be taken from shipments at intervals specified by the Engineer.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Size</th>
<th>Percent Passing Sieve Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 1/2&quot;</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>No. 4 to 0</td>
<td>---</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>1</td>
<td>1&quot; to 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1&quot; to No. 4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3/4&quot; to No. 4</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1/2&quot; to No. 4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3/8&quot; to No. 8</td>
</tr>
</tbody>
</table>
SECTION 1006
AGGREGATE FOR SURFACING

1006.1 Scope. This specification covers aggregate to be used for surfacing.

1006.2 Aggregate for surfacing shall be composed of durable particles of rock. When tested in accordance with AASHTO T 96, the wear shall not exceed 60 percent. The deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 12 percent.

<table>
<thead>
<tr>
<th>Deleterious Material</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious Rock and Shale</td>
<td>12.0</td>
</tr>
<tr>
<td>Mud Balls</td>
<td>5.0</td>
</tr>
<tr>
<td>Other Foreign Material</td>
<td>2.0</td>
</tr>
</tbody>
</table>

1006.3 Aggregate shall be in accordance with the following for the grade specified in the contract:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Material</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sieve Sizes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 in.</td>
</tr>
<tr>
<td>A a</td>
<td>Gravel</td>
<td>100</td>
</tr>
<tr>
<td>B a</td>
<td>Crushed Stone</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>Chat</td>
<td>100</td>
</tr>
</tbody>
</table>

a Type 1 Aggregate for Base may be used, except all material shall be in accordance with Sec 1007.
b Indicates maximum permitted.

1006.4 If the quantity is of a size that makes sampling not practical, this material may be accepted on certification or visual inspection as allowed in Sec 106.1.4.

1006.4.1 If the quantity is less than 500 tons, a commercially available grade of aggregate may be accepted on certification or visual inspection.
SECTION 1007
AGGREGATE FOR BASE

1007.1 Scope. This specification covers aggregate to be used for base.

1007.2 Type 1 Aggregate.

1007.2.1 Type 1 aggregate for base shall consist of crushed stone, sand and gravel or reclaimed asphalt or concrete. The aggregate shall not contain more than 15 percent deleterious rock and shale. The fraction passing No. 40 sieve shall have a maximum plasticity index of six. Any sand, silt and clay and any deleterious rock and shale shall be uniformly distributed throughout the material.

1007.2.2 The aggregate shall be in accordance with the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 inch</td>
<td>100</td>
</tr>
<tr>
<td>Passing 1/2 inch</td>
<td>60-90</td>
</tr>
<tr>
<td>Passing No. 4</td>
<td>35-60</td>
</tr>
<tr>
<td>Passing No. 30</td>
<td>10-35</td>
</tr>
</tbody>
</table>

1007.3 Type 5 Aggregate.

1007.3.1 Type 5 aggregate for base shall consist of crushed stone, sand and gravel or reclaimed asphalt or concrete. The aggregate shall not contain more than 15 percent deleterious rock and shale. The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the material.

1007.3.2 Type 5 aggregate shall be in accordance with the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 inch</td>
<td>100</td>
</tr>
<tr>
<td>Passing 1/2 inch</td>
<td>60-90</td>
</tr>
<tr>
<td>Passing No. 4</td>
<td>35-60</td>
</tr>
<tr>
<td>Passing No. 30</td>
<td>10-35</td>
</tr>
<tr>
<td>Passing No. 200</td>
<td>0-15</td>
</tr>
</tbody>
</table>

1007.4 Type 7 Aggregate.

1007.4.1 Type 7 aggregate for base shall consist of crushed stone, sand and gravel, or reclaimed asphalt or concrete. The aggregate shall not contain more than 15 percent deleterious rock and shale. The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the material.

1007.4.2 Type 7 aggregate shall be in accordance with the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>Passing 1 inch</td>
<td>70-100</td>
</tr>
<tr>
<td>Passing No. 8</td>
<td>15-50</td>
</tr>
<tr>
<td>Passing No. 200</td>
<td>0-12</td>
</tr>
</tbody>
</table>
SECTION 1009
AGGREGATE FOR DRAINAGE

1009.1 Scope. This specification covers material requirements for aggregate as specified for various drainage systems.

1009.2 Quality. All aggregate shall be in accordance with Sec 1002, and shall be of the material and gradation specified herein.

1009.3 Gradation.

1009.3.1 Grade 1. The aggregate shall be sand and shall be in accordance with Sec 1005.3.

1009.3.2 Grade 2. The aggregate shall be a washed sand-gravel mixture in accordance with the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>55-90</td>
</tr>
<tr>
<td>No. 10</td>
<td>25-50</td>
</tr>
<tr>
<td>No. 40</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-3</td>
</tr>
</tbody>
</table>

1009.3.3 Grade 3. The aggregate shall be gravel, crushed stone or other approved material meeting one of the gradation requirements for Sec 1005.2.

1009.3.4 Grade 4. The aggregate shall be crushed limestone or dolomite or reclaimed concrete, in accordance with the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1 inch</td>
<td>95-100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>25-60</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>20-55</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
</tbody>
</table>

1009.3.5 Grade 5. The aggregate shall be a crushed limestone or dolomite in accordance with the following gradation requirements:
<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1 inch</td>
<td>95-100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>60-80</td>
</tr>
<tr>
<td>No. 4</td>
<td>40-55</td>
</tr>
<tr>
<td>No. 8</td>
<td>5-25</td>
</tr>
<tr>
<td>No. 16</td>
<td>0-8</td>
</tr>
<tr>
<td>No. 50</td>
<td>0-5</td>
</tr>
</tbody>
</table>
SECTION 1010
SELECT GRANULAR BACKFILL FOR STRUCTURAL SYSTEMS

1010.1 Scope. This specification covers backfill material used as part of a mechanically stabilized earth wall system or in other applications requiring an Engineered backfill material.

1010.2 Material. Aggregate used for backfill material may consist of gravel, crushed stone, reclaimed concrete, or other approved material meeting the requirements of this Section. The requirements for the gradation of the material, the general makeup of the material, and the testing of the material will apply to all potential uses of this material, unless otherwise specified on the plans or in the contract documents. The electrochemical requirements listed in this specification will apply to backfill material used for mechanically stabilized earth wall systems.

1010.3 General.

1010.3.1 To ensure proper functioning of the structure, the backfill material used for structural applications shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-10*</td>
</tr>
</tbody>
</table>

* May be increased to 15% if gradation sample is obtained from the compacted backfill material.

1010.3.2 The frequency of sampling of the backfill material necessary to assure gradation control throughout construction shall be as directed by the Engineer.

1010.3.3 The plasticity index (PI) of the backfill material shall be determined in accordance with AASHTO T 90 and shall not exceed 6.

1010.3.4 The angle of internal friction for the backfill material shall be no less than 34 degrees. No testing will be required whenever 80 percent of the particle sizes are greater than 0.75 inch or whenever the backfill material consists entirely of crushed stone. When testing is required, testing shall be in accordance with one of the tests specified below.

1010.3.5 The angle of internal friction may be determined by the direct shear test in accordance with AASHTO T 236. This test shall be performed on the portion of the material finer than the No. 10 sieve, utilizing a sample of the material compacted to 95 percent of the maximum density as determined by AASHTO T 99, Methods C or D (with oversize correction as outlined in Note 7 in that publication), at optimum moisture content.

1010.3.6 For select granular backfill other than crushed stone the organic content of the backfill material shall be less than or equal to one percent and shall be measured in accordance with AASSHTO T 267 for material finer than the No. 10 sieve.

1010.4 Electrochemical Requirements. The following electrochemical requirements will apply to this backfill material whenever the material is used for mechanically stabilized earth wall systems.

1010.4.1 Metallic Soil Reinforcement

1010.4.1.1 When metallic soil reinforcements are used, the backfill material shall be in accordance with the electrochemical requirements as follows:
<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistivity &gt; 2000 ohm-cm</td>
<td>AASHTO T 288</td>
</tr>
<tr>
<td>pH of 5-10**</td>
<td>AASHTO T 289</td>
</tr>
<tr>
<td>Chlorides ~ 100 ppm</td>
<td>AASHTO T 291</td>
</tr>
<tr>
<td>Sulfates ~ 200 ppm</td>
<td>AASHTO T 290*</td>
</tr>
</tbody>
</table>

* Water soluble sulfates shall be tested in accordance with 508 AASHTO T 290 Method A-Gravimetric Method with the following modifications: Per section 13, follow subsection 13.1 through 13.3 as stated in the test procedure. Transfer 250 ml of extracted sample to a 400-ml plastic beaker and place in a 90°C oven for 30 minutes. A blank should be run concurrently with the test sample using 250 ml of DI water. After 30 minutes, add 10 ml of barium chloride (100g/L) to test sample and blank. Place test sample and blank back into a 90°C oven and let samples digest for 12 to 24 hours. Filter through a retentive paper, wash the precipitate thoroughly with hot DI water, place the paper and contents in a weighted porcelain crucible, and slowly char and consume the paper without inflaming. Ignite at 1000°C for 2 hours, cool in a desiccator, and determine the mass as grams of barium sulfate. Subtract the blank and convert grams of barium sulfate to mg/kg of sulfate ion content.

** Use pH of 5-9 for aluminized soil reinforcement.

1010.4.1.2 Whenever the resistivity of the backfill material is greater than or equal to 5000 ohm-cm, the chlorides and sulfates requirements may be waived.

1010.4.1.3 Resistivity shall be tested by the Contractor in accordance with AASHTO T 288. Resistivity result will be defined by the minimum resistivity noted during the test. Resistivity shall be tested a minimum of once per 30,000 tons, by the Contractor and a minimum of once by quality assurance representing the Engineer. Minimum sample frequency is per project, per source, per product. For samples that do not meet specifications a split sample shall be obtained from the source stockpile for final comparison testing. Contact the Engineer for acceptance.

1010.4.2 Polymeric Soil Reinforcement. When polymeric soil reinforcements are used, the backfill material shall be in accordance with the electrochemical requirements as follows:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH of 4.5-9</td>
<td>AASHTO T 289</td>
</tr>
</tbody>
</table>

1010.5 Certification and Acceptance.

1010.5.1 The Contractor shall furnish to the Engineer written certification that the backfill material provided complies with the applicable sections of this specification. Test results in the certification shall be within one year from the start of construction of each wall. Copies of all test results for tests performed to ensure compliance with this specification shall be furnished to the Engineer. The Engineer will assure a minimum of one complete set of quality assurance tests for each complete certification supplied by the Contractor, within the same time constraints.

1010.5.2 Acceptance will be based on the written certification, accompanying test reports, and any applicable tests performed as directed by the Engineer.
1011.1 **Scope.** This specification covers geotextile for use in subsurface drainage, sediment control and erosion control, or as a permeable separator.

1011.2 **Acceptance.** Acceptance of the material will be based on the manufacturer's certification and upon the results of such tests as may be performed by the Engineer.

1011.3 **Material.** Geotextiles shall be in accordance with the physical and chemical requirements of AASHTO M 288 for the specified application, except as modified in this specification.

1011.3.1 **Subsurface Drainage Geotextile.** Subsurface drainage geotextile shall be used in subsurface drainage as a filter to protect drainage media from clogging with fines from adjacent soil. Typical applications include the lining of drainage trenches and the wrapping of drainpipes.

1011.3.1.1 The minimum permittivity shall be 1.0 sec-1.

1011.3.1.2 The material shall be AASHTO Class 2.

1011.3.2 **Temporary Silt Fence Geotextile.** Temporary silt fence geotextile shall be used in supported or non-supported sediment control fencing.

1011.3.3 **Permanent Erosion Control Geotextile.** Permanent erosion control geotextile shall be used when the erosion control measure will not be removed, such as erosion control of slopes and channels when placed under a rock blanket, rock ditch liner, etc.

1011.3.3.1 The minimum permittivity shall be 1.0 sec-1.

1011.3.3.2 The material shall be either AASHTO Class 1 or Class 2.

1011.3.4 **Separation Geotextile.** Separation geotextile shall be used as a separation material to prevent mixing of dissimilar material, and to control migration of backfill material through joints in structural elements.

1011.3.4.1 The minimum permittivity shall be 1.0 sec-1.

1011.3.4.2 The material shall be AASHTO Class 1.

1011.3.5 **Erosion Control Blankets.** Erosion control blankets (ECB) shall be categorized based on performance testing for the C-factor by ASTM D6459 and physical testing for the minimum tensile strength by ASTM D5035. Erosion control blankets shall meet the following requirements.
<table>
<thead>
<tr>
<th>ECB Type</th>
<th>Description</th>
<th>Material Composition</th>
<th>Longevity</th>
<th>Max Slope</th>
<th>C-factor</th>
<th>Minimum Tensile Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.A</td>
<td>Mulch Control Nets</td>
<td>A photodegradable synthetic mesh or woven biodegradable natural fiber netting</td>
<td>3 Months</td>
<td>5:1</td>
<td>≤ 0.10 @5:1</td>
<td>5 lb/ft</td>
</tr>
<tr>
<td>1.B</td>
<td>Netless Rolled Erosion Control Blankets</td>
<td>Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form an RECP</td>
<td>3 Months</td>
<td>4:1</td>
<td>≤ 0.10 @4:1</td>
<td>5 lb/ft</td>
</tr>
<tr>
<td>1.C</td>
<td>Light-Weight Double-Net Erosion Control Blankets</td>
<td>Natural and/or polymer fibers mechanically bound together by two rapidly degrading, synthetic or natural fiber netting</td>
<td>3 Months</td>
<td>3:1</td>
<td>≤ 0.15 @3:1</td>
<td>50 lb/ft</td>
</tr>
<tr>
<td>1.D</td>
<td>Heavy Double-Net Erosion Control Blankets</td>
<td>Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nettings</td>
<td>3 Months</td>
<td>2:1</td>
<td>≤ 0.20 @2:1</td>
<td>75 lb/ft</td>
</tr>
<tr>
<td>2.A</td>
<td>Mulch Control Nets</td>
<td>A photodegradable synthetic mesh or woven biodegradable natural fiber netting</td>
<td>12 Months</td>
<td>5:1</td>
<td>≤ 0.10 @5:1</td>
<td>5 lb/ft</td>
</tr>
<tr>
<td>2.B</td>
<td>Netless Rolled Erosion Control</td>
<td>Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form an RECP</td>
<td>12 Months</td>
<td>4:1</td>
<td>≤ 0.10 @4:1</td>
<td>5 lb/ft</td>
</tr>
<tr>
<td>2.C</td>
<td>Light-Weight Double-Net Erosion Control Blankets</td>
<td>Natural and/or polymer fibers mechanically bound together by two degrading, synthetic or natural fiber nettings</td>
<td>12 Months</td>
<td>3:1</td>
<td>≤ 0.15 @3:1</td>
<td>50 lb/ft</td>
</tr>
<tr>
<td>2.D</td>
<td>Heavy Double-Net Erosion Control Blankets</td>
<td>Processed degradable natural and/or polymer fibers mechanically bound together between two degrading, synthetic or natural fiber nettings</td>
<td>12 Months</td>
<td>2:1</td>
<td>≤ 0.20 @2:1</td>
<td>75 lb/ft</td>
</tr>
<tr>
<td>3.A</td>
<td>Mulch Control Nets</td>
<td>A slow degrading synthetic mesh or woven natural fiber netting</td>
<td>24 Months</td>
<td>5:1</td>
<td>≤ 0.10 @5:1</td>
<td>25 lb/ft</td>
</tr>
<tr>
<td>3.B</td>
<td>Erosion Control Blankets</td>
<td>An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix</td>
<td>24 Months</td>
<td>1.5:1</td>
<td>≤ 0.25 @1.5:1</td>
<td>100 lb/ft</td>
</tr>
<tr>
<td>4</td>
<td>Erosion Control Blankets</td>
<td>An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix</td>
<td>24 Months</td>
<td>1:1</td>
<td>≤ 0.25 @1:1</td>
<td>125 lb/ft</td>
</tr>
</tbody>
</table>
1011.3.5.1 Anchors. Anchors as recommended by the erosion control product manufacturer shall be used.

1011.3.5.2 Test Methods.

1011.3.5.2.1 ASTM D6459 testing shall be performed on loam soil. The calculated C-factor for the tested slope shall be determined from the reported C-factor regression equation using an erosivity value of 224. Type 1.A, Type 2.A, and Type 3.A mulch control nets must be tested in conjunction with pre-applied mulch material. Minimum tensile strength shall be tested in accordance with ASTM D5035 in the machine direction.

1011.3.5.2.2 Texas Department of Transportation and the Texas Transportation Institute testing for product acceptance on 3:1 or 2:1 sand may be substituted for acceptance of ASTM D6459 on loam soil.

1011.3.5.3 Pre-Qualification List: Prior to use, the manufacturer shall furnish a manufacturer’s certification to the Engineer stating the name of the manufacturer, the chemical composition of the filaments or yarns and certifying that the material supplied is in accordance with this specification. The certification shall include recent results of tests for all specified requirements. Final acceptance of erosion control blankets will be based on certification and field performance.

1011.3.5.4 Acceptance. Final acceptance of erosion control blankets will be based on the erosion control blankets being utilized as pre-qualified and actual field performance.

1011.3.6 Turf Reinforcement Mats. Turf reinforcement mats (TRM) shall be certified by the manufacturer for open flow channels and shall meet the following calculated shear stress:

<table>
<thead>
<tr>
<th>TRM Type</th>
<th>Calculated Shear Stress (lbs/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>3.5 – 6</td>
</tr>
<tr>
<td>Type 2</td>
<td>6.1 – 8</td>
</tr>
<tr>
<td>Type 3</td>
<td>8.1 – 10</td>
</tr>
<tr>
<td>Type 4</td>
<td>10.1 or greater</td>
</tr>
</tbody>
</table>

1011.3.6.1 Anchors. Anchors as recommended by the product manufacturer shall be used.

1011.3.6.2 Test Methods. Turf reinforcement mats tested and evaluated by either ASTM D6460 or by the Texas Department of Transportation and Texas Transportation Institute independent testing. The test results must indicate the maximum allowable shear strength. ASTM D6460 shall be tested on the loam soil.

1011.3.6.3 Pre-Qualification List: Prior to use, the manufacturer shall furnish a manufacturer’s certification to the Engineer stating the name of the manufacturer, the chemical composition of the filaments or yarns and certifying that the material supplied is in accordance with this specification. The certification shall include recent results of tests for all specified requirements. Final acceptance of turf reinforcement mat will be based on certification and field performance.

1011.3.6.4 Acceptance. Final acceptance of turf reinforcement mats will be based on the turf reinforcement mat being utilized as pre-qualified and actual field performance.

1011.3.7 Unbonded Concrete Overlay Interlayer. Unbonded concrete overlay interlayers shall have the following material properties:
<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric Type</td>
<td>Non-woven Geotextile</td>
<td></td>
</tr>
<tr>
<td>Mass per unit area</td>
<td>Min. 14.8 oz/sq.yd</td>
<td>ASTM D 5261</td>
</tr>
<tr>
<td>Thickness under load (pressure)</td>
<td>0.29 psi: ≥ 0.12 in 2.9 psi: ≥ 0.10 in 29 psi: ≥ 0.04 in</td>
<td>ASTM D 5199, modified under loads of 0.29, 2.9, and 29 psi</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>≥ 685 lb/ft</td>
<td>ASTM D 4595</td>
</tr>
<tr>
<td>Maximum elongation</td>
<td>≤ 130%</td>
<td>ASTM D 4595</td>
</tr>
<tr>
<td>Water permeability in normal direction under load (pressure)</td>
<td>≥ 3.3×10⁻⁴ ft/s [under pressure of 2.9 psi]</td>
<td>ASTM D 5493</td>
</tr>
<tr>
<td>Water permeability in the plane direction of the fabric (transmittivity) under load (pressure)</td>
<td>≥ 1.6×10⁻³ ft/s [under pressure of 2.9 psi] ≥ 6.6×10⁻⁴ ft/s [under pressure of 29 psi]</td>
<td>ASTM D 6574</td>
</tr>
<tr>
<td>Weather resistance</td>
<td>Resistance ≥ 60%</td>
<td>EN 12224</td>
</tr>
<tr>
<td>Alkali resistance</td>
<td>≥ 96% Polypropylene/Polyethylene</td>
<td></td>
</tr>
</tbody>
</table>

1011.4 Certification. The Contractor shall furnish a manufacturer's certification to the Engineer for each lot of material furnished stating the name of the manufacturer, the chemical composition of the filaments or yarns and certifying that the material supplied is in accordance with this specification. The certification shall include or have attached typical results of tests from specific lots for all specified requirements.
SECTION 1012
GEOCOMPOSITE DRAINAGE MATERIAL

1012.1 Scope. This specification covers material for use as geocomposite drains.

1012.2 Acceptance. Acceptance of the material will be based on the manufacturer’s certification and upon the results of such tests as may be performed by the Engineer.

1012.3 Material.

1012.3.1 General. During shipment and storage, the geocomposite material shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140°F, mud, dust and debris.

1012.3.2 Edge Drain. The edge drain shall consist of a plastic core completely surrounded by geotextile.

1012.3.2.1 The edge drain shall have nominal dimensions of 1 to 1 1/2 inches in thickness x 12 inches in height.

1012.3.2.2 The edge drain shall have a minimum flow capacity of 15 gallons per minute per foot of width, as determined by ASTM D 4716, when tested under a confining stress of 10 psi or more at a gradient of 0.1 or less.

1012.3.2.3 The edge drain shall have a minimum compressive strength of either 7000 psf at a maximum deformation of 10 percent of the original thickness when tested in accordance with ASTM D 1621, or 8000 psf at a maximum deformation of 20 percent when tested in accordance with ASTM D 695.

1012.3.2.4 The core shall provide a minimum of 10 percent open area to facilitate water entry or cross flow and shall be composed of plastic, which is physically and chemically stable under a normal range of service conditions.

1012.3.2.5 The geotextile shall be in accordance with Sec 1011 for subsurface drainage geotextile.

1012.3.3 Vertical Drain at End Bents. The vertical drain shall consist of a plastic core with a geotextile attached to one or both sides.

1012.3.3.1 The vertical drain shall be no less than 3/8 inch or no greater than one inch in thickness.

1012.3.3.2 The vertical drain shall have a minimum flow capacity of 5 gallons per minute per foot of width in either principal direction.

1012.3.3.3 The vertical drain shall have a minimum compressive strength of 6000 psf at a maximum deformation of 10 percent of the original thickness, when tested in accordance with ASTM D 1621.

1012.3.3.4 The core shall be composed of plastic which is physically and chemically stable under a normal range of service conditions.

1012.3.3.5 Geotextile shall be in accordance with Sec 1011 for subsurface drainage geotextile.

1012.4 Certification. The Contractor shall furnish a manufacturer’s certification to the Engineer for each lot of material furnished stating the name of the manufacturer, and that the material supplied is in accordance with this specification. The certification shall include or have attached typical results of tests from specific lots for all specified requirements, including the geotextile.
SECTION 1013
MISCELLANEOUS DRAINAGE MATERIAL

1013.1 Scope. This specification covers material requirements for various plastic pipes and other miscellaneous items required to provide underdrainage and edge drainage as specified elsewhere.

1013.2 Acceptance. Acceptance of the material will be based on visual examination and the results of such tests as required by the Engineer.

1013.3 Material. Pipe material shall be PVC or HDPE.

1013.3.1 Plastic Pipe.

1013.3.1.1 The pipe material shall have a minimum pipe stiffness of 46 psi.

1013.3.1.2 Corrugated PVC sewer pipe with a smooth interior and fittings shall be in accordance with ASTM F 949.

1013.3.1.3 Smooth wall PVC underdrain pipe and fittings shall be in accordance with ASTM D 3034.

1013.3.1.4 Corrugated PE pipe with a smooth interior and fittings shall be in accordance with AASHTO M 252, Type S or SP.

1013.3.1.5 Schedule 40 PVC pipe shall be in accordance with ASTM D 1785.

1013.3.2 Rodent Screens. Rodent screens shall be press-formed of 3 or 4 mesh, 21 gauges or heavier, stainless steel or hot-dipped galvanized wire screen or approved equivalent, to provide a cup-shaped screen that will provide a friction-tight fit when inserted into the drain outlet.

1013.4 Certification. The Contractor shall furnish a manufacturer’s certification to the Engineer for each lot of plastic pipe material furnished stating the name of the manufacturer and certifying that the material supplied is in accordance with this specification.
1015.1 Scope. This specification covers bituminous material to be used in highway construction.

1015.2 Approval of Source. The Contractor shall obtain approval of the source of bituminous material from the Engineer before any shipments to the work site are made.

1015.3 Sampling, Testing and Acceptance Procedures. The supplier shall certify that the bituminous material complies with the specification requirements.

1015.3.1 Certification. The supplier shall furnish the truck driver a copy of the bill of lading, manifest or truck ticket to be available to St. Charles County at the destination prior to unloading. The Engineer at the source shall be furnished a copy. The bill of lading, manifest or truck ticket shall provide the following information regarding the shipment: type and grade of material, specific gravity at 60°F, net gallons, consignee, truck number, identification number, weight of truck before and after loading, destination, date loaded, name and location of the source, and a certification statement. The certification statement shall be signed by an authorized representative of the supplier and shall be substantially as follows:

"This certifies that the bituminous material in this shipment is in accordance with St. Charles County specifications for the grade specified and the weights (masses) shown hereon were obtained on MoDOT approved scales and are correct within the specified scale requirements."

1015.3.2 Sampling. The Engineer will at random observe the sampling and testing of truck shipments and tanks, and will select representative samples of the material being supplied for testing in the field or in a testing laboratory. When test results certified by the supplier are not representative of the material being shipped, the source approval will be withdrawn. A source may be reinstated when proof is furnished that the deficiency has been corrected and adequate controls are in effect to guarantee delivery of material meeting specifications. Sampling and test methods for asphalt shall be as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Method</th>
<th>RC</th>
<th>MC</th>
<th>PG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling</td>
<td>AASHTO T 40</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Water</td>
<td>AASHTO T 55</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Flash Point (Tag Open Cup)</td>
<td>AASHTO T 79</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Flash Point (Cleveland Open Cup)</td>
<td>AASHTO T 48</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Viscosity, Centistokes</td>
<td>AASHTO T 201</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Distillation</td>
<td>AASHTO T 78</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Penetration</td>
<td>AASHTO T 49</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ductility</td>
<td>AASHTO T 51</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Solubility in Trichlorethylene</td>
<td>AASHTO T 44</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ash in Bituminous Material</td>
<td>AASHTO T 111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity (Rotational)</td>
<td>ASTM D 4402</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Dynamic Shear</td>
<td>AASHTO 315</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Rolling Thin Film Oven Test</td>
<td>AASHTO T 240</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Pressure Aging Test</td>
<td>AASHTO R28</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Creep Stiffness</td>
<td>AASHTO T 313</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Direct Tension</td>
<td>AASHTO T 314</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1015.3.3 Sampling Equipment. The supplier shall furnish the required sampling equipment and shall sample the contents of the truck under the direction of the Engineer. The supplier shall keep all sampling equipment clean and
in good condition. Sampling devices on truck transports will be approved provided an adequately insulated valve is used with a pipe or nipple inserted a suitable distance into the tank.

**1015.3.4 Truck Log.** Each truck transport shall carry a log showing types of material and the dates hauled with respect to previous shipments, or the supplier shall furnish to the Engineer such information with respect to the previous load.

**1015.3.5 Intermediate Storage.** Intermediate storage tanks for storage and transfer of material between the refinery or terminal and the point of acceptance shall be equipped for sealing and shall be reserved exclusively for St. Charles County work. Use of any material from unsealed tanks will be subject to delay until material can be sampled, tested and approved.

**1015.3.6 Other Transportation.** At sources from which liquid bituminous material is being accepted by certification, the applicable requirements of the foregoing sections shall be followed for shipments of material in transportation units other than trucks. The certification and all information regarding each shipment shall be furnished to the Engineer at the source.

**1015.3.7 Railroad Shipments.** For railroad shipments from refineries where inspection is not maintained by St. Charles County, the supplier shall sample each car load at the source and submit the sample promptly to the Engineer. A bill of lading or identification sheet shall accompany each sample and contain the following information: car number, type and grade of material, quantity represented, including gross gallons, temperature and net gallons at 60°F, destination of shipment, project number and consignee. A certification statement as specified in **Sec 1015.3.1** shall accompany each sample. Approval of the source may be withdrawn if samples submitted are not representative of the material shipped in the car.

**1015.4 Proportioning and Blending Bituminous Material Constituents.** All material shall be properly proportioned and thoroughly blended in suitable tanks prior to delivery to transportation equipment, or material may be proportioned and blended by use of automatic proportioning equipment. All automatic-proportioning blenders shall meet the approval of the Engineer and shall be equipped with precision instruments, including electrically interlocked motors and automatic meters.

**1015.5 Application Temperatures for Bituminous Material.**
<table>
<thead>
<tr>
<th>Bituminous Material</th>
<th>Temperature, Degrees Fahrenheit</th>
<th>Spraying</th>
<th>Mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Asphalt Binder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG 46-28</td>
<td></td>
<td>260</td>
<td>325</td>
</tr>
<tr>
<td>All Other Grades</td>
<td></td>
<td>285</td>
<td>350</td>
</tr>
<tr>
<td>Liquid Asphalt RC-MC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>70</td>
<td>150</td>
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<td>70</td>
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<td>250</td>
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<td>800</td>
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<td>260</td>
</tr>
<tr>
<td>3000</td>
<td></td>
<td>210</td>
<td>290</td>
</tr>
<tr>
<td>Asphalt Emulsions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS-1</td>
<td></td>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td>RS-2</td>
<td></td>
<td>125</td>
<td>185</td>
</tr>
<tr>
<td>SS-1</td>
<td></td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>SS-1h</td>
<td></td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>SS-1vh</td>
<td></td>
<td>160</td>
<td>180</td>
</tr>
<tr>
<td>CRS-1</td>
<td></td>
<td>125</td>
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</tr>
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<td></td>
<td>125</td>
<td>185</td>
</tr>
<tr>
<td>CSS-1</td>
<td></td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>CSS-1h</td>
<td></td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>EA-90P</td>
<td></td>
<td>130</td>
<td>180</td>
</tr>
<tr>
<td>CRS-2P</td>
<td></td>
<td>130</td>
<td>180</td>
</tr>
<tr>
<td>CHFRS-2P</td>
<td></td>
<td>130</td>
<td>180</td>
</tr>
</tbody>
</table>

* The minimum mixing temperature shall be lowered to 200 when a warm mix technology, as approved by the Engineer, is used.

1015.5.1 Application temperatures of other grades of emulsions shall be as specified in the contract.

1015.5.2 The spraying temperature for non-modified PG 46-28 asphalt binder shall be 260 - 325°F, and for all other higher temperature non-modified performance grades, the spraying temperature shall be 285 - 350°F. The mixing and compaction temperatures for performance graded asphalt binder shall be determined by rotational viscosity testing as defined in ASTM D 4402.

1015.5.3 When material to be applied by pressure distributor is, due to refining or blending procedures, delivered at a temperature above the specified limits, the material may be applied at the higher temperature provided satisfactory application can be obtained at the specified rate and provided sufficient precaution is exercised with respect to the fire hazard.

1015.6 Measurement of Bituminous Material. Field weight or field volumetric determinations of the material actually incorporated into the work will be used for measurement of the quantity of bituminous material for payment. The volume of material supplied from intermediate storage tanks will be determined from the net weight of the material. The net weight will be determined from the gross weight of the loaded transport vehicle used to deliver the material to the project less the empty transport vehicle weight. The volume correction methods
specified below will be used for determining the volume of bituminous material. Scales for determining the weight of bituminous material shall be in accordance with Sec 310.

1015.6.1 Liquid Bituminous Material and Asphalt Binder - Volumetric Determination. Measurement of the material will be based on the volume at 60°F. The volume correction factors of ASTM D 1250, Table 24b, will be used for converting the material from the volume at the observed temperature to the volume at 60°F. The volume of uncalibrated distributors and tank trucks will be determined from the net weight of the material. The net weight will be determined from the gross weight of the loaded delivery vehicle less the empty delivery vehicle weight. For computing the volume in gallons from weight, the following formula will be used:

\[ G = \frac{W}{SG \times 8.328} \]

where:
- \( G \) = Volume in gallons at 60°F.
- \( W \) = Weight of material in pounds.
- \( SG \) = Specific Gravity of material at 60°F.

1015.6.2 Emulsified Asphalt. Measurement of the material will be based on the volume at 60°F using a coefficient of expansion of 0.0003 per degree F for converting the material from the volume at the observed temperature to the volume at 60°F.

SECTION 1015.10 PERFORMANCE GRADED ASPHALT BINDER.

1015.10.1 General. Performance graded asphalt binder shall be an asphalt-based binder produced from petroleum residue either with or without the addition of non-particulate organic modifiers. The grade shall be as specified in the contract.

1015.10.2 Basis of Acceptance. Suppliers furnishing PG and MSCR asphalt binders to St. Charles County projects by certification shall be in accordance with AASHTO R 26, except as noted herein. Materials shall be pre-qualified with MoDOT Construction and Materials. Changes in formulation, base stock or methods of manufacture of qualified performance graded binders shall be noted and may require requalification. All PG and MSCR binders must meet specifications after the introduction of any liquid anti-strip or warm mix additives. If the results of any test do not conform to the requirements of this specification, retest to determine conformity.

1015.10.3 Characteristics. Performance graded asphalt binder shall be in accordance with AASHTO M 320 for the grade specified, except as follows. AASHTO T 111, Inorganic Matter or Ash in Bituminous Materials, may be substituted for AASHTO T 44, Solubility of Bituminous Materials, at the specification value indicated prior to the addition of ground tire rubber (GTR.) All blends containing GTR shall include 4.5 percent transpolyoctenamer rubber (TOR) by weight of the GTR. The direct tension test will be waived. The following additional requirements will apply:

<table>
<thead>
<tr>
<th>Binder Characteristics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Temperature Spread Between Upper and Lower Temperature for PG Binder Grade(^a)</td>
<td>Elastic Recovery(^b), Percent, Minimum, AASHTO T 301</td>
<td>Separation Test(^c), Percent Difference, Maximum, ASTM D 5976</td>
</tr>
<tr>
<td>86°C</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>92°C</td>
<td>55%</td>
<td>10%</td>
</tr>
<tr>
<td>98°C</td>
<td>65%</td>
<td>10%</td>
</tr>
<tr>
<td>104°C</td>
<td>75%</td>
<td>10%</td>
</tr>
</tbody>
</table>

\(^a\) Temperature Spread = Upper PG Temperature minus Lower PG Temperature.
Elastic recovery test to be performed on the residue from the Rolling Thin Film Oven Test at 25°C and 10 cm elongation.

Separation test to be performed in accordance with ASTM D 5976, except test upper and lower portions as original binder for G* value according to AASHTO T 315 except for GTR binders that require continuous agitation.

1015.10.3.1 In lieu of AASHTO M 320, AASHTO M 332 may be substituted eliminating the elastic recovery requirement, except for use with Sec 413.30, Ultrathin Bonded Asphalt Wearing Surface. The equivalent grading will PG 64-22, Grade S for PG 64-22, Grade H for PG 70-22 and Grade V for PG 76-22. Specialty grades will be tested at the grade temperature for the desired characteristics, i.e. PG 58-28 for RAS mixtures.

1015.10.4 Characteristics for GTR. Ground tire rubber shall be ambient ground, free of wire or other contaminating materials and not contain more than 0.1 percent fabric. Cryogenically ground rubber may be used by demonstrating that the GTR is satisfactorily suspended during all phases of production and storage. The gradation of the GTR shall be as follows:

<table>
<thead>
<tr>
<th>Ground Tire Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
</tbody>
</table>

1015.10.4.1 Modification Process. The percentage by weight of binder shall be included with each lot of material. Ground tire rubber modified asphalt binder shall be tested and certified in accordance with Sec 1015.10.2 and may be incorporated by any of the following methods:

1015.10.4.1.1 Blending at HMA Plant. All sampling and testing shall be performed in accordance the requirements for terminal blending including high and low temperature testing.

1015.10.4.1.2 Terminal Blending. Blending and certification shall be in accordance with Sec 1015.

1015.10.5 Storage. Performance graded asphalt binder shall be furnished as a uniform mixture shipped directly to the project site from the asphalt binder supplier's permanent plant address or intermediate storage facility, suitable for direct use. Asphalt binder shall be capable of being stored at the project site without separation or settling. Automatic blending will be allowed at the terminal. Intermediate blending of asphalt binder and additives will not be allowed at the project site, unless the asphalt binder is sampled at a point in the operation which captures the final blended binder with all additives incorporated.

SECTION 1015.20 LIQUID BITUMINOUS MATERIAL.

1015.20.1 Suppliers furnishing liquid bituminous materials shall comply with the following. All truck shipments shall be loaded from approved storage tanks, which have been sampled, tested, and certified by the supplier to the Engineer. If automatic blending equipment is used, blender material will be approved for use provided the finished product complies with specifications. At least one complete test shall be conducted every 2 weeks on each grade of material furnished for County work from the blender. A certified copy of the test results shall be furnished to the Engineer. Sampling and testing for certification purposes shall be conducted prior to shipping material to County work. After loading, the supplier shall sample and make identifying tests on a sufficient number of truck shipments of material consigned to a construction project to ensure that proper quality control is being maintained and that all such shipments comply with the specification requirements. The identifying test is viscosity for liquid bituminous
material. For all liquid bituminous material, AASHTO T 111, "Inorganic Matter or Ash in Bituminous Materials", may be substituted for AASHTO T 44, "Solubility of Bituminous Materials", at the specification value indicated.

1015.20.2 Not Used.

1015.20.3 Type RC Liquid Asphalt. Type RC liquid asphalt shall be produced by fluxing an asphaltic base with suitable petroleum distillates. The material shall show no separation or curdling prior to use and shall not foam when heated to the application temperature. The material shall be in accordance with AASHTO M 81, invoking Note 3 using penetration in lieu of viscosity for the grade specified in the contract.

1015.20.4 Type MC Liquid Asphalt. Type MC liquid asphalt shall be produced by fluxing an asphaltic base with suitable petroleum distillates. The material shall show no separation or curdling prior to use and shall not foam when heated to the application temperature. The material shall be in accordance with AASHTO M 82, invoking Note 4 using penetration in lieu of viscosity for the grade specified in the contract.

1015.20.5 Emulsified Asphalt. Non-polymer emulsified asphalt shall be in accordance with AASHTO M 140 or AASHTO M 208, for the type and grade specified in the contract.

1015.20.5.1 Polymer Modified Asphalt Emulsion - Seal Coat. Bituminous material for polymer modified asphalt shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Polymer Modified Asphalt Emulsion</th>
<th>CRS-2P</th>
<th>EA-90P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Viscosity, SSF @ 50°C</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>Storage Stability Testb, 24 hour, percent</td>
<td>----</td>
<td>1</td>
</tr>
<tr>
<td>Classification Test</td>
<td>Pass</td>
<td>----</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>Positive</td>
<td>----</td>
</tr>
<tr>
<td>Sieve Test, 850 µm mesh, percent</td>
<td>----</td>
<td>0.3</td>
</tr>
<tr>
<td>Demulsibility, 0.02 N CaC12, percent</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Distillation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil distillate by volume of emulsion, percent</td>
<td>----</td>
<td>3</td>
</tr>
<tr>
<td>Residue from distillationc, percent</td>
<td>65</td>
<td>----</td>
</tr>
<tr>
<td>Tests on Residue from Distillation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration, 25°C, 100 g, 5 sec</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Ductility, 4°C, 5 cm/minute, cm</td>
<td>30</td>
<td>----</td>
</tr>
<tr>
<td>Ashd, percent</td>
<td>----</td>
<td>1</td>
</tr>
<tr>
<td>Float Test at 60°C, sec</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Elastic Recoverye, percent</td>
<td>58</td>
<td>----</td>
</tr>
</tbody>
</table>

a All tests shall be performed in accordance with AASHTO T 59 except as noted.
b In addition to AASHTO T 59, upon examination of the test cylinder, and after standing undisturbed for 24 hours, the surface shall show no appreciable white, milky colored substance and shall be a homogeneous brown color throughout.
c AASHTO T 59 shall be modified to maintain a 399°F ± 10°F maximum temperature for 15 minutes.
d Percent ash shall be determined in accordance with AASHTO T 111, Ash in Bituminous Material.
e Elastic recovery shall be determined as follows. Condition the ductilometer and samples to be treated at 50°F. Prepare the brass plate, mold and briquet specimen in accordance with AASHTO T 51. Keep the specimen at the specified test temperature of 50°F for 85 to 95 minutes. Immediately after conditioning, place the specimen in the ductilometer and proceed to elongate the sample to 20 cm at a rate of pull of 5 cm/min. After the 20 cm elongation has been reached, stop the ductilometer and hold the sample in the elongated position for 5 minutes. After 5 minutes, clip the sample approximately in half by means of scissors or other suitable cutting
devices. Let the sample remain in the ductilometer in an undisturbed condition for one hour. At the end of this time period, retract the half sample specimen until the two broken ends touch. At this point note the elongation (x) in cm. Calculate the percent recovery by the following formula:

\[
\% \text{ Recovery} = \frac{20 - x}{20} \times 100
\]

### Polymer Modified Asphalt Emulsion

<table>
<thead>
<tr>
<th>Test</th>
<th>CHFRS-2P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>Viscosity, SFS @ 50°C</td>
<td>100</td>
</tr>
<tr>
<td>Storage Stability Test, 24 hour, percent</td>
<td>---</td>
</tr>
<tr>
<td>Demulsibility, 35 ml 0.8% dioctyl sodium sulfo succinate, percent</td>
<td>60</td>
</tr>
<tr>
<td>Sieve Test, percent</td>
<td>---</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>Positive</td>
</tr>
<tr>
<td>Distillation</td>
<td></td>
</tr>
<tr>
<td>Oil Distillate, by volume of emulsion, percent</td>
<td>---</td>
</tr>
<tr>
<td>Residue from distillation, percent</td>
<td>65</td>
</tr>
<tr>
<td>Tests on Residue from Distillation:</td>
<td></td>
</tr>
<tr>
<td>Polymer content, weight, percent (solids based)</td>
<td>3.0</td>
</tr>
<tr>
<td>Softening Point, °C</td>
<td>54</td>
</tr>
<tr>
<td>Float test at 60°C, s</td>
<td>1800</td>
</tr>
<tr>
<td>Penetration, 25°C, 100 g, 5 s</td>
<td>80</td>
</tr>
<tr>
<td>Viscosity @ 60°C, Poise</td>
<td>1300</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, percent</td>
<td>95</td>
</tr>
<tr>
<td>Elastic Recovery(^c) @ 10°C, percent</td>
<td>65</td>
</tr>
</tbody>
</table>

\(^a\) All tests shall be performed in accordance with AASHTO T-59 except as noted.  
\(^b\) AASHTO T59 shall be modified to maintain a 177 ± 5°C maximum temperature to be held for 20 minutes. Complete the total distillation in 60 ± 5 minutes from the first application of heat.  
\(^c\) Elastic recovery shall be determined as follows. Condition the ductilometer and samples to be treated at 10°C. Prepare the brass plate, mold, and briquet specimen in accordance with AASHTO T 51. Keep the specimen at the specified test temperature of 10°C for 85 to 95 minutes. Immediately after conditioning, place the specimen in the ductilometer and proceed to elongate the sample to 20 cm at a rate of pull of 5 cm/min. After the 20 cm elongation has been reached, stop the ductilometer and hold the sample in the elongated position for 5 minutes. After the 5 minutes, clip the sample approximately in half by means of scissors or other suitable cutting devices. Let the sample remain in the ductilometer in an undisturbed condition for one hour. At the end of this time period, retract the half sample specimen until the two broken ends touch. At this point note the elongation recovery (X) in cm. Calculate the percent recovery by the following formula:

\[
\% \text{ Recovery} = \frac{20 - X}{20} \times 100
\]

1015.20.5.1.1 Polymer Modified Asphalt Emulsion - Tack Coat. Bituminous material for polymer modified asphalt shall be in accordance with the following:
<table>
<thead>
<tr>
<th>Test on Emulsion</th>
<th>Method</th>
<th>SS-1HP</th>
<th>CSS-1HP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol @ 25°C (77°F), s</td>
<td>AASHTO T 59</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td></td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Storage Stability Test&lt;sup&gt;b&lt;/sup&gt;, 24 hr, percent</td>
<td>AASHTO T 59</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Sieve Test, percent</td>
<td>AASHTO T 59</td>
<td>--</td>
<td>0.5</td>
</tr>
<tr>
<td>Residue by Distillation&lt;sup&gt;c&lt;/sup&gt;, percent</td>
<td>AASHTO T 59</td>
<td>57</td>
<td>--</td>
</tr>
<tr>
<td>Oil Distillate by Distillation, percent</td>
<td>AASHTO T 59</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Test on Residue from Distillation

<table>
<thead>
<tr>
<th>Test on Residue from Distillation</th>
<th>Method</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration 25°C, 100 g, 5 s</td>
<td>AASHTO T 49</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>Elastic Recovery&lt;sup&gt;d&lt;/sup&gt;, 20 cm, 5 cm/min, 60 min, %</td>
<td>AASHTO T 301</td>
<td>30</td>
<td>--</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene&lt;sup&gt;e&lt;/sup&gt;, %</td>
<td>AASHTO T 44</td>
<td>97.5</td>
<td>--</td>
</tr>
</tbody>
</table>

<sup>a</sup> The emulsified asphalt shall be in accordance with Sec 1015.20.5, except as indicated above, and shall be modified with a styrene-butadiene diblock or triblock copolymer or a styrene butadiene rubber.

<sup>b</sup> In addition to AASHTO T 59, upon examination of the test cylinder, and after standing undisturbed for 24 hours, the surface shall show no appreciable white, milky colored substance and shall be homogeneous brown color throughout. The storage stability test may be waived provided the asphalt emulsion storage tank at the project site has adequate provisions for circulating the entire contents of the tank, provided satisfactory field results are obtained.

<sup>c</sup> AASHTO T 59 shall be modified to use a lower distillation temperature of 177°C (350°F).

<sup>d</sup> AASHTO T 301 shall be modified to allow the residue to be obtained from distillation as long as the distillation temperature is modified as stated above. The test on residue shall be conducted at a temperature of 10°C (50°F).

<sup>e</sup> In lieu of performing AASHTO T 44, AASHTO T 111, Ash in Bituminous Material, may be performed with a maximum allowable percent ash of 1.0 percent.

### 1015.20.5.2 Asphalt Emulsion for Micro-Surfacing

Bituminous material for micro-surfacing shall be a polymer modified asphalt emulsion, grade CSS-1h, in accordance with the following table. The bituminous material shall show no separation after mixing. A minimum of 3.0 percent polymer content, by mass, of an approved polymer shall be milled into the asphalt emulsion at the time of manufacture of the emulsion. The emulsion shall be sampled in accordance with AASHTO T 40.

<table>
<thead>
<tr>
<th>Micro-Surfacing Emulsion (MSE-1)</th>
<th>Min</th>
<th>Max</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 77°F, s</td>
<td>20</td>
<td>100</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Storage stability test, 24 hr, percent</td>
<td>- -</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Particle charge test positive&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Sieve test, percent</td>
<td>- -</td>
<td>0.50</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Residue, percent</td>
<td>62</td>
<td>--</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Tests on Residue from Distillation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration, 77°F, 100 g, 5 s,</td>
<td>40</td>
<td>90</td>
<td>AASHTO T 49</td>
</tr>
<tr>
<td>Ductility, 25°C, 5 cm/min, cm,</td>
<td>40</td>
<td>--</td>
<td>AASHTO T 51</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97.50</td>
<td>--</td>
<td>AASHTO T 44</td>
</tr>
</tbody>
</table>

<sup>a</sup> The storage stability test may be waived provided the asphalt emulsion storage tank at the project site has adequate provisions for circulating the entire contents of the tank, and provided satisfactory field results are obtained.

<sup>b</sup> If the particle charge test is inconclusive, material having a maximum pH value of 6.7 will be acceptable.
1015.20.5.3 Scrub Seal Emulsion. Scrub seal emulsion shall be smooth and homogeneous, polymer modified, shall contain an asphalt rejuvenator and shall be in accordance with the following:

**Scrub Seal Emulsion (SSE-1)**

<table>
<thead>
<tr>
<th>Test on Emulsion</th>
<th>Min</th>
<th>Max</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saybolt Furol Viscosity, SFS @ 77°F</td>
<td>30</td>
<td>100</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Storage Stability Test a, 24 hr., %</td>
<td>--</td>
<td>1a</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Demulsibility, 35 ml of 0.02N, CACl₂, %</td>
<td>--</td>
<td>60</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Sieve Testb, percent</td>
<td>--</td>
<td>0.3</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Residue by Distillationc @ 205 ± 5°C, %</td>
<td>60</td>
<td>--</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Oil Distillate by Volume, percent</td>
<td>--</td>
<td>3</td>
<td>AASHTO T 59</td>
</tr>
</tbody>
</table>

**Tests on Residue from Distillation**

<table>
<thead>
<tr>
<th>Test on Residue from Distillation</th>
<th>Min</th>
<th>Max</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration @ 77°F, 5 s, 100 g, dmm</td>
<td>100</td>
<td>300</td>
<td>AASHTO T 49</td>
</tr>
<tr>
<td>Float Test @ 140°F, s</td>
<td>1200</td>
<td>--</td>
<td>AASHTO T 50</td>
</tr>
<tr>
<td>Ash, percent</td>
<td>--</td>
<td>1</td>
<td>AASHTO T 111</td>
</tr>
<tr>
<td>Elastic Recovery, 10°C, 200 mm elongation, 60 min. recovery, percent</td>
<td>30</td>
<td>--</td>
<td>ASTM D 5976</td>
</tr>
<tr>
<td>Saturatesd, percent</td>
<td>--</td>
<td>20</td>
<td>ASTM D 4124</td>
</tr>
</tbody>
</table>

a Upon examination of the test cylinder after standing undisturbed for 24 hours, the surface shall show no white, milky colored substance and shall be a homogeneous brown color throughout.

b A percentage of 0.30 will be acceptable for samples taken at the point of use or shipped to the Central Laboratory for testing.

c ASTM D 244 shall be modified to include a 205 ± 5°C maximum temperature to be held for 15 minutes.

d ASTM D 4124 shall be modified to use Alumina, CG - 20 Grade, available from Aluminum Company of America, Pittsburgh, PA.

1015.20.5.4 Hard Penetration Asphalt Emulsions (SS-1vh). The hard penetration asphalt emulsions shall be in accordance with the following:

**Emulsion Properties of Hard Penetration Asphalt Emulsions (SS-1vh)**

<table>
<thead>
<tr>
<th>Test on Emulsion</th>
<th>Method</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol @ 25°C (77°F), s</td>
<td>AASHTO T 59</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Storage Stability Testa, 24 hr., percent</td>
<td>AASHTO T 59</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Sieve Test, percent</td>
<td>AASHTO T 59</td>
<td>--</td>
<td>0.3</td>
</tr>
<tr>
<td>Residue by Distillation, percent</td>
<td>AASHTO T 59</td>
<td>50</td>
<td>--</td>
</tr>
<tr>
<td>Oil Distillate by Distillation, percent</td>
<td>AASHTO T 59</td>
<td>--</td>
<td>1</td>
</tr>
</tbody>
</table>

**Tests on Residue from Distillation**

<table>
<thead>
<tr>
<th>Test on Residue from Distillation</th>
<th>Method</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softening Point, °F</td>
<td>AASHTO T 53</td>
<td>149</td>
<td>200</td>
</tr>
<tr>
<td>Penetration 25°C (77°F), 100 g, 5 s</td>
<td>AASHTO T 49</td>
<td>--</td>
<td>40</td>
</tr>
<tr>
<td>G* / sin delta @ 76°C – 10 rad/sec, kPa</td>
<td>AASHTO T 315</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>Solubility in Trichloroethyleneb, %</td>
<td>AASHTO T 44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a In addition to AASHTO T 59, upon examination of the test cylinder, and after standing undisturbed for 24 hours, the surface shall show no appreciable white, milky colored substance and shall be homogeneous brown color throughout. The storage stability test may be waived provided the asphalt emulsion storage tank at the project site has adequate provisions for circulating the entire contents of the tank, provided satisfactory field results are obtained.

b In lieu of performing AASHTO T 44, AASHTO T 111, Ash in Bituminous Material, may be performed with a maximum allowable percent ash of 1.0 percent.
1015.20.6 Ultrathin Bonded Wearing Surface. Bituminous material for ultrathin bonded wearing surface shall be in accordance with the following.

1015.20.6.1 Asphalt Binder. The asphalt binder shall be in accordance with Sec 1015.10, and specifically as follows:

<table>
<thead>
<tr>
<th>Tests</th>
<th>Method</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation Test, %</td>
<td>AASHTO PP-5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Elastic Recovery Test, %</td>
<td>ASTM D 6084</td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

1015.20.6.2 Polymer Modified Emulsion Membrane. The anionic or cationic emulsion shall be polymer modified and shall be in accordance with one of the following:

<table>
<thead>
<tr>
<th>Anionic Polymer Modified Emulsion Membrane (PEM-1)</th>
<th>Tests on Emulsion</th>
<th>Method</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol @122°F, s</td>
<td>AASHTO T 59</td>
<td>25</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Storage Stability Test(^a), 24 h, percent</td>
<td>AASHTO T 59</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve Test(^b), percent</td>
<td>AASHTO T 59</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residue by Distillation(^c), percent</td>
<td>AASHTO T 59</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Distillate by Distillation, percent</td>
<td>AASHTO T 59</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demulsibility, % 35 ml, 0.02 N CaCl(_2)</td>
<td>AASHTO T 59</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Tests on Residue From Distillation                |                   |       |     |
| Penetration                                      | AASHTO T 49       | 90    | 150 |
| Elastic Recovery, percent                        | AASHTO T 301      | 60    |     |

<table>
<thead>
<tr>
<th>Cationic Polymer Modified Emulsion Membrane (CPEM-1)</th>
<th>Tests on Emulsion</th>
<th>Method</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol @122°F, s</td>
<td>AASHTO T 59</td>
<td>25</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Storage Stability Test(^a), 24 h, percent</td>
<td>AASHTO T 59</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve Test(^b), percent</td>
<td>AASHTO T 59</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residue by Distillation(^c), percent</td>
<td>AASHTO T 59</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Distillate by Distillation, percent</td>
<td>AASHTO T 59</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demulsibility, % 35 ml, 0.8% dioctyl sodium sulfosuccinate</td>
<td>AASHTO T 59</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Tests on Residue From Distillation                |                   |       |     |
| Penetration                                      | AASHTO T 49       | 90    | 150 |
| Elastic Recovery, %                               | AASHTO T 301      | 60    |     |

\(^a\) After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

\(^b\) The sieve test will be waived if successful application of the material has been achieved in the field.

\(^c\) AASHTO T 59 shall be modified to include a 400°F ± 10°F maximum temperature to be held for a period of 15 minutes.
SECTION 1017
GROUND GRANULATED BLAST FURNACE SLAG

1017.1 Scope. This specification covers ground Granulated Blast Furnace Slag (GGBFS) for use in Portland cement concrete.

1017.2 General. All GGBFS shall be in accordance with AASHTO M 302, Grade 100 or 120, except as herein specified. Only GGBFS from sources qualified in accordance with these specifications will be permitted.

1017.2.1 GGBFS may only be used with AASHTO M 85, Type I or Type II Portland cement, unless otherwise directed by the Engineer.

1017.2.2 The mixing of different grades and sources of GGBFS will not be permitted.

1017.2.3 The term "manufacturer", as used in this specification, will be the company grinding the granulated blast furnace slag to produce GGBFS. The term "marketing entity", as used in this specification, will be the supplier or broker of the GGBFS. The marketing entity will be responsible for complying with these specifications.

1017.2.4 All tests shall be performed in a MoDOT approved laboratory.

1017.3 Sampling, Testing Shipping and Storage. All marketing entities, independent laboratories and terminals testing or furnishing GGBFS to St. Charles County projects shall be MoDOT qualified.

1017.3.1 Storage. All GGBFS intended for use shall be sampled, tested and placed in designated silos or bins, or buildings that are weather-tight that will protect the GGBFS from dampness and minimize quality deterioration. All silos, bins or buildings shall be completely empty and clean before GGBFS is deposited therein. GGBFS that is delivered in packages shall have the classification of the GGBFS, the name and brand of manufacturer, and the mass of the GGBFS contained therein plainly marked on each package. Similar information is to be provided in the shipping documents. No GGBFS stored by the Contractor over the winter shall be used until retested by a Contractor's independent laboratory.

1017.3.2 Shipping. GGBFS continually sampled and tested via autosamplers at a location, frequency and duration acceptable to MoDOT, may be continuously shipped direct from a marketing entity. All GGBFS manually sampled and tested shall be held in the silo or bin until such time as the test results are completed prior to shipping. Conveyances for bulk shipment shall have the compartments completely empty and clean before any GGBFS is loaded therein.

1017.4 Basis of Acceptance. The marketing entity shall certify that the material complies with the St. Charles County specification requirements. When a qualified marketing entity or terminal is shipping GGBFS for, or purchasing GGBFS from, another qualified marketing entity, the bill of lading or delivery receipt shall be from the shipping company. The certification statement showing the actual manufacturer shall be prominently placed on the bill of lading or delivery receipt. A copy of the bill of lading or delivery receipt shall accompany each shipment and shall be furnished to St. Charles County at the shipping and destination points.

1017.4.1 The bill of lading or delivery receipt for each shipment to St. Charles County projects shall carry the following certification statement:

"This is to certify this Grade _____ GGBFS originated from a MoDOT qualified manufacturer, has been maintained to meet St. Charles County specifications and was loaded from silo number ________.

__________________________________ Name and Location of Manufacturer
__________________________________ Name and Location of Shipping Facility
By_________________________________ Signature and Name of Marketing Entity"
SECTION 1018
FLY ASH FOR CONCRETE

1018.1 Scope. This specification covers fly ash for use in Portland cement concrete. Fly ash is considered a finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gasses. Fly ash is collected by mechanical or electrical means and stored in stockpiles or bins.

1018.2 General. Only fly ash from sources qualified in accordance with these specifications will be permitted. The mixing of different classes and sources of fly ash will not be permitted. All fly ash shall be in accordance with AASHTO M 295, Class C (has pozzolanic and cementitious properties) or F (has pozzolanic properties), except as herein specified. Different classes of fly ash shall not be mixed nor shall different types be used in the same unit of construction.

1018.2.1 The percent each of silicon dioxide (SiO2), aluminum oxide (Al2O3) and iron oxide (Fe2O3) shall be reported in addition to the total of the three.

<table>
<thead>
<tr>
<th>Class</th>
<th>Total of silicon dioxide, aluminum oxide and iron oxide</th>
<th>Range, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>66</td>
</tr>
<tr>
<td>F</td>
<td>74</td>
<td>-</td>
</tr>
</tbody>
</table>

1018.2.2 Loss on ignition shall not exceed 1.5 percent. When used with Controlled Low Slump Material the loss on ignition requirements is waived.

1018.2.3 The available alkalies, as equivalent, as Na2O, shall not exceed 1.5 percent.

1018.2.4 The term "manufacturer", as used in this specification, is the actual manufacturer of the fly ash. The term, "marketing entity", as used in this specification, is the supplier or broker of the fly ash. The marketing entity shall be responsible for complying with these specifications.

1018.2.5 Cement used by the marketing entity for testing fly ash shall be in accordance with AASHTO M 85.

1018.2.6 All tests shall be performed in a MoDOT approved laboratory.

1018.3 Sampling, Testing, Shipping and Storage. All marketing entities, independent laboratories and terminals testing and furnishing fly ash to St. Charles County projects shall be MoDOT qualified.

1018.3.1 Shipping. Fly ash shall be continually sampled and tested via autosamplers at a location, frequency, and duration acceptable to the County, and may be continuously shipped direct from a marketing entity or generating station silo.

1018.3.2 Storage. All fly ash intended for use shall be sampled, tested, and placed in designated silos or bins.

1018.3.3 Coal Sources and Process. Fly ash from each coal source at each plant shall be qualified separately. Coals from different sources may be blended prior to burning, but the qualification shall be based on the blend. When the production procedure or fuel source is changed, or when any change is made by the manufacturer that alters the properties or characteristics of the qualified fly ash, requalification may be required.

1018.4 Acceptance. The marketing entity shall certify that the material complies with St. Charles County specification requirements. When a qualified marketing entity or terminal is shipping fly ash for, or purchasing fly
ash from, another qualified marketing entity, the bill of lading or delivery receipt shall be from the shipping company. The certification statement showing the actual manufacturer shall be prominently placed on the bill of lading or delivery receipt. A copy of the bill of lading or delivery receipt shall accompany each shipment and shall be furnished to St. Charles County at the shipping and destination points.

1018.4.1 The bill of lading or delivery receipt for each shipment to County projects shall carry the following certification statement:

"This is to certify this Class ___ fly ash originated from a County qualified manufacturer, has been maintained to meet County specifications and was loaded from silo number __."  
Name and Location of Manufacturer: ____________________________  
Name and Location of Shipping Facility: ____________________________  
By: ______________________________ (Signature and Name of Marketing Entity)
SECTION 1019
CEMENT

1019.1 Scope. This specification covers Portland cement, hydraulic cement and blended hydraulic cement.

1019.2 General. All Portland cement shall be in accordance with the following requirements. The basis of acceptance will be as described in Sec 1019.4.

1019.2.1 Portland Cement. All Portland cement shall be in accordance with AASHTO M 85 with the following modifications:

(a) Specific surface, fineness, for all Type I Portland cements shall not exceed 430 m²/kg using Air permeability test. Maximum fineness limits do not apply if the sum of C3S + 4.75C3A is less than or equal to 90.

(b) When slag cement is used as an inorganic processing addition, loss on ignition shall be corrected in accordance with ASTM C 114 and reported on mill test reports.

1019.2.2 Hydraulic Cement. All hydraulic cement shall be in accordance with ASTM C 1157.

1019.2.3 Blended Hydraulic Cement. All blended hydraulic cement shall be in accordance with Type IP, IS, IL or IT of AASHTO M 240 with the following modification that chemical composition shall be provided and tolerances checked in accordance with Section 7.1.1 of AASHTO M240 and allowable constituent amounts of Type IP, IS, IL and IT cements are within the specified limits listed below:

(a) Type IP cement shall have a pozzolan constituent up to 25 percent by mass of the blended cement. Type IP cements, in which the pozzolan constituent is metakaolin or silica fume, shall be a maximum of 15 or 8 percent, respectively.

(b) Type IS cement shall have a slag cement constituent up to 25 percent by mass of the blended cement.

(c) Type IL cement shall have a limestone constituent up to 15 percent by mass of blended cement.

(d) Type IT cement shall have a slag cement, limestone and pozzolan constituent up to 40 percent by mass of the ternary blended cement. The maximum constituent requirements shall be in accordance with Sec 1019.2.3 (a), (b) and (c) in some combination up to 40 percent.

1019.2.4 Other Cements. White Portland cement shall meet the requirements for Type I. Air-entraining Portland cement shall be used only when specified in the contract. Different types of cement shall not be mixed nor shall different types be used in the same unit of construction.

1019.2.5 Sack or Bag. A sack or bag of cement will be considered to be 94 pounds net.

1019.3 Sampling, Testing, Packaging and Storage. All manufacturers and terminals furnishing cement to St. Charles County projects shall be MoDOT qualified.

1019.3.1 Foreign Cement. All tests on foreign cement shall be performed by a qualified domestic manufacturer's independent laboratory.

1019.3.2 Packaging and Storage. All cement intended for use shall be sampled, tested, and placed in designated silos, bins, or buildings that are weather-tight that will protect the cement from dampness and minimize warehouse set. Cement that is delivered in packages shall have the words "Portland Cement", the type of cement, the name and brand of manufacturer, and the mass of cement contained therein plainly marked on each package. When the
cement is an air-entraining type, the words “air-entraining” shall be plainly marked on each package. Similar information is to be provided in the shipping documents.

1019.4 Acceptance. The supplier shall certify that the material complies with the specification requirements. When a qualified manufacturer or terminal is shipping cement for, or purchasing cement from, another qualified manufacturer, the bill of lading or delivery receipt shall be from the shipping company. The certification statement showing the actual manufacturer shall be prominently placed on the bill of lading or delivery receipt. A copy of the bill of lading or delivery receipt shall accompany each shipment and shall be furnished to St. Charles County at the shipping and destination points.

1019.4.1 Certification. The bill of lading or delivery receipt for each shipment to St. Charles County projects shall carry the following certification statement:

"This is to certify this Type ___ cement originated from a MoDOT qualified manufacturer, has been maintained to meet St. Charles County specifications and was loaded from silo number ________.

__________________________________ Name and Location of Manufacturer

__________________________________ Name and Location of Shipping Facility

By_______________________________ Signature and Name of Marketing Entity
1020.1 **Scope.** This specification covers corrugated steel pipe, pipe-arches and flared end sections intended for use in the construction of culverts and similar uses. The steel used in fabrication shall have a protective metallic coating of zinc (galvanizing) or aluminum.

1020.2 **Basis of Acceptance.** Unless otherwise specified, the basis of acceptance will be in accordance with AASHTO M 36. Pipe shall be from an approved qualified plant and will be accepted based on certification, manufacturer quality control documentation and tests on samples as required by the Engineer.

1020.3 **Material.**

1020.3.1 **Steel Sheet.** Steel sheet shall be certifiable in accordance with AASHTO M 218 or AASHTO M 274. Finished steel sheet shall be free from injurious defects such as blisters, flux and uncoated spots.

1020.3.2 **Zinc Coating.** Zinc for coating or galvanizing shall be prime western grade or better. Zinc-coated steel shall have a weight of zinc coating no less than 2.00 ounces psf of double exposed surface. If the average weight of zinc coating, as determined from the required samples, is less than 2.00 ounces psf, or if any one specimen has less than 1.80 ounces of zinc psf of double exposed surface, the lot sampled will be rejected or resampled, as determined by the Engineer. If a retest is conducted, the weight of zinc coating of all of the original samples and the samples for retest shall average at least 2.00 ounces psf of double exposed surface, and no specimen shall have less than 1.80 ounces psf, or the entire lot sampled will be rejected. Adherence of coating shall be such that no peeling occurs while the material is being corrugated or formed into pipe.

1020.3.3 **Aluminum Coating.** Aluminum for coating shall be commercially pure aluminum. The bath analysis shall be in accordance with the *Aluminum Bath Analysis* table shown on the plans. Aluminum-coated steel shall have a weight of aluminum coating no less than 1.00-ounce psf of double exposed surface. If the average weight of aluminum coating, as determined from the required samples, is less than 1.00-ounce psf or if any one specimen has less than 0.90 ounce of aluminum psf of double exposed surface, the lot sampled will be rejected or resampled, as determined by the Engineer. If a retest is conducted, the weight of aluminum coating of all of the original samples and the samples for retest shall average at least 1.00-ounce psf of double exposed surface and no specimen shall have less than 0.90-ounce psf or the entire lot sampled will be rejected.

1020.3.4 **Documentation.**

1020.3.4.1 **Sheet Manufacturer’s Certified Analysis.** The manufacturer of each brand shall file with the St. Charles County Highway Department a certificate setting forth the name or brand of metal to be furnished, the specified chemical composition and a typical or average analysis showing the percent of carbon, phosphorus, manganese, sulfur and silicon. The certificate shall be sworn to, for the manufacturer, by a person having legal authority to bind the company.

1020.3.4.2 **Sheet Manufacturer’s Guarantee.** The manufacturer of the steel sheet shall submit with the certified analysis a guarantee providing that all metal furnished is in accordance with the specification requirements, shall bear a suitable identification brand or mark and shall be replaced without cost to the County when not in accordance with the specified analysis, sheet thickness or coating. The guarantee shall be so worded as to remain in effect as long as the manufacturer continues to furnish material. The manufacturer shall conduct such tests and measurements as necessary to ensure the material produced is in accordance with all specification requirements. These tests and measurements shall be identified by the identification symbols or code used on the sheet in a manner that will permit the manufacturer to produce specific reports showing test results representative of specific lots of steel sheet. Copies of reports of these tests shall be kept on file and shall be submitted to the Engineer upon
request. The brand shall be removed or obliterated by the manufacturer on all material where control tests, as outlined herein, do not show conformance to this specification.

1020.4 Fabrication.

1020.4.1 Riveted Seams. A longitudinal seam will not be permitted on the corner radius or invert of pipe-arch.

1020.4.2 Resistance Spot Welded Seams. A longitudinal seam will not be permitted on the corner radius or invert of pipe arch.

1020.4.3 Shop Elongation. If round pipe is required to be shop elongated, the vertical axis shall be five percent greater than the nominal diameter. A tolerance of one percentage point in elongation will be permitted. Approximately 2 feet at each end of an installation may be left round to accommodate connecting end treatments or extensions. A paint mark to indicate the top of the pipe shall be placed on each piece of shop elongated pipe, and round ends on an elongated pipe shall be clearly marked "Outside End-Round".

1020.4.4 Beveled Ends. Corrugated metal pipe requiring beveled ends to conform to the adjacent roadway slope shall be cut in such a manner as to leave smooth edges without damage to the coating away from the cut edge. Cut edges shall be completely covered with two coats of single component inorganic zinc or organic zinc-rich paint meeting the approval of the Engineer. No other end finish will be required for pipe with beveled ends.

1020.4.5 End Sections. Metal end sections shall be in accordance with the requirements for base metal, coating, fabrication, sampling, accepted brands of metal, sheet manufacturer's certified analysis, sheet manufacturer's guarantee, sheet thickness, workmanship and repair of coating. The sections shall conform to the shape, dimensions and sheet thicknesses shown on the plans, and shall be manufactured as integral units or so the sections may be readily assembled in place.

1020.4.6 Bands. Formed bands may be used on pipe with annular corrugations and helically corrugated pipe with reformed ends. Bands shall be formed with a minimum of two corrugations matching the profile of the pipes being joined together. The corrugations shall be spaced to provide seating in the second corrugation of each pipe and without creating more than 1/2 inch annular space between the pipe ends when joined together.

1020.4.6.1 Circumferentially corrugated bands, bands with projections and helically corrugated bands shall be so constructed as to lap on an equal portion of each of the culvert sections and shall be connected at the ends by galvanized angles having minimum dimensions of 2 x 2 x 3/16 inch, fastened with galvanized bolts of 1/2 inch minimum diameter. Formed bands shall be fastened together by two 1/2 inch bolts through a bar, and strap welded to the band. Angles shall be secured to the coupling bands by riveting, welding, resistance spot welding or a method approved by the Engineer at each corrugation. Rivets shall be placed such that the head of the rivet will be on the inside of the band. Welds, except for resistance spot welds, shall be painted with one coat of zinc dust-zinc oxide or zinc-rich paint meeting the approval of the Engineer. The 7 inch and 10 1/2 inch bands shall have at least two fastening bolts, the 12 inch and 14 inch bands shall have at least three fastening bolts and the 16 1/4 inch or greater bands shall have at least four fastening bolts. Alternate methods of fastening the ends of coupling bands may be used if approved by the Engineer. Coupling bands for pipe-arch and shop elongated pipe shall be shaped to fit the structure.

1020.4.6.2 As an alternate to coupling bands, a bell and spigot joint system may be used as approved by the Engineer.

1020.4.7 Special Fittings. Special fittings, angles and tees shown on the plans shall be fabricated by welding in such a manner as to avoid excessive damage to the coating away from the welded area. The welded area and adjacent damaged coating shall be repaired in accordance with Sec 1020.6.
1020.5 Sampling, Testing and Acceptance Procedures. All fabrication plants furnishing pipe for County projects shall be qualified as herein described. A pipe distributor, who does not fabricate pipe, may attain qualification as set forth for a pipe manufacturer or may furnish pipe for County projects that is marked and certified from an approved plant. All pipe will be subject to inspection by the Engineer at the source of manufacture, at an intermediate shipping terminal or at destination. The Engineer shall be allowed unlimited access to all facilities and records, as required, to conduct inspection and sampling in accordance with Sec 1020.

1020.5.1 Sampling of Material. Random sampling of the pipe or material used in the production of pipe will be conducted by the Engineer to verify if the pipe and material are in accordance with the applicable specifications. Sampling size and frequency will be at the discretion of the Engineer. In the event pipe materials certified by the manufacturer are not in accordance with Sec 1020 as determined by random sampling, testing and inspection, all pipe incorporating that material will be rejected.

1020.5.2 Mill and Factory Inspection. The Engineer may have the material inspected and sampled in the rolling mill or in the shop where fabricated. The Engineer may require from the mill the chemical analysis of any heat number. The inspection, either in the mill or in the shop, shall be under the direction of the Engineer. The Engineer shall have unlimited access to the mill or shop for inspection, and every facility shall be extended for the purpose of inspection. Any material or pipe that has been previously rejected at the mill or shop and included in a later lot will be considered sufficient cause for rejection of the entire lot.

1020.5.3 Inspection. Inspection by the Engineer will include an examination of the pipe for deficiency in specified diameter, net length of finished pipe and any evidence of poor workmanship. The inspection may include taking samples for chemical analysis, mechanical properties and determination of weight (mass) of coating. The pipe making up the shipment shall meet all requirements of these specifications. If 10 percent of the pipe in any lot fails to meet these requirements, the entire lot may be rejected.

1020.5.4 Sampling of Coated Steel. Samples of coated steel sheet may be obtained from coils, flat or corrugated cut lengths or fabricated culverts. Samples shall be taken at a frequency determined by the manufacturer’s QC Plan or as required by the Engineer.

1020.5.4.1 For testing weight of coating of flat or corrugated cut lengths before fabrication, three specimens, each no less than 2 1/4 inches square or of an equivalent area, shall be taken from each test sheet selected to represent the lot. The specimens shall be taken such that no part includes metal closer than 2 inches from an edge or 4 inches from an end of the cut length. These specimens shall be obtained in any one of the following patterns:

(a) One specimen shall be obtained from the center of the cut length and the other two in a straight line diagonally at the opposite corners.

(b) Specimens shall be taken in a straight line from one end of the cut length, one from the middle portion and one from near each edge.

1020.5.4.2 For testing weight of coating of coils before fabrication, three specimens, each no less than 2 1/4 inches square or of an equivalent area, shall be taken, one from the middle of the width and one from each side. No specimen shall be taken closer than 2 inches from an edge or 4 inches from an end of the coil.

1020.5.4.3 For testing weight of coating of fabricated pipe or pipe-arch, at least one specimen 2 1/4 inches square or of equivalent area, shall be selected for each 20 pieces of pipe within a given lot selected to be tested, provided that no less than three specimens, each from a different piece, shall represent any one lot. The three specimens shall constitute one sample and shall be in accordance with Sec 1020.3.

1020.5.4.4 For chemical analysis of the base metal of flat or corrugated cut lengths before fabrication, a specimen, no less than 2 1/4 inches square or of an equivalent area, shall be taken from each of three different cut lengths for
lots weighing 5 tons or less, from four cut lengths for lots weighing more than 5 tons and less than 10 tons and from five cut lengths for lots weighing 10 tons or more. Drillings or chips from the specimens shall be thoroughly mixed for analysis.

1020.5.4.5 For chemical analysis of the base metal of coils, three specimens, each no less than 2 1/4 inches square or of an equivalent area, shall be taken from across the width of the coil, or if more than one mill lift or coil is involved, three specimens shall be selected from each of at least two different coils. Drillings or chips from the specimens shall be thoroughly mixed for analysis.

1020.5.4.6 When chemical analysis of base metal of fabricated pipe or pipe-arch is required, the analysis shall be performed on the same specimens taken for determination of weight (mass) of coating.

1020.5.4.7 For testing mechanical properties of the base metal, two specimens, each 4 x 14 inches, shall be taken from one end of a cut length or coil. The 14 inch dimension shall be in the longitudinal direction of the steel sheet. No specimen shall be taken closer than 2 inches from an edge or 4 inches from an end of a sheet.

1020.5.4.8 Samples for retest of weight of coating on cut lengths shall be taken in accordance with pattern (a) of Sec 1020.5.4.1. Samples for retest of mechanical properties or chemical composition of any base metal or retest of weight of coating on coils or fabricated pipe or pipe-arch shall be taken in the same manner as for the original test.

1020.5.5 Testing of Metallic-Coated Steel. Tests for weight of coating, chemical composition and mechanical properties of metallic-coated steel sheets shall be as herein specified.

1020.5.5.1 Test specimen size and method of test for determining weight of coating shall be in accordance with AASHTO T 65 for zinc coatings, and AASHTO T 213 for aluminum coatings. At the option of the Engineer, material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

1020.5.5.2 The method of test for chemical analysis shall be in accordance with ASTM E 30-68, exclusive of any later revisions or additions.

1020.5.5.3 Test specimen size and method of test for determining tensile strength, yield strength and elongation shall be in accordance with ASTM A 370 for sheet steel.

1020.5.6 Acceptance of Metallic-Coated Steel Sheet. Acceptance of metallic-coated steel sheet will be based on a satisfactory sheet manufacturer's certified analysis and guarantee and sheet identification markings, upon tests on samples of the material, or upon both. The frequency of sampling will be determined by the Engineer. The fabricator shall provide the equipment and personnel required to obtain the samples as directed by the Engineer.

1020.5.7 Accepted Brands of Metal. No metal will be accepted under these specifications until the sheet manufacturer's certified analysis and manufacturer's guarantee have been approved by the Engineer. Misbranding or other misrepresentation and non-uniformity of product, will each be considered sufficient reason to discontinue the acceptance of any brand under these specifications, and notice sent to the sheet manufacturer of the discontinuance of acceptance of any brand will be considered to be notice to all culvert companies that handle that particular brand.

1020.5.8 Sampling and Testing of Continuous Lock Seam. Sampling and testing for continuous lock seam quality control shall be in accordance with AASHTO T 249.

1020.5.8.1 The pipe manufacturer or plant shall cut, log and retain quality control samples, which shall be retained for two years. Visual examination samples for quality control shall be cut during production. The manufacturer or plant shall sample a minimum of one lock per coil when the same diameter of pipe is being produced. The samples shall be taken from the beginning of the coil. If diameters are changed within a coil, at least one lock per diameter
shall be taken. Quality control tension test specimens shall be taken from pipe representing each sheet thickness and diameter the first time that sheet thickness and diameter is produced. In addition, each sheet thickness thereafter shall be sampled on a monthly basis during production for tension testing of the seam. The manufacturer or plant shall record all tension test results and retain those records for two years.

**1020.5.8.2** Inspection by the Engineer will include random visual examination samples and tension test samples taken in the presence of the Engineer. If visual examination samples indicate nonconformance, that length of the pipe will be rejected, and a resample will be taken from a different length of pipe of the same sheet thickness of the same diameter. If the resample fails, each shipment of that sheet thickness thereafter shall be sampled for visual examination and tension testing until the Engineer determines that satisfactory quality control is established. Pipe from which tension test specimens have been taken may be cut and the undamaged portion accepted for use.

**1020.6 Repair of Damaged Coating.** Damaged coating on pipe shall be repaired in accordance with AASHTO M 36, except as follows. Coating damaged in the field shall be repaired by recoating by the hot-dip process or by the metallizing process, except that in instances of minor damage to areas in the upper two-thirds of the perimeter as installed, the Engineer may permit repair in the same manner as specified for repair during fabrication. The fabricated unit shall be thoroughly cleaned prior to recoating. The hot-dip process shall be in accordance with Sec 1020.3.

**1020.7 Marking.** Each section of pipe to be used on St. Charles County projects shall be marked with an approved manufacturer’s identification marking prior to shipment. The marking shall be permanent and located within 12 inches of the downstream end of the pipe.

**1020.8 Handling.** All pipe shall be handled with care to avoid damage. Pipe having damaged coating, localized bends in excess of 5 percent of the specified pipe diameter or any dent in excess of 1/2 inch will be rejected at the site of the work regardless of previous approvals. Rejected damaged pipe may be used if repaired to the satisfaction of the Engineer.

**1020.9 Bill of Lading.** A bill of lading or delivery receipt for each shipment of pipe shall be furnished to the Engineer at the shipping and destination points. The bill of lading shall contain an itemized statement of the sizes and lengths of pipe for that shipment. The bill of lading shall contain a certified statement. The certified statement shall be signed by an authorized representative of the manufacturer and shall state the following:

“This certifies that the pipe, bands and end sections in this shipment are in accordance with St. Charles County specifications, were fabricated at an approved plant and were fabricated from the following brand names:”
SECTION 1021
BITUMINOUS-COATED CORRUGATED METAL CULVERT PIPE AND PIPE ARCHES

1021.1 Scope. This specification covers bituminous-coated corrugated metal culvert pipe and pipe arches to be used for the construction of culverts.

1021.2 Basis of Acceptance. The basis of acceptance for pipe and pipe-arches will be in accordance with Sec 1020.2, Sec 1020.5 and as specified herein. The basis of acceptance for bituminous material will be in accordance with AASHTO M 190, except acceptance may be based on samples obtained from storage or from the dipping tanks.

1021.3 Material. The pipe shall be in accordance, as applicable, with Sec 1020 or Sec 1024. The bituminous material shall be in accordance with AASHTO M 190.

1021.4 Lift Hooks or Loops. Lift hooks or loops, if agreed upon by the Engineer and manufacturer, may be attached to pipe and pipe-arches to facilitate handling.

1021.5 Repair of Damaged Bituminous Coating. Bituminous coating damaged or displaced during delivery or installation shall be repaired as directed by the Engineer by application of hot bituminous material of the same type as that originally used. Care shall be taken to avoid damage to the bituminous material during heating.
SECTION 1022
CORRUGATED METALLIC-COATED STEEL
PIPE UNDERDRAIN

1022.1 Scope. This specification covers corrugated metallic-coated steel pipe underdrain.

1022.2 Basis of Acceptance. Basis of acceptance will be in accordance with Sec 1020.2, and Sec 1020.5, as specified herein.

1022.3 Material. Corrugated metallic-coated steel underdrain shall be in accordance with Sec 1020 and AASHTO M 36, Type III pipe for zinc-coated or aluminum-coated, with the following modifications.

1022.3.1 Pipe 6 inches (150 mm) in diameter shall be fabricated of steel no less than 0.052 inch, 18 gauge, (1.32 mm) specified thickness. Pipe with diameters 8 to 21 inches (200 to 525 mm), inclusive, shall be fabricated of steel no less than 0.064 inch, 16 gage (1.63 mm), of the specified thickness.

1022.3.2 Coupling bands shall be of the same base metal as the pipe.

1022.3.3 Mechanical requirements of the base metal shall not apply.

1022.3.4 Samples for determination of coating thickness may be taken from fabricated pipe.

1022.4 Perforations. Unless otherwise specified, all pipe shall be perforated in accordance with the requirements for Class 1 perforations AASHTO M 36.
1023.1 Scope. This specification covers corrugated galvanized steel structural plates intended for use in construction of pipe and pipe arches. The plates shall consist of corrugated galvanized metal and shall be curved such that the plates can be bolted together to form a structure of the specified shape and size.

1023.2 Basis of Acceptance. The basis of acceptance will be in accordance with Sec 1020.2, Sec 1020.5, and as specified herein.

1023.3 Material. Corrugated galvanized steel structural plate for structural plate pipe and pipe arches shall be in accordance with AASHTO M 167, with the following modifications.

1023.3.1 Corrugations. The radii of curvature of the corrugations shall be at least one-half the depth of the corrugations. The corrugations shall have a depth of 2 inches and a pitch of 6 inches. The depth of corrugations shall not underrun the specified depth by more than 5 percent, and the pitch of the corrugations shall not deviate from the specified depth by more than 1/4 inch.

1023.3.2 Spelter Coating. The spelter coating shall be free from injurious defects such as blisters, flux and uncoated spots. For testing the weight of spelter coating and for chemical analysis, if required, the manufacturer shall take two samples for each 100 plates of each thickness of a shipment or fraction thereof. The samples may be obtained from a piece approximately 3 inches square, cut from a corner of a plate or from a coupon approximately 6 inches square attached to the center of one edge of the plate prior to galvanizing. The coupon shall be of the same thickness and base metal as the plate to which the coupon is attached. One sample shall be retained for the Engineer for QA purposes and one sample shall be tested by the manufacturer. If the result of a test for weight of coating for any sample is not in accordance with AASHTO M 167, an additional sample shall be cut for tests from each of two other plates in the lot represented by the nonconforming sample. All original samples and samples for retest shall be in accordance with AASHTO M 167, or the entire shipment will be rejected. At the option of the Engineer, the material may be accepted or rejected on the basis of magnetic gauge results, except at the request of the Contractor or manufacturer, plates rejected by magnetic gauge results will be sampled as specified above.

1023.3.3 Accepted Brands of Metal. No metal will be accepted under these specifications until after the manufacturer’s certificate and guarantee have been approved by the Engineer.

1023.3.3.1 Manufacturer’s Certificate. The manufacturer of the structural plate identified by the manufacturer’s mark shall file with the County Highway Department, a certificate setting forth the name of the manufacturer, the base metal manufacturer, the specified chemical composition and a typical or average analysis showing the percent of sulfur, copper and any other elements specified in Table I of AASHTO M 167. The certificate shall be sworn to for the manufacturer by a person having legal authority to bind the company. Mismarking or other misrepresentation by the manufacturer will be considered sufficient reason to discontinue acceptance under these specifications. Notice sent to the manufacturer of the discontinuance of acceptance will be considered to be notice to all companies handling that particular manufacturer’s product.

1023.3.3.2 Manufacturer’s Guarantee. The manufacturer of the structural plate shall submit with the certificate a guarantee providing that all structural plate furnished is in accordance with the specifications, shall bear the manufacturer’s identification mark and shall be replaced without cost when not in accordance with the specified analysis, sheet thickness or spelter coating. The guarantee shall be so worded as to remain in effect as long as the manufacturer continues to furnish the material.

1023.4 Bolts and Nuts for Connecting Plates.
1023.3.4.1 Bolts for connecting plates shall be 3/4 inch in diameter and shall be in accordance with ASTM A 449. Nuts shall be in accordance with ASTM A 563, Grade C. Bolts, nuts and washers shall be galvanized in accordance with AASHTO M 232, or the bolts, nuts and washers may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Except as specified herein, bolts and nuts shall meet the dimension requirements of ANSI B 18.2.1 for heavy hex bolts and ANSI B 18.2.2 for heavy hex nuts. The bearing surface of both bolts and nuts shall be symmetrically shaped to a one inch radius spherical surface. The maximum height of the wrench flats on bolts and thickness of nuts shall be within the limits specified in ANSI B 18.2.1 and ANSI B 18.2.2, respectively. Bolt lengths shall be such as to result in at least "full nuts" when tightened in place. The bolts and nuts may be sampled and tested before erection, or the bolts, nuts and washers may be accepted on certified mill tests by the manufacturer.

1023.3.4.2 Other fasteners may be used if the fasteners:

(a) Meet the chemical and mechanical requirements in Sec 1023.3.4.1.

(b) Have body diameter and bearing areas no less than those specified in Sec 1023.3.4.1.

(c) Provide a comparable fit with the corrugations.

1023.4 Manufacture. Plates shall be connected by bolts at longitudinal and circumferential seams. Joints shall be staggered such that no more than three plates come together at any one point. Plates shall be furnished in standard sizes to permit structure length increments of 2 feet. The size and shape of the plates shall be such that the finished structure will have the dimensions shown on the plans or as specified herein and the circumferential or peripheral transverse seams will be staggered at least one foot, except that the Engineer may permit the seams in adjacent plates used for construction of beveled or skewed ends to be continuous. At least four bolts shall be used per foot of longitudinal seam, unless a greater number is specified on the plans, staggered in two rows 2 inches apart, with one row in the valleys and one row on the crests of the corrugations. Bolts along circumferential seams shall be spaced no more than 10 inches apart. The distance from the center of bolt hole to the edge of the plate shall be no less than 1.75 times the diameter of the bolt. The diameter of the bolt holes for the longitudinal seams, except holes at corners of plates, shall not exceed the diameter of the bolts by more than 1/4 inch. The major axis of the holes for transverse seams, including the holes at the corners of the plates, shall not exceed the diameter of the bolt by more than 1/2 inch and the average of the major and minor axis shall not exceed the diameter of the bolt by more than 1/4 inch.

1023.4.1 Circular Pipe. A manufacturing tolerance of 3 inches will be permitted in the diameter of the pipe. The thickness of metal to be used for each structure will be specified in the contract. The plates shall be prominently marked to show the position in which the plates are to be placed in the structure.

1023.4.2 Pipe-Arch. Plates for a pipe-arch shall form a cross-section made up of four circular arcs tangent to each other at the arcs' junctions and symmetrical about the vertical axis. The top shall be an arc of no more than 180 degrees or no less than 155 degrees. The bottom shall be an arc of no more than 50 degrees or no less than 10 degrees. The top shall be joined at each end to the bottom by an arc of no more than 87.5 degrees or no less than 75 degrees. The radius of corner arcs shall be between 16 and 21 inches for Type C-29 and smaller sizes, and between 29 and 33 inches for Type C-30 and larger sizes. The dimensions of structural plate pipe-arch shall be as specified below, subject to a manufacturing tolerance of two percent plus one inch. The thickness of metal to be used for each structure will be specified in the contract.
### 1023.4.3 Beveled Ends
When specified on the plans, end plates for forming beveled ends shall be shaped to produce the specified slope in the finished structure. Burnt edges shall be free from oxide and burrs, and shall present a workmanlike finish. Any edges cut after galvanizing shall be completely covered with two coats of single component inorganic zinc or organic zinc-rich paint, meeting the approval of the Engineer. Legible identification marks shall be placed on each part plate to designate the plate's proper position in the structure.

### 1023.5 Workmanship.
All plates shall show careful and finished workmanship. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of these defects in an individual plate or in general in any shipment, will be considered sufficient cause for rejection:

(a) Improper shape.

(b) Ragged edges.

(c) Unevenly aligned or spaced bolt holes.

(d) Illegible brands.
(e) Bruised, scaled or broken spelter coating.

(f) Dents in the metal.

(g) Bends in the metal not specified.

1023.6 Assembly Instructions and Drawings. The Contractor shall provide the Engineer with detailed assembly instructions and drawings for each structural plate pipe or pipe-arch prior to the installation of these structures.

1023.7 Repair of Galvanizing. Spelter coating damaged in the field shall be repaired by hot-dip galvanizing, the metallizing process as specified in Sec 1020 or by the zinc alloy stick method in accordance with Sec 1081, except that in instances of minor damage, the Engineer may permit repair by painting with two coats of single component inorganic zinc or organic zinc-rich paint. The paint and application shall meet the approval of the Engineer.
SECTION 1024
CORRUGATED ALUMINUM ALLOY CULVERT PIPE AND CORRUGATED ALUMINUM ALLOY STRUCTURAL PLATE

1024.1 Scope. This specification covers corrugated aluminum alloy culvert pipe and corrugated aluminum alloy structural plate intended for use in construction of pipe and pipe arches.

1024.2 Basis of Acceptance. The basis of acceptance will be in accordance with Sec 1020.2, Sec 1020.5 and as specified herein.

1024.3 Material.

1024.3.1 Corrugated Aluminum Alloy Culvert Pipe. This pipe shall be in accordance with AASHTO M 196, Type I.

1024.3.2 Corrugated Aluminum Alloy Structural Plate. Plates, shapes and fasteners for aluminum alloy field bolted pipe and pipe arch shall be in accordance with AASHTO M 219.
SECTION 1025
CORRUGATED ALUMINUM ALLOY
PIPE UNDERDRAINS

1025.1 Scope. This specification covers corrugated aluminum alloy pipe underdrains.

1025.2 Basis of Acceptance. The basis of acceptance will be in accordance with Sec 1020.2, and Sec 1020.5 as specified herein.

1025.3 Material. Pipe for corrugated aluminum alloy pipe underdrains shall be in accordance with AASHTO M 196, Type III, with the following modifications.

1025.3.1 Pipe 6 inches (150 mm) in diameter shall be fabricated of metal no less than 0.048 inch, 18 gage, (1.2 mm) specified thickness. Pipe with diameters 8 to 21 inches (200 to 525 mm), inclusive, shall be fabricated of metal no less than 0.060 inch, 16 gage, (1.5 mm) specified thickness.

1025.3.2 Coupling bands shall be of the same aluminum alloy as the pipe.
SECTION 1026
REINFORCED CONCRETE CULVERT PIPE

1026.1 Scope. This specification covers reinforced concrete pipe to be used for the conveyance of sewage, industrial wastes and storm water, and for the construction of culverts.

1026.2 Basis of Acceptance.

1026.2.1 The basis of acceptance will be in accordance with AASHTO M 170, unless otherwise specified. Pipe shall be from an approved qualified plant and accepted based on certification, manufacturer quality control documentation, and tests on samples as required by the Engineer.

1026.2.2 The Contractor for quality control purposes and the Engineer for quality assurance purposes may select and apply the basis of acceptance in accordance with either Section 5.1.1 or 5.1.2 in AASHTO M 170.

1026.2.2.1 If cylinders are tested, the cylinders shall be tested in accordance with AASHTO T 22. The average compressive strength of all cylinders tested shall be equal to or greater than the design concrete strength.

1026.2.2.2 If cores are cut from the wall of the pipe and tested, the cores shall be cut and tested in accordance with AASHTO T 280. If the compressive strength of each core tested is equal to or greater than the design concrete strength, the compressive strength of the concrete for the lot will be considered acceptable.

1026.2.2.2.1 If the compressive strength of a core tested is less than the design concrete strength, two additional cores shall be taken from that pipe section and tested. Concrete represented by these core tests will be considered acceptable if the average of the two additional cores is equal to or greater than the specified strength, and no single core is less than 85 percent of the specified strength.

1026.2.2.2.2 If the compressive strength of the three cores is not in accordance with Sec 1026.2.2.2.1, the pipe section from which the core was taken will be rejected. Two pipe sections from the remainder of the lot shall be selected at random and tested for conformance with either Sec 1026.2.2.2 or Sec 1026.2.2.2.1. If both pipe sections meet the core strength requirements of either Sec 1026.2.2.2 or Sec 1026.2.2.2.1, the concrete compressive strength of the remainder of the lot will be accepted. If the compressive strength of either of the two pipe sections tested does not meet the requirements, the remainder of the lot will be either rejected or, at the option of the manufacturer, each pipe section of the remaining lot shall be cored and will be accepted individually. Any pipe sections that have a core not meeting the requirements of either Sec 1026.2.2.2 or Sec 1026.2.2.2.1 will be rejected.

1026.2.2.3 If the cores cut from a section of pipe meet the strength test requirements, the core holes shall be plugged and sealed by the manufacturer in a manner such that the pipe section will meet all requirements of these specifications. Pipe sections so sealed will be considered satisfactory for use.

1026.3 Material. Reinforced concrete pipe shall be in accordance with AASHTO M 170, except as specified otherwise herein.

1026.3.1 Reinforced Concrete. Reinforced concrete shall consist of a mixture of cement, mineral aggregate and water, in which steel has been embedded in such a manner that the steel and the concrete act together.

1026.3.2 Cement. Cement shall be in accordance with Sec 1019. Fly ash or GGBFS may be used to replace cement in accordance with Sec 501, except approved Class C or Class F fly ash may be used to replace a maximum of 25 percent of Type I or II cement on an equivalent weight basis. Fly ash shall not exceed 25 percent by weight of the total cementitious material, i.e., microsilica, steel slag or other pozzolanic material.

1026.3.3 Steel Reinforcement. All steel reinforcement shall be in accordance with Sec 1036.
1026.3.4 Aggregate. Fine and coarse aggregate shall be in accordance with Sec 1005, except that gradation requirements and percent passing the No. 200 sieve will not apply.

1026.3.5 Concrete Mixture. The proportion of cementious material in the mixture shall be no less than 470 pounds per cubic yard of concrete.

1026.3.6 Modified or Special Designs. The manufacturer may request approval of modified designs that differ from the designs in Section 7.1, AASHTO M 170; or special designs for sizes and loads beyond those shown in Tables I to V of AASHTO M 170; or special designs for pipe sizes that do not have steel reinforcement areas shown in Tables II to V of AASHTO M 170. Modified or special designs will not be permitted for pipe diameters greater than 36 inches under earth fills greater than 51 feet. Modified or special designs shall be in accordance with AASHTO M 242.

1026.3.6.1 Design Acceptance. The manufacturer shall submit to the Engineer four copies of the pipe design, shop drawings and installation procedures all signed and sealed by a professional Engineer registered in the State of Missouri. The pipe design, shop drawings and installation procedures shall be accepted in writing prior to the fabrication of the reinforced concrete pipe.

1026.3.6.1.1 Pipe designs may be based on either the indirect design method or direct design method and shall be in accordance with the current AASHTO LRFD Bridge Design Specifications.

1026.3.6.1.2 Designs shall provide all variables required to support computations. Designs based on the indirect design method shall provide test results in accordance with Section 9 of AASHTO M 242 with at least three specimens being tested under the three-edge-bearing method for both the D-Load to produce a 0.01 inch crack and the D-Load to produce the ultimate load. The computations of D-Load shall be included in the designs for both the indirect design method and direct design method.

1026.3.6.1.3 Shop drawings reflecting design and stress details shall include complete details required for reinforced concrete pipe fabrication including wall thickness, concrete design strength, the type, size and placement of reinforcement, and inside and outside dimensions.

1026.3.6.1.4 The installation procedure shall include bedding and compaction details.

1026.3.6.2 Pipe Acceptance. Acceptance of pipe designed by the indirect design method shall be in accordance with Section 4.1.2 of AASHTO M 242. Acceptance of pipe designed by the direct design method shall be in accordance with Section 4.1.1 of AASHTO M 242 by testing against the D-Load to produce the formation of a 0.01 inch crack, which was provided in the previously submitted and accepted design.

1026.3.7 Joints. The ends of rubber-gasketed pipe shall be formed by machined metal rings and be accurately manufactured so that, when the adjacent pipe sections are drawn together, the rubber gasket will be uniformly compressed around the periphery of the pipe to provide a watertight seal. Rubber joints shall be approved compression-type joints and shall conform to the requirements of the Specifications for joints for Circular Concrete Sewer and Culvert Pipe, using Flexible, watertight, Rubber-type Gaskets ASTM C443 or ASTM C361(with a 25 foot head). Band-type gaskets depending entirely on cement for adhesion and resistance to displacement during jointing shall not be used.

1026.3.8 Curing. A curing membrane in accordance with Sec 1055 may be applied, and if used, shall be left intact until the strength requirements are met.

1026.3.9 Lift Holes. If agreed upon by the Engineer and the manufacturer, no more than two holes may be cast or drilled in the wall of each pipe for the purpose of handling at the construction site. The holes shall be no larger than 2 1/2 inches in diameter for pipe 60 inches in diameter or less, and no larger than 3 1/2 inches for pipe greater than...
60 inches in diameter. Lift holes shall be carefully cast or drilled in a manner such that it will not be necessary to cut, bend or otherwise weaken the circumferential steel in the inner cage in pipe having two lines of reinforcement, or any of the circumferential steel in pipe having one line of reinforcement. Lift holes will be permitted for pipe specified with rubber gasketed joints only with written approval from the Engineer.

1026.3.10 Marking. Each pipe shall be marked by the manufacturer with a “Q Cast” stamp to certify the pipe was produced by an American Concrete Pipe Association (ACPA) certified plant or the equivalent mark of another approved certification program.

1026.3.10.1 The following additional information shall be clearly marked on the inside of each section of pipe by indenting on the pipe section or by painting thereon with waterproof paint:

(a) Pipe class.

(b) Date of manufacture.

(c) Name or trade-mark of the manufacturer.

1026.3.10.2 One end of each section of pipe with elliptical reinforcement shall be clearly marked, during the process of manufacturing or immediately thereafter, on the inside and the outside of opposite walls along the minor axis of the elliptical reinforcement with the word “Top” or “Bottom” to designate the proper position when laid.

1026.4 Sampling, Testing and Acceptance Procedures. All manufacturers furnishing pipe for St. Charles County projects shall be qualified as herein described. All pipe will be subject to inspection by the Engineer at the source of manufacture, at an intermediate shipping terminal or at destination. The Engineer shall be allowed unlimited access to all facilities and records as required to conduct inspection and sampling in accordance with Sec 106.

1026.4.1 Application for Placement on Qualified List. To become qualified, a written request shall be sent by the manufacturer to MoDOT Construction and Materials division or the County with the following information:

(a) A statement certifying that the quality control procedures at the plant meet the requirements set forth by the American Concrete Pipe Association (ACPA) or National Precast Concrete Association (NCPA) Compliance Audit and Certification Program or an equivalent, MoDOT approved, nationally recognized program.

(b) Sources for each material to be used in the fabrication of pipe. For aggregate sources, the ledge the material is being taken from shall also be included.

(c) A guarantee that all material to be used in the fabrication of pipe will be in accordance with St. Charles County specifications, and pre-approval for any source of material will be received prior to use.

(d) Units of measurement, English or metric, used to fabricate the pipe.

1026.4.2 Maintaining Qualification. To maintain qualification, the manufacturer shall perform and maintain a quality control program in accordance with the approved program, with the following modifications:

(a) The bill of lading for each shipment of material used in the production of pipe shall be kept on file for three years.

(b) For all aggregate, the aggregate producer shall provide a certificate of compliance to applicable St. Charles County specifications and identify what ledges the aggregate is being produced from. The certificate of compliance shall be kept as long as that material from that source and ledge is being used.
(c) A sieve analysis for determination of aggregate gradations used in each concrete mix shall be conducted once per month, and when an aggregate source is changed.

(d) The percentage of deleterious substance for each aggregate fraction shall be determined once a month.

(e) Admixtures shall be from approved sources and the manufacturer’s certification that the material meets St. Charles County specifications shall be kept on file for one year.

(f) Mill test reports for reinforcing steel shall be kept on file for one year.

(g) Once a month, an absorption test shall be conducted for each mix used in the production of pipe. Test results shall be kept on file for one year.

(h) For pipe with diameters of 66 inches or larger, three edge bearing tests shall be performed once per 1000 feet of pipe manufactured, and at least once per year. Testing will not be required at plants where pipe of these diameters is not manufactured, nor will pipe of these diameters be required to be manufactured solely for the purpose of performing this testing.

(i) The manufacturer shall notify MoDOT Construction and Materials or the County at least 24 hours prior to each shipment.

1026.4.3 Plant Certification. Plants for concrete pipe production shall be certified by an approved program, and the certification shall be maintained current.

1026.4.4 Disqualification of a Manufacturer. A manufacturer may be disqualified to provide pipe for use on St. Charles County projects based on the discretion of MoDOT Construction and Materials or the County, for reasons including, but not limited to, not maintaining approved program certification, failure of material to consistently meet specifications, falsification of any documentation, misbranding of pipe, unsatisfactory performance in the field or for other reasons indicating lack of consistent material quality.

1026.4.4.1 In a case where a manufacturer loses ACPA certification and was not disqualified for any other reason, reinstatement will be considered when the manufacturer is recertified by the approved program.

1026.4.4.2 A manufacturer will not be considered for reinstatement until after one year from the date of removal for falsification of documents.

1026.4.4.3 Three notices of failure to meet specification requirements within a 12-month period will be cause for disqualification of the manufacturer for one year, effective from the date of the third notice.

1026.4.4.4 A manufacturer disqualified within one year of the end of a disqualification may be subject to permanent removal, with no application for reinstatement accepted for a period of three years.

1026.4.5 Reinstatement of a Manufacturer. Consideration of reinstatement of a manufacturer once disqualified will be no sooner than specified in Sec 1026.4.4, will require a written document from the manufacturer stating the reasons for disqualification and the action taken to correct those deficiencies, written concurrence from MoDOT Construction and Materials or the County that the problem has been suitably addressed, and followed by an application in accordance with Sec 1026.4.1.

1026.4.6 Sampling of Material. Random sampling of the pipe or material used in the production of pipe will be conducted by the Engineer to verify the pipe and material are in compliance with applicable specifications. Sampling size and frequency will be at the discretion of the Engineer.
1026.5 Bill of Lading. A bill of lading or delivery receipt for each shipment of pipe shall be furnished to the Engineer at the shipping and destination points. The bill of lading shall contain an itemized statement of the sizes and lengths of pipe for that shipment. The bill of lading shall contain a certified statement. The certified statement shall be signed by an authorized representative of the manufacturer and shall state the following:

“This certifies that the pipe, bands and end sections in this shipment are in accordance with St. Charles County specifications, were fabricated at an approved plant and were fabricated from the following brand names:”
SECTION 1027
POLYMER COATED CORRUGATED
METAL CULVERT PIPE AND PIPE ARCHES

1027.1 Scope. This specification covers polymer coated corrugated metal culvert pipe and pipe-arches to be used for the construction of culverts and storm sewers.

1027.2 Basis of Acceptance. Basis of acceptance for pipe and pipe-arches will be in accordance with Sec 1020.2, Sec 1020.5 and the AASHTO specifications cited herein. The basis of acceptance for polymer material will be in accordance with AASHTO M 245. Pipe shall be from an approved qualified plant and will be accepted based on certification, manufacturer QC documentation and results from tests on samples as required by the Engineer.

1027.3 Material. Polymer coated corrugated metal pipe and pipe-arches shall be in accordance with Sec 1020 and AASHTO M 245.
1028.1 **Scope.** This specification covers corrugated PVC culvert pipe intended to be used for the construction of culverts, sewers and similar uses.

1028.2 **Basis of Acceptance.** Acceptance of corrugated PVC culvert pipe will be based upon the pipe being in accordance with this specification. Pipe shall be provided from an approved manufacturer, and will be accepted based on certification, identification markings and results from tests required by the Engineer.

1028.3 **Material.** All corrugated PVC culvert pipe, couplings and fittings shall be in accordance with ASTM F 949, except as follows.

1028.3.1 The pipe shall not be perforated unless otherwise specified.

1028.3.2 Field joints of corrugated PVC pipe shall provide circumferential and longitudinal strength to maintain the pipe alignment, prevent separation of pipe and prevent infiltration of side fill material. Coupling bands, if used, shall be of the same base material as the pipe. Prior to use, the design of coupling bands and fastening devices shall be submitted to and approved by the Engineer. Final acceptance of coupling bands and fastening devices will be based upon field performance.

1028.3.3 The manufacturer shall provide to the Engineer an itemized statement of the sizes and lengths of pipe in each shipment.

1028.3.4 Each individual section of pipe shall be marked in accordance with ASTM F 949, and shall have ASTM F 949 and the manufacturer's name marked on the pipe.

1028.4 **Sampling, Testing and Acceptance Procedures.** Manufacturers furnishing pipe to St. Charles County projects shall be MoDOT qualified. All pipe shall be subject to inspection by the Engineer at the source of manufacture, at an intermediate shipping terminal or at the destination. The Engineer shall be allowed free access to all facilities and records as required to conduct inspection and sampling in accordance with Sec 106.

1028.4.1 **Disqualification of a Manufacturer.** A manufacturer may be disqualified from providing pipe for use on St. Charles County projects based on the discretion of the Engineer for reasons including, but not limited to, failure of material to consistently meet specifications; falsification of any documentation; misbranding of the pipe; unsatisfactory performance in the field; or for other reasons indicating lack of consistent material quality.

1028.4.1.1 A manufacturer will not be considered for reinstatement until after one year from the date of removal for falsification of documents.

1028.4.1.2 Three warnings for failure to meet specification requirements will constitute disqualification of the manufacturer for one year.

1028.4.1.3 A plant disqualified twice for any reason in any two-year period will be subject for permanent removal, with a minimal suspension of three years.

1028.4.2 **Disqualification of a Manufacturer.** A manufacturer may be disqualified from providing pipe for use on St. Charles County projects based on the discretion of County Engineer, for reasons including, but not limited to, failure of material to consistently meet specifications, falsification of any documentation, misbranding of the pipe, unsatisfactory performance in the field or for other reasons indicating lack of consistent material quality.
1028.4.2.1 A manufacturer will not be considered for reinstatement until after one year from the date of removal for falsification of documents.

1028.4.2.2 Three notices of failure to meet specification requirements within a 12-month period will be cause for disqualification of the manufacturer for one year, effective from the date of the third notice.

1028.4.2.3 A plant disqualified twice for any reason in any two-year period will be subject for permanent removal, with a minimal suspension of three years.

1028.4.3 Reinstatement of a Manufacturer or Plant. Consideration of reinstatement of a manufacturer once disqualified will be no sooner than specified in Sec 1028.4.2, will require a written document from the manufacturer stating the reasons for disqualification and the action taken to correct those deficiencies, written concurrence from the Engineer that the problem has been suitably addressed, and followed by an application in accordance with Sec 1028.4.1.

1028.4.4 Sampling of Material. Random sampling of the pipe will be conducted by the Engineer to verify if the pipe and material is in accordance with Sec 1028. Samples of PVC pipe will be obtained from fabricated culvert sections in accordance with ASTM F at a frequency determined by the Engineer.

1028.4.5 Inspection. Inspection will include an examination of the pipe for markings, deficiency in specified diameter, net length of fabricated pipe and any evidence of poor workmanship. The inspection may include taking samples.

1028.4.6 Testing. Specimen testing size and method of tests shall be in accordance with ASTM F 949. The Contractor or manufacturer shall provide the equipment and personnel to cut a sample from a section of pipe. The sample shall include the markings or a record of the markings for that section of pipe.

1028.4.7 Rejection.

1028.4.7.1 Any individual section of pipe failing to meet the marking, diameter, length or workmanship requirements of these specifications will be rejected. If 10% of the pipe in any lot fails to meet these requirements, the entire shipment of that pipe size may be rejected.

1028.4.7.2 If a test specimen taken in accordance with Sec 1028.4.6 fails to meet the requirements of ASTM F 949, the pipe sampled will be rejected and the lot will be resampled. A resample shall be of the same size as the original sample. The resample shall be in accordance to these specifications or the entire shipment will be rejected.

1028.5 Bill of Lading. A bill of lading or delivery receipt for each shipment of pipe shall be furnished to the Engineer at the shipping and destination points. The bill of lading shall contain an itemized statement of the sizes and lengths of pipe for that shipment. The bill of lading shall contain a certified statement. The certified statement shall be signed by an authorized representative of the manufacturer and shall state the following:

“This certifies that the pipe, bands and end sections in this shipment are in accordance with St. Charles County specifications, were fabricated at an approved plant and were fabricated from the following brand names:”
SECTION 1029
FABRICATING PRESTRESSED CONCRETE MEMBERS FOR BRIDGES

1029.1 Scope. This specification covers the fabrication of prestressed concrete members for bridges. This specification covers both pretensioned and post-tensioned members.

1029.2 Acceptance. Unless otherwise specified in the contract, acceptance of prestressed units will be based on tests of the material and inspection of the completed product. Acceptability of all types of sections covered by these specifications will be determined by the material tests required in the referenced sections of Sec 1029.3, by crushing tests on concrete cores or cured concrete cylinders, and by inspection of the finished sections, including quantity and placement of reinforcement, and freedom from defect.

1029.3 Material.

1029.3.1 Cement. Cement shall be in accordance with Sec 1019.

1029.3.2 Aggregate. Fine and coarse aggregate shall be in accordance with Sec 1005, except that requirements for gradation and percent passing the No. 200 sieve will not apply.

1029.3.3 Steel Reinforcement. Reinforcement shall be in accordance with Sec 1036.

1029.3.4 Steel Strand. Steel strand shall be in accordance with AASHTO M 203.

1029.3.5 Structural Steel. Structural steel shall be in accordance with ASTM A 36. Structural steel for anchorage plates shall be in accordance with AASHTO M 270, Grade 50.

1029.3.6 Wire and Parallel Lay Wire Cables. Wire and parallel lay wire cables shall be in accordance with AASHTO M 203.

1029.3.7 High-Strength Steel Bars. High-Strength Steel Bars shall be in accordance with AASHTO M 275.

1029.3.8 Enclosures. Enclosures for post-tensioning tendons shall be mortar tight, semi-rigid metal tubes with an internal diameter at least 1/4 inch larger than the bar, cable, strand or wire group to be enclosed, and shall be provided with suitable entrance and discharge ports for grouting.

1029.3.9 Mortar. Mortar for grouting tendons in post-tensioned members shall consist of a mixture of cement and fine sand in the approximate proportions of four parts cement to three parts sand, by volume, with sufficient water to form a grout having the consistency of heavy paint.

1029.3.10 Concrete Mixture. Concrete material, proportioning, air-entraining, mixing, slump and transporting of concrete shall be in accordance with Sec 501, except as noted herein. Concrete for prestressed members shall conform to all requirements of Class A-1 concrete, except as noted herein. The Contractor may use Type I, IP, I(PM), IS, I(SM), Type II or Type III cement. Alternate mix designs may be submitted to MoDOT Construction and Materials or the County for approval. Trial batches may be required. Independent laboratory testing may be required. Submissions shall include all mix design, testing and production detail requested by the Engineer.

1029.4 Documentation. All wire, strand, bars and anchorage assemblies shall be assigned a lot number and tagged for identification. The Contractor shall furnish one copy of the certified mill test report giving the chemical analysis and results of physical tests on the material furnished, except chemical analysis will not be required for steel strand in accordance with AASHTO M 203. The Contractor shall also furnish one certified copy of the stress-strain curve representative of the lot to be used.
1029.5 Equipment.

1029.5.1 Prestressing. The Contractor shall provide all equipment necessary for the construction and the prestressing of concrete members. Prestressing shall be done with approved jacking equipment. If hydraulic jacks are used, the jacks shall be equipped with accurate pressure gauges. All gauges, load cells, dynamometers and other devices for measuring the stressing load shall have an accuracy within two percent. The combination of jack and gauge shall be calibrated by a testing laboratory meeting the approval of the Engineer. A certified graph or table showing the calibration shall be furnished to the Engineer. The total load as determined from the strand elongation shall check that indicated by the gauge within five percent of the total load required to achieve the designated elongation. If other types of jacks are used, proving rings or other devices calibrated by a testing laboratory meeting the approval of the Engineer shall be furnished such that the jacking forces may be accurately determined. Calibration shall be repeated at intervals not exceeding one year and after each overhaul. While work is in progress, if any jack or gauge appears, in the judgment of the Engineer, to be giving erratic results, or if gauge pressure and elongation indicate materially different stresses, recalibration may be required. The Contractor shall furnish means of accurately measuring the elongation of the tendons to within 1/16 inch. Elongation upon completion of stressing operations shall be within five percent of that specified. No tensioning of strands shall be done when strand temperatures are below 30°F.

1029.5.2 End Anchorages. End anchorages and stressing blocks for pretensioned members shall be adequately designed to withstand the forces incidental to prestressing and to maintain the tension in all prestressed tendons of any member until the concrete has been placed and attained its specified transfer strength.

1029.5.3 Concrete Testing Equipment. Equipment for field determination of compressive strength of concrete shall be furnished by the Contractor at the location of manufacture of prestressed concrete members. The testing machine may be of any mechanical or hydraulic type, shall be power operated in accordance with AASHTO T 22, Section 1.2.1, shall be capable of testing cylinders to failure, and shall comply with the accuracy tolerances and corrections specified in AASHTO T 67, Sections 16.1 and 17. Approximately the last one-half of the load shall be applied at a rate between 1200 and 3000 psi per minute. The Contractor shall furnish a sufficient number of 6 x 12 inch compression test cylinder molds of a type meeting the approval of the Engineer. The Contractor shall furnish sufficient personnel for cleaning and preparing reusable molds. The Contractor shall, at the option of the Engineer, furnish technicians to assist the Engineer with concrete testing and the making of test cylinders during the placing of concrete.

1029.6 Construction Requirements.

1029.6.1 Shop Drawings. Shop drawings showing in detail the type, size, number of units, location of tendons, enclosures, method and sequence of releasing the strands, anchorage details and details of proposed lifting loops and lifting procedure shall be submitted to the Engineer for approval. The Contractor may select the method of prestressing, provided an approved specific method is used and the total prestressing force and the center of gravity of the prestressing tendons as shown on the plans are maintained. The shop drawings shall show a tabulation of the design computations and the total prestress force, size and spacing of all reinforcing steel and concrete compressive strengths for strand release and design. No inspection will be conducted until the plant inspector has received a copy of the approved shop drawings. Prior to making shop drawings, the Contractor shall submit in writing for approval of the Engineer any proposed tack welding in lieu of tying of the reinforcing bars of prestressed members. If approved by the Engineer, the location of tack welding of reinforcing bars shall be shown on the shop drawings submitted for approval. No heat or welding will be permitted in the proximity of prestressing tendons in the members. Shop drawings for the prestressed concrete solid, voided slab and box girder beams shall be required to include the alignment of the holes for the tie rods. The holes shall be aligned in such a way as to prevent damage to the precast units during the placement of the precast units on the beam caps and the installation and tensioning of the tie rods through the precast units.
1029.6.2 Forms and Formwork. Forms and formwork, placing and tying of reinforcing bars and placing and vibrating of concrete shall be in accordance with Sec 703 and Sec 706, with the following additions:

(a) Clamps, bolts or other devices connecting the bulk-head to the side forms, inserts and blockouts shall be capable of being removed or loosened before steam curing is applied.

(b) The casting bed shall have a concrete deck on which the form grillage and soffit plates may be adequately centered, aligned and leveled to the same plane.

(c) Exterior forms for prestressed members shall be metal other than aluminum, mortar-tight and of adequate design to produce members within the tolerances specified. Supplemental forms, such as those used to form steps or to establish slopes, may be made of a material other than metal, so long as dimensional tolerances and mortar-tightness are maintained.

(d) The temperature of the mixed concrete when placed shall be no higher than 90°F. The forms and reinforcing steel shall be cooled by acceptable methods to an ambient temperature of 90°F or lower.

(e) Fabricating plants with demonstrated facilities for protection of the concrete during cold weather may, with the approval of the Engineer, cast prestressed units when the ambient temperature is below 40°F. When the ambient temperature is below 40°F, the forms or enclosures and reinforcing steel shall be heated to attain and maintain a temperature of at least 40°F. No concrete shall be placed when the concrete temperature is below 60°F.

(f) Concrete for girders shall be placed in a minimum of two continuous lifts. No more than 30 minutes shall elapse between the placing of contiguous lifts of concrete. The thickness of the first layer for I-girder beam sections shall be such that the top of the concrete is slightly above the top of the bottom fillet. The casting procedure shall be modified if the length of girders and placement conditions are such that an initial set of concrete may result if each lift is continued full length before another lift is placed.

1029.6.3 Prestressing Tendons. Prestressing tendons for pretensioned members, and metal enclosures for post-tensioned members, shall be accurately placed and securely held during placing and curing of the concrete. Strand chucks for pretensioning shall anchor the strand positively without slippage after seating. Strand chuck components shall be cleaned and inspected between each use and lubricated as necessary. All strands shall be free of contaminants such as dirt, oil, paint, wax, corrosion or other foreign material that may prevent a bond between the strands and the concrete. The use of prestressing strands having kinks, bends, nicks or other defects shall not be permitted. A light coating of rust will not be cause for rejection, provided that the loose rust is removed and the surface of the strands is not visibly damaged. Tensioned strands shall be protected against excessive temperatures such as those produced by torches, welding equipment or sparks. Strands from more than one source shall not be used in any one tensioning operation.

1029.6.4 Strand Splices. One approved splice per strand will be permitted provided the splices are located outside of the prestressed member. For single strand tensioning, the number of strands per bed that may be spliced is not restricted. If multi-strand jacking is used, either all strands shall be spliced or no more than 10 percent of the strands shall be spliced. Spliced strands shall be similar in physical properties, from the same source, and have the same twist or lay. Previously tensioned strands may be reused one time provided the strands meet all requirements of these specifications.

1029.6.5 Wire Failures. Wire failures may be accepted, provided no more than one wire in any strand is broken and the area of broken wires does not exceed two percent of the total area of the strands.
1029.6.6 Stressing Requirements. The Contractor shall provide a technician skilled in the use of the system of prestressing to supervise the prestressing operations.

1029.6.7 Elongation. The Contractor shall compute the required elongation. Two copies of the computations shall be submitted to the Engineer. The length of the strand to be used in calculating elongations shall be the actual length of the strand along the strand’s trajectory between the fixed anchorage and the reference point at jacking end of the strand. Stress losses due to slippage of strand anchorages, splice chucks and movement of anchorage abutments shall be included in the elongation computations.

1029.6.8 Pretensioned Members. Prestressing tendons shall be uncoated seven-wire low relaxation strands in accordance with AASHTO M 203, Grade 270. Several pretensioned members may be cast in one continuous line. The time intervening between the casting of the first and last member on a bed shall not exceed four days unless otherwise permitted by the Engineer. When the temperature at the time of tensioning is such that correction must be made to compensate for change in strand stresses, all members on the bed shall be cast in a continuous pour. The tension in the strand as determined from the elongation at the time of placing concrete shall be within five percent of that specified. The stress to be given each strand shall be as shown on the plans. Pretensioning shall be by either the single strand or multi-strand jacking method. Each strand shall be brought to a uniform initial tension. The initial tension of each strand shall be accurately measured by a dynamometer or other approved means. The initial tension shall be within 50 pounds or two percent of that required, whichever is the larger. The same jack used for single strand tensioning may be used for initial tensioning provided the jack is equipped with a proper gauging system for measuring the initial tension. Measurement of elongation shall not begin until initial tensioning has been completed. Strands tensioned as a group shall have the same initial tension, be from the same source, and have essentially the same modulus of elasticity. Coil ties shall be held in place in the forms by setting studs projecting through the forms. Studs shall be left in place until girders are erected and then replaced by coil tie rods. Alternate methods may be used, provided acceptable results are achieved. Coil ties shall have a concrete pull-out strength of at least 9000 pounds in 3000 psi concrete.

1029.6.9 Post-Tensioned Members. Post-tensioned members shall be stressed in such a manner that the tension being applied and the elongation of the tendon may be measured at all times. The Contractor shall furnish a certified record of gauge pressures and elongations to the Engineer. Friction losses in the enclosures, elastic shortening and anchorage set shall be included in the computations for the required elongation of the tendon. In cases of discrepancies between gauge readings and the stress indicated by the elongation of the tendon, the elongation method of stress determination shall govern. Loads shall not be applied to the concrete until the concrete has attained the design compressive strength shown on the plans. Tendons shall be stressed in a sequence to produce the least eccentricity of the load. Post-tensioning elements shall be placed in metal enclosures and after stressing shall be bonded by pressure grouting the space between the enclosure and the tendon. Enclosures shall be thoroughly cleaned of all foreign material prior to grouting. The discharge ports shall be closed after all air has been forced out of the enclosure, as evidenced by the steady discharge of grout at the grout’s proper consistency, and a pump pressure of at least 50 psi maintained on the grout for a sufficient length of time to ensure completely filling all voids in the enclosure. Post-tensioned members shall not be removed from their supports for at least 24 hours after grouting.

1029.6.10 Strand Release. Strands shall not be released until the concrete has attained the required compressive strength shown on the approved shop drawings. The compressive strength shall be determined by tests of standard cylinders made of concrete from the same batches and cured in the same manner as the members. The strands or prestressing elements shall be cut or released in a sequence that produces the least eccentricity of the load. If steam curing is used, strand release shall be performed while the members are still warm. Forms, hold down devices, or other appurtenances that may restrict movement of the members shall be removed or loosened prior to strand release. The sequence of release for hold down devices and strands shall be indicated on the shop drawings. Release shall be in accordance with the approved shop drawings.
1029.6.11 Curing. Concrete members shall be kept continuously wet until the conclusion of the curing period. Curing shall be accomplished by covering with burlap or jute mats kept continuously wet by moist air, live steam or any combination of these methods. Other moist curing methods that will keep the member moist may be used provided the details of the proposed method are submitted to the Engineer and approved. As soon as the concrete has set sufficiently that no marring of the surface or distortion will result, wet burlap or jute mats shall be applied, covering the exposed surface. Curing shall be continued until the concrete has attained the design compressive strength shown on the plans. The concrete shall not be exposed to temperatures below freezing until the curing has been completed.

1029.6.11.1 Steam Curing. A preset period of no less than four hours shall be allowed before steam cure is applied. When the ambient temperature is below 50°F, steam shall be applied also during the preset period, but only at a rate sufficient to keep the air surrounding the member at a temperature between 50 and 70°F. After the preset period, steam shall be applied at a rate that will not increase the temperature of the air surrounding the members more than 40°F per hour. The maximum curing temperature shall not exceed 160°F, and the difference in temperature adjacent to the concrete at different locations within the enclosure shall not exceed 30°F at any time. Fluctuations of the temperature adjacent to the concrete during the curing period at any one location shall vary no more than 30°F. The Contractor shall furnish and place, at the direction of the Engineer, a minimum of two portable recording thermometers and no less than one for each 150 feet of enclosure, for use in determining the magnitude and degree of uniformity of temperatures within the enclosure. The temperature recording system shall be capable of automatically producing a temperature record during the entire curing period. The temperature record shall show the temperature at each location at intervals of no more than 15 minutes and have a range of approximately zero to 200°F. The temperature recording system shall be accurate within plus or minus 5°F. Steam shall be applied from pipes with perforations at suitable intervals laid along each side of the member, or by other approved arrangements. Jets of steam will not be permitted to impinge directly against the member, forms or test specimens. Provisions shall be made for effective circulation of the steam around all portions of the members. The concrete shall be kept continuously moist during the steam curing period. Steam curing shall continue until the required strength for transfer of load has developed. Steam or other curing methods shall continue until the concrete has attained the design compressive strength shown on the plans. After the expiration of the steam curing period, the temperature inside the chamber shall be reduced at a rate that will not increase the temperature of the air surrounding the members.

1029.6.12 Form Removal. Forms shall not be stripped from prestressed concrete members sooner than 12 hours after casting. If strand release strength has then been attained, forms may be removed and members moved without unnecessary delay to a curing area. If forms are removed before the concrete has attained the strength which will permit the units to be moved or stressed, only the minimum area of the curing enclosure that is necessary to remove each individual form section shall be removed at any one time. The open area in the enclosure shall immediately be closed as each form section is removed. When the surrounding air temperature is below 30°F, no portion of the enclosure shall be removed before the unit has attained the required transfer strength. Forms of test specimens shall be stripped at the same time the forms are removed from the members.

1029.6.13 Handling. Handling and storage of prestressed members shall be performed with the members in an upright position and with points of support in approximately the same position as designated for the final position of the members in the structure. Members shall not be transported nor erected until the concrete has attained the design compressive strength shown on the plans. In storage, the members shall be fully supported across their width on battens that are no less than 4 inches wide. During transportation, the ends of I-beams shall not extend a distance of more than the depth of the beam beyond the bolsters or other supports on the transporting vehicle. Other beams shall not extend more than 1 1/2 times their depth beyond the supports on the transporting vehicle. During storage, the supports shall maintain the members in essentially a level position without twisting. Stacking of members in storage shall be done only with the approval of the Engineer. If such permission is granted, the supports of all members shall be in the same vertical planes and shall be of adequate thickness to prevent damage to the lifting devices.
1029.6.14 Surface Finish, I-Girders. Surface finish shall be in accordance with Sec 703.3.5.8, except that no cracks of any kind in post-tensioned members shall be filled before the stressing is completed. The Engineer will determine the kind, type and extent of cracks and surface defects, such as honeycomb and chipped edges or corners, that will be tolerated. Repairs may be permitted with mortar in accordance with Sec 703.3.2.9. Commercially available patching material may be used if approved by the Engineer. The top surface of members shall be scored transversely to a depth of approximately 1/4 inch with a wire brush, stiff broom or other approved method. A 3 inch wide strip across the top flange of the member shall be smooth finished to accurate top flange depth at each point designated on the plans. No laitance shall remain on surfaces to be embedded in concrete. After removal of hold-down devices, holes shall be plugged. If the method for plugging these holes is not shown on the shop drawings, written approval of the proposed method shall be obtained from the Engineer. Exposed reinforcing steel shall be thoroughly cleaned of all concrete before delivery of members. The portions of girders to be embedded in the diaphragms at supports shall be roughened by sandblasting or other approved methods to provide suitable bond between girder and diaphragm. Mechanical benders, without the use of heat, shall be used to bend the strands on girders.

1029.6.15 Surface Finish, Tee Girders. Surface finish shall be in accordance with Sec 703.3.5.8, except that no cracks of any kind in post-tensioned members shall be filled before the stressing is completed. The Engineer will determine the kind, type and extent of cracks and surface defects, such as honeycomb and chipped edges or corners, that will be tolerated. Repairs may be permitted with mortar in accordance with Sec 703.3.2.9. Commercially available patching material may be used if approved by the Engineer. The top surface of members shall be scored transversely to a depth of approximately 1/8 inch. A 6 inch square area at each end and at each point designated on the plans, centered on each stem, shall be smooth finished to accurate top flange depth. Laitance on surfaces to be embedded in concrete shall be removed by sandblasting, waterblasting or other approved methods. After removal of hold down devices, holes shall be plugged. If the method for plugging these holes is not shown on the shop drawings, written approval of the proposed method shall be obtained from the Engineer. Exposed reinforcing steel shall be thoroughly cleaned of all concrete before delivery of members. The portion of girders to be embedded in the diaphragms at supports shall be roughened by sandblasting or other approved methods to provide suitable bond between girder and diaphragm. Mechanical benders, without the use of heat, shall be used to bend the strands on girders.

1029.6.16 Surface Finish, Deck Panels. The top surface of the panel shall be scored to facilitate bond with the cast-in-place deck. The scoring shall be perpendicular to the prestressing strands in the panel and shall be approximately 1/8 inch in depth.

1029.7 Dimensional Tolerances. The dimensional tolerances shall be as shown in Table I, II or III.

1029.8 Marking. Each precast unit shall be identified with the date, manufacturer and identification number. Markings may be indented on the unit or painted thereon with waterproof paint, and shall be located as shown on the plans or as directed by the Engineer.
<table>
<thead>
<tr>
<th>Table 1</th>
<th>Dimensional Tolerances – I – Girders and Miscellaneous Prestressed Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Beam</td>
<td>±1/8 inch per 10 feet of beam length, but no greater than 3/4 inch</td>
</tr>
<tr>
<td>Width (Flanges, Web and Fillets)</td>
<td>+3/8 inch, -1/4 inch</td>
</tr>
<tr>
<td>Depth (Flanges, Web and Fillets)</td>
<td>±1/4 inch</td>
</tr>
<tr>
<td>Depth (Overall)</td>
<td>+1/2 inch, -1/4 inch</td>
</tr>
<tr>
<td>Horizontal Alignment - I-Girders and Miscellaneous Prestressed Units (Deviation from a straight line to face of web at mid depth)</td>
<td>Length/8 in tenths of an inch max., all lengths</td>
</tr>
<tr>
<td>Horizontal Alignment - Solid Slab, Voided Slab and Box Girder Beams (Deviation from a straight line to face of slab/web)</td>
<td>1/4 inch max., to 40 foot lengths 3/8 inch max., 40 to 60 foot lengths 1/2 inch max., 60 to 80 foot or greater lengths 5/8 inch max, 80 to 100 foot lengths</td>
</tr>
<tr>
<td>Camber (Deviation from design camber within 7 days of strand release)</td>
<td>±1/2 inch, to 80 foot lengths ±1 inch, greater than 80 foot lengths ±1 1/2 inch, greater than 120 foot lengths</td>
</tr>
<tr>
<td>Stirrup Bars (Projection above top of beam)</td>
<td>± 3/4 inch</td>
</tr>
<tr>
<td>Stirrup Bars (Longitudinal spacing)</td>
<td>± 2 inches</td>
</tr>
<tr>
<td>Tendon Position - I-Girders and Miscellaneous Prestressed Units</td>
<td>±1/4 inch center of gravity of strand group and individual tendons</td>
</tr>
<tr>
<td>Tendon Position - Solid Slab, Voided Slab and Box Girder Beams</td>
<td>±1/8 inch center of gravity of strand group and individual tendons</td>
</tr>
<tr>
<td>Position of Deflection Points for Deflected Strands</td>
<td>± 6 inches, longitudinal</td>
</tr>
<tr>
<td>Position of Lifting Devices</td>
<td>± 6 inches, longitudinal</td>
</tr>
<tr>
<td>Side Inserts (Centerline to centerline and centerline to end)</td>
<td>± 1/2 inch</td>
</tr>
<tr>
<td>Coil Inserts (Centerline to centerline and centerline to end)</td>
<td>± 2 inches horizontal, except must be 3 inches or more from end of beam and within reinforcement cage of bent, ±1 inch vertical</td>
</tr>
<tr>
<td>Slab Drain Inserts</td>
<td>± 1/2 inch from designated location, Engineer may approve location ± 6 inches from design, multiple inserts for single drain must be within ± 1/2 inch of vertical line</td>
</tr>
<tr>
<td>Exposed Beam Ends (Deviation from square or designated skew)</td>
<td>± 1/4 inch horizontal, ± 1/8 inch vertical per foot of beam height</td>
</tr>
<tr>
<td>Bearing Area (Deviation from plane)</td>
<td>±1/8 inch</td>
</tr>
<tr>
<td>Bearing Plates (Centerline to centerline)</td>
<td>±1/8 inch per 10 feet of beam length, but no greater than 3/4 inch</td>
</tr>
<tr>
<td>Bearing Plates (Centerline to end of beam)</td>
<td>±1/2 inch</td>
</tr>
<tr>
<td>Diaphragm Hole Location</td>
<td>±1 1/2 inches for centerline of group ±1/2 inch within group</td>
</tr>
<tr>
<td>Scupper holes, blockouts and voids</td>
<td>Placed as close as possible to design location after reinforcement steel and strands are properly located</td>
</tr>
<tr>
<td>Dimensional Tolerances – Tee Girders</td>
<td></td>
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<tr>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Length of Beam</strong></td>
<td>± 1/8 inch per 10 feet of beam length, but not greater than 1/2 inch</td>
</tr>
<tr>
<td><strong>Width (Overall)</strong></td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td><strong>Depth (Overall)</strong></td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td><strong>Flange Thickness and Stem Thickness</strong></td>
<td>± 1/8 inch</td>
</tr>
<tr>
<td><strong>Horizontal Alignment (Deviation from a straight line to face of each web)</strong></td>
<td>1/4 inch max., to 40 foot lengths 3/8 inch max., 40 to 60 foot lengths 1/2 inch max., 60 foot or greater lengths</td>
</tr>
<tr>
<td><strong>Camber (Deviation from design camber within 7 days of strand release)</strong></td>
<td>± 1/2 inch, to 80 foot lengths ± 1 inch, greater than 80 foot lengths</td>
</tr>
<tr>
<td><strong>Stirrup Bars (Projection above top of beam)</strong></td>
<td>± 3/4 inch</td>
</tr>
<tr>
<td><strong>Stirrup Bars (Longitudinal spacing)</strong></td>
<td>± 2 inches</td>
</tr>
<tr>
<td><strong>Tendon Position</strong></td>
<td>± 1/8 inch center of gravity of strand group and individual tendons</td>
</tr>
<tr>
<td><strong>Strand Projection</strong></td>
<td>± 1 inch</td>
</tr>
<tr>
<td><strong>Diagonal Tolerance</strong></td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td><strong>Position of Deflection Points for Deflected Strands</strong></td>
<td>± 6 inches, longitudinal</td>
</tr>
<tr>
<td><strong>Position of Lifting Devices</strong></td>
<td>± 6 inches, longitudinal</td>
</tr>
<tr>
<td><strong>Side Inserts (Centerline to centerline and centerline to end)</strong></td>
<td>± 1/2 inch</td>
</tr>
<tr>
<td><strong>Coil Inserts (Centerline to centerline and centerline to end)</strong></td>
<td>± 2 inches horizontal, except must be 3 inches or more from end of beam and within reinforcement cage of bent, ± 1 inch vertical</td>
</tr>
<tr>
<td><strong>Exposed Beam Ends (Deviation from square or designated skew)</strong></td>
<td>± 1/4 inch horizontal, ± 1/8 inch vertical per foot of beam height</td>
</tr>
<tr>
<td><strong>Bearing Area (Deviation from plane)</strong></td>
<td>± 1/8 inch</td>
</tr>
<tr>
<td><strong>Bearing Plates (Centerline to centerline)</strong></td>
<td>± 1/8 inch per 10 feet of beam length, but not greater than 3/4 inch</td>
</tr>
<tr>
<td><strong>Bearing Plates (Centerline to end of beam)</strong></td>
<td>± 1/2 inch</td>
</tr>
<tr>
<td><strong>Center of Stem to Outside Edge of Top Flange</strong></td>
<td>± 1/8 inch</td>
</tr>
<tr>
<td><strong>Center to Center Distance Between Stems</strong></td>
<td>± 1/8 inch</td>
</tr>
<tr>
<td><strong>Stem End to End of Top Flange</strong></td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td><strong>Diaphragm Hole Location</strong></td>
<td>± 1 1/2 inches for centerline of group ± 1/2 inch within group</td>
</tr>
<tr>
<td><strong>Scupper holes, blockouts and voids</strong></td>
<td>Placed as close as possible to design location after reinforcement steel and strands are properly located</td>
</tr>
<tr>
<td>Dimensional Tolerances – Deck Panels</td>
<td></td>
</tr>
<tr>
<td>------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>+ 1/8 inch, -1/2 inch</td>
</tr>
<tr>
<td>Width</td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td>Depth</td>
<td>± 1/8 inch</td>
</tr>
<tr>
<td>Stirrup Bars (Projection above top of panel)</td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td>Stirrup Bars (Longitudinal spacing)</td>
<td>± 1 inch</td>
</tr>
<tr>
<td>Tendon Position</td>
<td>± 1/8 inch center of gravity of strand group and individual tendons</td>
</tr>
<tr>
<td>Strand Projection</td>
<td>± 1 inch</td>
</tr>
<tr>
<td>Diagonal Tolerance</td>
<td>± 1/4 inch</td>
</tr>
<tr>
<td>Scupper holes, blockouts and voids</td>
<td>Placed as close as possible to design location after reinforcement steel and strands are properly located</td>
</tr>
<tr>
<td>Warpage of corner (one corner out of plane of other three)</td>
<td>Be 1/16 in./ft times the distance from the nearest adjacent corner</td>
</tr>
<tr>
<td>Bowing or camber, concave or convex, of any part of a flat surface</td>
<td>Shall not exceed length of bow in inches divided by 360, with maximum of 3/4 inch; and differential bowing or camber between the adjacent members of the same design shall not exceed 1/4 inch</td>
</tr>
<tr>
<td>Scupper holes, blockouts and voids</td>
<td>Placed as close as possible to design location after reinforcement steel and strands are properly located</td>
</tr>
</tbody>
</table>
SECTION 1032
PRECAST CONCRETE FLARED END SECTIONS

1032.1 Scope. This specification covers reinforced precast concrete flared end sections for use at inlets and outlets of rigid pipe culverts.

1032.2 Material. All material shall be in accordance with Sec 1026.3, except that marking required by Sec 1026.3.10 will be limited to Sec 1026.3.10.1.

1032.2.1 Steel Fibers. Steel fibers shall be in accordance with ASTM A820. MoDOT's Pre-Accepted List (PAL) process as outlined in Sec 106 shall apply to steel fibers used in flared end sections.

1032.3 Design.

1032.3.1 Standard Reinforcement. Flared end sections, utilizing rebar or cold drawn steel wire shall be in accordance with the Missouri Standard Plans for Highway Construction.

1032.3.2 Steel Fibers. Steel fibers may be used exclusively or in combination with standard reinforcement. When steel fibers are used, the amount of steel fibers and standard reinforcement required shall be determined through proof of design testing accordance with ASTM C1765, Section 9, for Class III pipe of the same diameter. Proof of design testing shall be performed every three years and the results provided to the Engineer upon request. Additional proof of design testing shall be performed when the type of steel fiber is changed or when the dosage rate of the steel fibers is changed.

1032.4 Basis of Acceptance.

1032.4.1 Acceptance Criteria. Acceptability of end sections for all diameters will be determined by the results of such material tests as required in Sec 1026.3, by crushing tests on concrete cores or cured concrete cylinders, and by inspection of the finished end sections, including quantity and placement of reinforcement, to determine the conformance with the design and the freedom from defects.

1032.4.2 Workmanship. All protruding steel fibers shall be removed from the flared end prior to shipping.
1033.1 Scope. This specification covers precast reinforced concrete manhole and inlet sections and appurtenances, such as grade rings, tops and special sections.

1033.2 Acceptance. Unless otherwise specified, the basis for acceptance shall be in accordance with ASTM-C478 and MSD’s Standard Details of Sewer Construction. If Class B or B-1 concrete is used, compressive tests and absorption test specimens will not be required.

1033.3 Material.

1033.3.1 Cement. Cement shall be in accordance with Sec 1019. Fly ash or GGBFS may be substituted for cement in accordance with Sec 501.

1033.3.2 Fly Ash. Fly ash shall be in accordance with Sec 1018.

1033.3.3 Ground Granulated Blast Furnace Slag. GGBFS shall be in accordance with Section 1017.

1033.3.4 Aggregate. Fine and coarse aggregate shall be in accordance with Sec 1005, except that requirements for gradation and percent passing the No. 200 sieve shall not apply.

1033.3.5 Steel Reinforcement. Reinforcement shall be in accordance with Sec 1036.

1033.3.6 Concrete Mixture. The manufacturer may designate the mixture proportions, but in no case shall the proportion of cement in the mixture be less than 470 lb./yd3 of concrete. Admixtures or blends may be used with the approval of the Engineer. At the option of the manufacturer, Class B or B-1 concrete may be used. If Class B or B-1 concrete is used, material, proportioning, mixing, slump, and transporting of concrete shall be in accordance with Sec 501.

1033.4 Design.

1033.4.1 Precast Drainage Units. The design of precast drainage units shall be in accordance with ASTM-C478 and MSD’s Standard Details of Sewer Construction.

1033.4.2 Modified or Special Designs. The manufacturer may request approval of designs, prior to manufacture, other than those specified in the contract documents. Special or modified designs shall be submitted to the Engineer, in writing and shall fully describe any deviations from the contract documents. The description shall also include the wall thickness, all other dimensions, concrete compressive strength and the area, type, placement and strength of the steel reinforcement. Such sections shall meet all of the test and performance requirements specified by the Engineer in accordance with Sec 1033.2.

1033.4.3 Manhole Risers and Conical Tops. Each line of circumferential reinforcement shall be assembled into a cage that shall contain sufficient spacer bars or members, extending through the wall of the manhole risers and conical tops, to maintain the reinforcement rigidly in shape and correct position within the form. The exposure of the ends of stirrups or spacers that have been used to position the cages during the placement of the concrete will not be cause for rejection.

1033.5 Joints. The reinforced concrete riser sections, except grade rings, shall be formed with male and female ends so that when the manhole base, rider and top section are assembled they will make a continuous, uniform manhole. The joints shall be designed to permit placement without appreciable irregularities in the interior wall surface.
1033.6 Manufacture.

1033.6.1 Placement of Concrete. The transporting and placing of concrete shall be by methods that will prevent the segregation of the concrete material and the displacement of the reinforcing steel from the proper position in the form.

1033.6.2 Curing.

1033.6.2.1 Precast units shall be cured in accordance with Sec 1026. Precast sections shall not be transported or erected until the design compressive strength has been reached.

1033.6.2.2 If Class B or B-1 concrete is used, the sections shall be cured with wet burlap for 72 hours or by covering with transparent membrane applied in accordance with Sec 502. Precast units constructed with Class B or B-1 concrete shall not be transported or erected until at least seven days after casting. If forms are removed before the expiration of the curing period, the parts of the structure exposed shall be cured as directed by the Engineer.

1033.6.3 Lift Holes. Lift holes shall be in accordance with Sec 1026. If approved by the Engineer, lifting hooks or bars may be cast into the sections.

1033.6.4 Forms. Forms shall be mortar-tight and of sound material adequate to prevent distortion during placing and curing of the concrete. Forms shall be reasonably smooth and free of loose knots, holes and other defects.

1033.6.5 Cold Weather Concreting. Concrete placed in cold weather shall be protected from freezing during the curing period by the use of a heated, weatherproof enclosure. Concrete shall not be placed on or against reinforcing steel or other surfaces with temperatures lower than 35°F. No concrete shall be placed when the ambient temperature is below 35°F.

1033.7 Physical Test Requirements.

1033.7.1 Concrete Test Requirements. The basis for concrete test requirements shall be AASHTO M 199. The specified number of specimens required for the tests shall be furnished without charge by the manufacturer and shall be selected at random by the Engineer. The cores for compression tests shall be taken from manhole or drop inlet sections that would not otherwise be rejected under this specification. The selection shall be made at the point or points designated by the Engineer.

1033.7.2 Compression Tests. Compression tests for satisfying the design concrete strength requirement may be made on either standard rodded concrete cylinders or cylinders compacted and cured in a similar manner to the manhole or inlet sections or, at the option of the manufacturer, on cores drilled from the wall of the section. If compression test cylinders are being used, the manufacturer shall furnish a sufficient number of molds of a type meeting the approval from the Engineer. The compressive strength of each core tested shall be equal to or greater than the design strength of the concrete. If a core does not meet the required strength, another core from the same section may be tested. If this core does not meet the required strength, that section will be rejected. Additional tests shall be made on other sections to determine the acceptability of the lot.

1033.7.3 Absorption Test Requirements. The Engineer may require samples for absorption tests if concrete other than Class B or B-1 is used. Each sample shall be a piece broken from the wall or a core drilled from the wall, have a minimum area of 9 square inches as measured on one surface of the wall, have a thickness equal to the wall and be free of visible cracks.

1033.8 Permissible Variations in Dimensions.

1033.8.1 The basis for permissible variations in dimensions shall be AASHTO M 199.
1033.8.2 The internal dimensions of precast units shall not vary more than one percent or 3/8 inch, whichever is greater.

1033.8.3 The vertical spacing and vertical alignment between adjacent manhole steps and horizontal distance from the inside wall to the centerline of a manhole step shall not vary more than one inch from the design dimensions.

1033.9 Steps. Steps for precast manholes and inlets shall be in accordance with Sec 604 and as shown on the plans.

1033.10 Repairs. Filling of form tie cavities and repair of other defects shall be in accordance with Sec 703.

1033.11 Inspection. The quality of material, the process of manufacture and the finished precast units shall be subject to inspection and approval by the Engineer.

1033.12 Marking. Marking shall be indented into the section or shall be painted thereon with waterproof paint. The following information shall be clearly marked on the inside of each precast unit:

   (a) MH for manholes or I for inlets. Other units do not need a designation.

   (b) Date of manufacture.

   (c) Name or trademark of the manufacturer.

1033.13 Rejection. Precast units shall be subject to rejection for failure to conform to any of the specified requirements in AASHTO M 199.
1034.1 Scope. This specification covers reinforced concrete elliptical culvert, storm drain and sewer pipe for use on County projects.

1034.2 Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe. Reinforced concrete elliptical culvert, storm drain and sewer pipe shall be in accordance with ASTM C507

1034.3 Class and Type. The class of the pipe and type, whether Horizontal Elliptical or Vertical Elliptical, shall be as specified in the contract.
SECTION 1035
REINFORCED CONCRETE ARCH CULVERT

1035.1 Scope. This specification covers reinforced concrete arch culvert, storm drain and sewer pipe for use on County projects.

1035.2 Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe. Reinforced concrete arch culvert, storm drain and sewer pipe shall be in accordance with AASHTO M 206, except material shall be in accordance with Sec 1026.

1035.3 Class and Size. The class and size of the arch pipe shall be as specified in the contract.
SECTION 1036
REINFORCING STEEL FOR CONCRETE

1036.1 Scope. This specification covers reinforcing steel to be used in concrete.

1036.2 Acceptance.

1036.2.1 All material for this specification shall be obtained from a source identified on MoDOT’s Pre-Accepted List (PAL). The source shall be listed on the PAL at the time the material is incorporated into the project.

1036.2.2 All material will be inspected and accepted in accordance with Sec 106.

1036.2.3 AASHTO specifications, when referenced, will control only the physical properties, chemical properties and handling and storage of the material, except as otherwise specified herein or shown on the plans.

1036.3 Reinforcing Steel for Concrete Structures.

1036.3.1 Unless otherwise specified, reinforcement shall be deformed bars in accordance with AASHTO M 31.

1036.3.2 Spiral reinforcement shall be in accordance with Sec 1036.3.1, except that the reinforcement may be plain or deformed or shall be cold drawn steel wire in accordance with AASHTO M 32 or deformed steel wire in accordance with AASHTO M 225.

1036.3.3 Steel welded wire reinforcement shall be in accordance with AASHTO M 55 or AASHTO M 221.

1036.4 Epoxy Coated Reinforcing Steel.

1036.4.1 Epoxy coated reinforcing steel shall be in accordance with ASTM A 775/A 775M except as otherwise specified herein or shown on the plans.

1036.4.1.1 Only steel in accordance with Sec 1036.3.1 shall be used.

1036.4.1.2 Coated bars shall not be spliced except as shown on the plans.

1036.4.1.3 Organic coatings, other than epoxy, shall not be used.

1036.4.1.4 Patching or repair material shall be compatible with the coating, inert in concrete and in accordance with the epoxy resin manufacturer’s recommendations. The material shall be epoxy and be suitable for application at the plant or in the field to uncoated areas and damaged areas of the coating.

1036.5 Documentation.

1036.5.1 Documentation of uncoated steel shall include the steel manufacturer’s certified mill test report showing complete chemical and physical test results for each heat.

1036.5.2 Documentation of coated steel shall include the coating applicator’s certification that all material used, the preparation of the bars, coating and curing are in accordance with these specifications, and that no bar contains more than one holiday per linear foot. The certification shall include or have attached specific results of tests of coating thickness and flexibility of coating.
SECTION 1037
SHEAR CONNECTORS

1037.1 Scope. This specification covers the requirements for stud-type shear connectors and weldability qualification.

1037.2 Material. Studs shall be in accordance with AASHTO M 169 for cold drawn carbon steel bars Grades 1015, 1017 or 1020, either semi- or fully-killed. If flux retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall be in accordance with ASTM A 109. The flux for welding shall be self-contained either in the base of the stud or in the ferrule and automatically applied in the welding operation. A ferrule of heat resistant ceramic or other suitable material shall be used with each stud, and the ferrule shall be composed of material, which is not detrimental to the welds, does not cause excessive slag and has sufficient strength to withstand thermal or structural shock.

1037.3 Qualification Procedure. The procedure for weldability tests to qualify shear connector studs for welding under shop or field conditions shall be as follows. Such tests may be performed by a university, independent laboratory or by other approved testing agencies. The tests shall be made on each type and size of stud. The agency performing the tests shall submit to the manufacturer of the stud a certified report giving procedures and results for all tests, including the information listed under Sec 1037.9.

1037.4 Duration of Qualification. Qualifications will be considered valid until the manufacturer makes a change in the base of the stud, the flux or the arc shield, which affects the welding characteristics.

1037.5 Preparation of Specimens.

1037.5.1 Test specimens shall be prepared by welding representative studs to the center of square specimen plates, 1/2 to 3/4 inch thick, in accordance with ASTM A 36. At the option of the manufacturer, several studs may be welded to a large plate and the specimen plates cut of a size suitable for test equipment used. Studs shall be welded with power source, welding gun and control equipment as recommended by the manufacturer. Welding voltage, current and time shall be measured by suitable instrumentation and recorded for each specimen. Lift and plunge shall be at the optimum setting as recommended by the manufacturer.

1037.5.2 Studs shall be of uniform quality and condition, free from laps, fins, seams, cracks, twists, bends or other injurious defects. The finish shall be as produced by cold drawing, cold rolling or machining. The overall height after welding will be shown on the plans. The size of studs with allowable tolerance shall be as follows.

<table>
<thead>
<tr>
<th>Stud Size - Inches</th>
<th>Shank Diameter Tolerances</th>
<th>Overall Height (Tolerances After Welding)</th>
<th>Head Diameter</th>
<th>Head Thickness, Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>+0.000</td>
<td>+0.062</td>
<td>1 1/4 ± 1/64</td>
<td>3/8</td>
</tr>
<tr>
<td></td>
<td>-0.010</td>
<td>-0.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/8</td>
<td>+0.000</td>
<td>+0.062</td>
<td>1 3/8 ± 1/64</td>
<td>3/8</td>
</tr>
<tr>
<td></td>
<td>-0.010</td>
<td>-0.125</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1037.5.3 Thirty test specimens shall be welded consecutively with optimum current and time. Optimum current and time shall be the midpoint of the range normally recommended by the manufacturer for production welding.
1037.5.4 Thirty test specimens shall be welded consecutively with time held constant at optimum, but with current 10 percent below optimum.

1037.5.5 Thirty test specimens shall be welded consecutively with time held constant at optimum, but with current 10 percent above optimum.

1037.6 Qualification Tests.

1037.6.1 Tensile Tests. Ten of the specimens welded in accordance with Sec 1037.5.3, ten in accordance with Sec 1037.5.4 and ten in accordance with Sec 1037.5.5, shall be subjected to a tensile test. Tensile properties shall be determined in accordance with the applicable sections of AASHTO T 244. If a fracture occurs outside the middle half of the gage length, the test shall be repeated. A stud will be considered as qualified if all test specimens meet the following requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, min.</td>
<td>60,000 psi</td>
</tr>
<tr>
<td>Yield Strength, as determined by a 0.2% offset method, min.</td>
<td>50,000 psi</td>
</tr>
<tr>
<td>Elongation, min.</td>
<td>20% in 2 inches</td>
</tr>
<tr>
<td>Reduction of Area</td>
<td>50%</td>
</tr>
</tbody>
</table>

1037.6.2 Bend Tests. Twenty of the specimens welded in accordance with Sec 1037.5.3, 20 in accordance with Sec 1037.5.4 and 20 in accordance with Sec 1037.5.5, shall be bent alternately 30 degrees in opposite directions until failure occurs. A stud will be considered as qualified if, on all test specimens, fracture occurs in the shank of the stud and not in the weld.

1037.7 Retests. If a weld failure occurs in any of the tensile or bend test groups, another test group may be prepared and tested. If weld failure repeats, the stud shall fail to qualify.

1037.8 Qualification. For a manufacturer's studs and arc shields to be qualified, each group of thirty studs shall, by test or retest, meet the requirements specified in Sec 1037.6.

1037.9 Report of Tests. The report of the testing laboratory to the manufacturer shall include the following:

(a) Drawings which show shapes and dimensions with tolerances of studs, arc shields and flux.

(b) A complete description of material used in the studs and arc shields, including the quantity and analysis of the flux.

(c) A certification that the studs and arc shields described in the report are qualified in accordance with Sec 1037.8.

1037.10 Certification. Prior to inspection, the Contractor shall submit to the Engineer the following information:

(a) The name of the manufacturer.

(b) A detailed description of the studs to be furnished.

(c) A certification from the manufacturer that the studs delivered are qualified in accordance with Sec 1037.8.

(d) A copy of the qualification test results as certified by the testing laboratory unless the source and
manufacturing process for these studs has been previously approved.

(e) Certified copies of in-plant quality control test results.
**SECTION 1038**

**BEARING PADS FOR STRUCTURES**

**1038.1 Scope.** These specifications cover elastomeric bearing pads of neoprene, of rubber and fabric and of rubber and fiber. Elastomeric bearing pads shall include plain bearings, consisting of elastomer only, and laminated bearings, consisting of layers of elastomer restrained at their interfaces by bonded laminates.

**1038.2 Acceptance.** All material will be accepted on the basis of the required certification and testing required by the Engineer.

**1038.3 Elastomeric Bearing Pads.**

**1038.3.1 Material.** The elastomer shall be 100 percent virgin chloroprene (neoprene) compound meeting the requirements shown below. The pads shall be of the Durometer Grade specified on the plans. If test specimens are cut from the finished product, a 10 percent variation in "Physical Properties" will be allowed.

<table>
<thead>
<tr>
<th>ASTM Standard</th>
<th>Property</th>
<th>Durometer Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>D 2240</td>
<td>Hardness</td>
<td>50 ± 5</td>
</tr>
<tr>
<td>D 412</td>
<td>Tensile Strength, psi, min</td>
<td>2500</td>
</tr>
<tr>
<td>D 412</td>
<td>Ultimate Elongation, percent, min</td>
<td>400</td>
</tr>
<tr>
<td>D 573</td>
<td>Heat Resistance</td>
<td></td>
</tr>
<tr>
<td>70 hrs @ 212°F</td>
<td>Change in Durometer Hardness, points, max</td>
<td>+15</td>
</tr>
<tr>
<td></td>
<td>Change in Tensile Strength, percent, max</td>
<td>-15</td>
</tr>
<tr>
<td></td>
<td>Change in Ultimate Elongation, percent, max</td>
<td>-40</td>
</tr>
<tr>
<td>D 395</td>
<td>Compressive Set</td>
<td></td>
</tr>
<tr>
<td>Method B</td>
<td>22 hrs at 212°F, percent, max</td>
<td>35</td>
</tr>
<tr>
<td>D 1149</td>
<td>Ozone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 pphm ozone in air by volume</td>
<td>No Cracks</td>
</tr>
<tr>
<td></td>
<td>20% strain 100 ± 2°F, 100 hrs, mounting procedure ASTM D 518 Procedure A</td>
<td></td>
</tr>
<tr>
<td>D 429</td>
<td>Adhesion</td>
<td></td>
</tr>
<tr>
<td>Method B</td>
<td>Bond made during vulcanization, Lbs/inch</td>
<td>40</td>
</tr>
<tr>
<td>D746, Procedure B</td>
<td>Low Temperature Test</td>
<td>No Failure</td>
</tr>
<tr>
<td></td>
<td>Brittleness at -40°F</td>
<td></td>
</tr>
</tbody>
</table>

**1038.3.2 Laminates.** Laminates shall be cold rolled sheets in accordance with ASTM A 1008 or hot rolled steel sheets in accordance with ASTM A 1011 with a minimum grade of 36.

**1038.3.3 Manufacturing Requirements.** Shop drawings for laminated neoprene bearings pad assemblies shall be prepared and submitted to the Engineer for approval in accordance with [Sec 1080.3.2](#). Shop drawings will not be required for plain neoprene bearing pads or laminated neoprene bearing pads without a steel sole plate. Cut edges shall be at least as smooth as ANSI 250 (6 µm) finish. Unless otherwise shown on the plans, all components of a laminated bearing shall be molded together into an integral unit, and all edges of the laminations shall be covered by a minimum of 1/8 inch of elastomer except at laminate restraining devices and around holes that will be entirely...
closed on the finished structure. The laminated neoprene bearings pad assembly steel sole plate shall be bonded by vulcanization to the laminated neoprene pad to provide a homogenous bond free of air and moisture pockets. The following values shall be met under laboratory testing conditions of full size bearings:

(a) Compressive strain of any layer of an elastomeric bearing shall not exceed seven percent at 800 psi average unit pressure or at the design dead load plus live load pressure, if so indicated on the plans.

(b) Shear resistance of the bearing shall not exceed 50 psi for 50 durometer, 75 psi for 60 durometer or 110 psi for 70 durometer compounds at 25 percent strain of the total effective elastomer thickness after an extended 4-day ambient temperature of -20°F.

1038.3.4 The manufacturer shall proof load each laminated neoprene bearing with a compressive load of 1,500 psi on the bearing area. The bulging pattern shall not indicate improper laminate placement or poor laminate bond. No more than two separate surface cracks with a width of 0.08 inches and a depth of 0.08 inches will be permitted.

1038.4 Type “N” Polytetrafluoroethylene (PTFE) Bearings.

1038.4.1 Type “N” PTFE bearings shall be either fixed units or expansion units having sliding surfaces of mirror stainless steel against PTFE material. Shop drawings for type “N” PTFE bearings shall be prepared and submitted to the Engineer for approval in accordance with Sec 1080.3.2. The PTFE sliding bearings shall consist of a steel sole plate with a welded upper element of stainless steel bearing on a lower element consisting of a layer of PTFE material bonded to a stainless steel plate that shall be bonded to the neoprene elastomeric pad. The surface of the stainless steel plate shall be protected from weld splatter during the welding procedure.

1038.4.2 The stainless steel sheet for the top and bottom elements of sliding bearings shall be Type 304 in accordance with ASTM A 240. The finished stainless surface of the top element shall be a plane within a tolerance of 1/32 inch, polished sufficiently to meet the friction requirement in Sec 1038.4.6.1, and shall be comparable to a No. 8 mirror finish as established by the American Iron and Steel Institute Committee of Stainless Steel Producers “Finishes for Stainless Steel” at the completion of fabrication.

1038.4.3 Neoprene elastomeric pads shall be in accordance with Sec 1038.3.

1038.4.4 The PTFE material shall be 100 percent virgin PTFE fluorocarbon resin, unfilled or filled with fiberglass reinforcement to minimize the cold flow tendencies while maintaining the friction properties of the PTFE fluorocarbon resin. The amount of filler by weight of filled PTFE sheet shall be no more than 15 percent. The finished material shall exhibit the following physical properties:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Method</th>
<th>Filled Value</th>
<th>Unfilled Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, psi</td>
<td>ASTM D 638</td>
<td>2000</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM D 2256</td>
<td>-</td>
<td>2800, min</td>
</tr>
<tr>
<td>Elongation, Percent</td>
<td>ASTM D 638</td>
<td>150, min</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM D 2256</td>
<td>-</td>
<td>200, min</td>
</tr>
<tr>
<td>Melting Point</td>
<td>ASTM D 4895</td>
<td>621 ± 18°F</td>
<td>623 ± 2°F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>ASTM D 4895</td>
<td>2.20 ± 0.03</td>
<td>2.16 ± 0.03</td>
</tr>
</tbody>
</table>

1038.4.5 The PTFE sheet shall be bonded to the stainless steel with epoxy bonding material designated by the manufacture as compatible with the PTFE sheet and stainless steel and be able to withstand the temperatures of vulcanization. The stainless steel shall then be bonded by vulcanization to the neoprene elastomeric pad to provide a homogenous bond free of air and moisture pockets.
1038.4.6 One load specimen from the sliding bearing, consisting of a bottom element and a compatible top element no less than the smaller of the bearing area or 7 x 7 inches shall be tested by the manufacturer.

1038.4.6.1 The specimen shall be loaded to 800 psi compression at 68°F ± 2°F and subjected to 100 cycles of one inch of horizontal movement each way from center at a rate of 2.5 inches per minute. The breakaway friction coefficient shall be computed for each direction of each cycle, and the breakaway friction coefficient mean and standard deviation shall be computed for the sixth through twelfth cycles. The initial static breakaway coefficient of friction for the first cycle shall not exceed twice the design coefficient of friction. The maximum coefficient of friction for all subsequent cycles shall not exceed the design coefficient of friction. Failure of a single sample shall result in rejection of the entire lot. Following the test, the breakaway coefficient of friction shall be determined again and shall not exceed the initial value. The bearing shall show no signs of bond failure or other defect.

1038.4.6.2 A minimum of one test for sliding bearings shall be performed for each lot of bearings.

1038.5 Rubber and Fabric Pads.

1038.5.1 Rubber and fabric bearings pads shall be manufactured of new material and be composed of multiple layers of prestressed cotton duck material weighing no less than 8.1 ounces per square yard. The duck warp count shall be 50 threads plus or minus one thread per inch and filing count 40 threads plus or minus two threads per inch, each with two yarns per thread. The finished pads shall have 64 plies per inch of thickness. The duck material shall be impregnated and bound with a high quality rubber compound containing rot and mildew inhibitors and anti-oxidants, compounded into resilient pads of uniform thickness.

1038.5.2 The pads shall withstand compressive loads perpendicular to the plane of laminations of no less than 10,000 psi without separation of bond or detrimental deformation. Load deflection properties, determined in accordance with procedures of Military Specifications MIL-C-882B, shall not exceed 10 percent of total pad thickness at 1000 psi and 15 percent of total pad thickness at 2000 psi. When loaded to 1500 psi, permanent set as load shall be removed in accordance with procedures of MIL-C-882B and shall be no more than 2.5 percent of the original "zero point" thickness. Type A Durometer hardness shall be 87 to 95. The ratio of lateral expansion to vertical deflection shall not exceed 0.25 when loaded to 1500 psi. The material shall not lose effectiveness throughout a temperature range of -65°F to 150°F. The thickness shall vary no more than five percent from that shown on the plans. There shall be no visible evidence of damage or deterioration resulting from environmental effects of sunshine, humidity, salt spray, fungus or dust in accordance with MIL-E-5272.

1038.6 Rubber and Fiber Pads.

1038.6.1 Rubber and fiber bearing pads shall consist of a rubber body and fabric fibers for insulation under aluminum rail posts. The bearing pads shall be made from new unvulcanized rubber and unused fabric fibers. Fibers and rubber shall be in proper proportion to maintain specified strength and stability.

1038.6.2 Type A durometer surface hardness of the pads shall be 70 to 90. Pads of the specified thickness shall be capable of withstanding compressive loads of no less than 7000 psi without excessive extrusion or detrimental reduction in thickness.

1038.7 Tolerances. For both plain and laminated bearings, the permissible variation from the dimensions and configuration shown on the plans shall be as follows:
### Item | Inch
--- | ---
**Overall Vertical Dimensions**<br>Average total thickness 1 1/4 inches or less | -0, +1/8
Average total thickness over 1 1/4 inches | -0, +1/4
**Overall Horizontal Dimensions**<br>36 inches and less | -0, +1/4
Over 36 inches | -0, +1/2
**Thickness of Individual Layers of Elastomer**<br>(Laminated bearings only) | ±1/8
**Variation from a Plane Parallel to Theoretical Surface**<br>(as determined by measurements at the edges of bearings) | 1/8
Top | 1/8
Sides | 1/4
Individual non-elastic laminates | 1/8
**Position of Exposed Connection Members** | 1/8
**Cover of Embedded Laminates or Connection Members** | -0, +1/8
**Size of Holes, Slots or Inserts** | -0, +1/8
**Position of Holes, Slots or Inserts** | ± 1/8

**1038.8 Certification.** The manufacturer shall furnish certification of all material. The certification shall indicate that the components are in accordance with this specification and shall include typical test results representative of the material, except for bearings meeting **Sec 1038.3** and **Sec 1038.4** which will require test results for the material actually used in the bearing. The certification shall indicate the results of the proof loading, when required.
SECTION 1039
EPOXY RESIN MATERIAL

SECTION 1039.10 TYPE II EPOXY

1039.10.1 Scope. This specification covers epoxy resin to be used to bond plastic concrete or mortar to hardened concrete or mortar.

1039.10.2 General Requirements. The epoxy shall be furnished as a system in accordance with the requirements of ASTM C 881, Type II, Grade 2, Class B or C.

1039.10.3 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to MoDOT Construction and Materials or the County a certified test report showing specific test results from an independent laboratory in accordance with all requirements of these specifications. The certified test report shall contain the manufacturer’s name, brand name of material, lot tested, date of manufacture and ratio of components. In addition, the manufacturer shall submit a one-quart sample of each component, A and B, for laboratory testing accompanied by a technical data sheet and an MSDS. With approval from the Engineer of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of concrete bonding compounds. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

1039.10.4 Acceptance. To obtain final acceptance of this material, the manufacturer shall furnish certification to the Engineer at the destination that the material supplied is in accordance with all requirements specified and stating that the material is the same system and is identically formulated to the material tested for manufacturer and brand name approval.

SECTION 1039.20 TYPE III EPOXY

1039.20.1 Scope. This specification covers epoxy to be used in the grouting of dry cracks, in epoxy mortar for patching concrete and in epoxy mortar surface leveling.

1039.20.2 General Requirements. The epoxy shall be furnished as a system in accordance with the requirements of ASTM C 881, Type III, Grade 1, Class B or C.

1039.20.3 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to MoDOT Construction and Materials or the County a certified test report showing specific test results from an independent laboratory in accordance with all requirements of these specifications. The certified test report shall contain the manufacturer’s name, brand name of material, lot tested, date of manufacture and ratio of components. In addition, the manufacturer shall submit a one-quart sample of each component, A and B, for laboratory testing accompanied by a technical data sheet and an MSDS. With approval from the Engineer of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of concrete bonding compounds. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

1039.20.4 Acceptance. To obtain final acceptance of this material, the manufacturer shall furnish a certification to the Engineer at destination certifying that the material supplied is in accordance with all requirements specified and stating that the material is the same system and is identically formulated to the material tested for manufacturer and brand name approval.
SECTION 1039.30 EPOXY OR POLYESTER BONDING AGENTS FOR DOWELS

1039.30.1 Scope. This specification covers a multi-component epoxy or polyester bonding agent to be used in anchoring epoxy coated dowel bars in concrete for pavement repair.

1039.30.2 General Requirements. Epoxy or polyester bonding agents for anchoring epoxy coated dowel bars shall be furnished as a multi-component system. The system shall include automatic mixing, whether in cartridge or bulk form. The component ratios shall be shown on the label of each cartridge or bulk container.

1039.30.3 Properties. The epoxy or polyester bonding agent shall exhibit good bonding properties between the epoxy coated dowel bar and the existing concrete and shall cure in two hours or less. Bonding agents, when initially mixed, shall have a viscosity, which prevents flow from a horizontal hole. When tested in accordance with MoDOT Test Method TM 49, the minimum pull-out load shall be 8100 pounds.

1039.30.4 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to MoDOT Construction and Materials or the County a certified test report from an independent laboratory showing specific test results in accordance with all requirements of this specification. The certified test report shall contain the manufacturer's name, brand name of material, lot tested, date of manufacture, ratio of components by volume and system tested. In addition, the manufacturer shall submit to MoDOT Construction and Materials a sample representing the system for laboratory testing accompanied by a technical data sheet, an MSDS and any special installation instructions relative to the system being submitted, including recommended curing time. With approval from the Engineer of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of bonding agents for dowels. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

1039.30.5 Acceptance. To obtain final acceptance of this material, the manufacturer shall furnish certification to the Engineer at the destination that the material supplied is in accordance with all requirements specified and stating that the material supplied is the same system and is identically formulated to the material tested for manufacturer and brand name approval.

SECTION 1039.40 EPOXY BONDING AGENTS FOR RESIN ANCHOR SYSTEMS

1039.40.1 Scope. This specification covers a multi-component epoxy bonding agents to be used in anchoring steel components in concrete for structures.

1039.40.2 General Requirements. The epoxy shall be furnished as a system in accordance with the requirements of ASTM C 881, Type IV, and Grade 3 and as described herein.

1039.40.3 Pull Test. The epoxy bonding agent shall exhibit good bonding properties between the anchored product and the existing concrete and shall cure in 24 hours or less. When tested in accordance with MoDOT Test Method TM 74, the ultimate minimum pull-out load shall be in accordance with the following table:
### Pull-Out Specification Requirements

<table>
<thead>
<tr>
<th>Diameter of Threaded Rod or Reinforcing Bar</th>
<th>Minimum Ultimate Pullout Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2”</td>
<td>9800 lbs</td>
</tr>
<tr>
<td>5/8”</td>
<td>15,500 lbs</td>
</tr>
<tr>
<td>3/4”</td>
<td>20,400 lbs</td>
</tr>
<tr>
<td>7/8”</td>
<td>27,500 lbs</td>
</tr>
<tr>
<td>1”</td>
<td>33,600 lbs</td>
</tr>
</tbody>
</table>

**1039.40.4 Manufacturer and Brand Name Approval.** Prior to approval and use of this material, the manufacturer shall submit to MoDOT Construction and Materials or the County a certified test report from an independent laboratory showing specific test results in accordance with all requirements of this specification. The certified test report shall contain the manufacturer's name, brand name of material, lot tested, date of manufacture, bar or rod size tested, embedment depth and ratio of components. In addition, the manufacturer shall submit a one-quarter sample of each component, A and B, for laboratory testing accompanied by a technical data sheet and a material safety data sheet. With approval from the Engineer of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of Epoxy Bonding Agents for Resin Anchor Systems. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

**1039.40.5 Acceptance.** To obtain final acceptance of this material, the manufacturer shall furnish certification to the Engineer at the destination that the material supplied is in accordance with all requirements specified and stating that the material is the same system and is identically formulated to the material tested for manufacturer and brand name approval.

### SECTION 1039.50 SAND FOR EPOXY MORTAR

**1039.50.1 Scope.** This specification covers sand for use in epoxy mortar for the repairing of concrete surfaces. The epoxy material used in epoxy mortar shall be Type III epoxy in accordance with Sec 1039.20.

**1039.50.2 Properties.** Sand for mortar shall be a quartzite sand, Ottawa sand or equal. The sand shall be clean and dust free. The maximum moisture content shall be 2 percent. The gradation shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Gradation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

**1039.50.3 Acceptance.** The manufacturer shall furnish certification to the Engineer at the destination that the material supplied is in accordance with all requirements of this specification. Acceptance will be based on certification and testing.

### SECTION 1039.60 EPOXY POLYMER CONCRETE OVERLAY
1039.60.1 Scope. This specification covers an epoxy concrete overlay system consisting of an epoxy resin material and aggregate for use on bridge deck surfaces.

1039.60.2 Epoxy Resin Material. The infrared spectrum for each component of the epoxy-resin material shall essentially match that of the standard infrared spectrum for the particular component as specified in AASHTO T 237, Sections 4 and 5. The epoxide equivalent for Component A shall not exceed 270. The mixed epoxy shall meet the following requirements:

<table>
<thead>
<tr>
<th>Epoxy Resin Requirements</th>
<th>Specific Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pot life, 75°F, minutes</td>
<td>10 - 55</td>
</tr>
<tr>
<td>Tensile strength, 75°F, 7 Days, psi, min.</td>
<td>1500</td>
</tr>
<tr>
<td>Tensile elongation, 75°F, percent, min.</td>
<td>20</td>
</tr>
<tr>
<td>Water absorption, percent, max.</td>
<td>0.8</td>
</tr>
<tr>
<td>Compressive strength, 4 hr., psi, min.</td>
<td>1000</td>
</tr>
<tr>
<td>Compressive strength, 48 hr. wet, psi, min.</td>
<td>4000</td>
</tr>
<tr>
<td>Ash content, percent, max.</td>
<td>0.5</td>
</tr>
<tr>
<td>Rotational Viscosity, 75°F, Spindle 3, 60 rpm, Poise</td>
<td>7 - 25</td>
</tr>
<tr>
<td>Volatile Content, percent, max.</td>
<td>3.0</td>
</tr>
<tr>
<td>Thermal Shear</td>
<td>No shearing, shrinkage, expansion or scaling.</td>
</tr>
</tbody>
</table>

1039.60.2.1 Classes. Epoxy resin shall be formulated for use at specific temperatures as specified in ASTM C 881. The controlling temperature shall be that of the hardened concrete surface to which the overlay is applied. Where unusual curing rates are desired and upon the approval from the Engineer, a class of epoxy may be used at a temperature other than that for which the epoxy is normally intended.

1039.60.2.2 Packaging. Containers shall be identified as "Component A--Contains Epoxy Resin" and "Component B--Contains Hardener" and shall show the type, class and mixing directions. Each container shall be marked with the name of the manufacturer, class, batch, or lot number, date of packaging, date of shelf life expiration, pigmentation, if any, manufacturer, and the quantity contained in pounds and gallons.

1039.60.3 Aggregate for Epoxy Polymer Concrete Overlay. Aggregate shall be bauxite, crushed porphyry, aluminum oxide, flint chat or other similarly hard, durable, dry aggregates with less than 0.2 percent moisture. Aggregate shall be in accordance with the following gradation:

<table>
<thead>
<tr>
<th>Aggregate Requirements</th>
<th>% Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
<td></td>
</tr>
<tr>
<td># 4</td>
<td>100</td>
</tr>
<tr>
<td># 20</td>
<td>0-5</td>
</tr>
<tr>
<td># 200</td>
<td>0-1.0</td>
</tr>
</tbody>
</table>

1039.60.3.1 Lead Content. Aggregate produced as a by-product from lead or zinc mining operations shall not have a total lead content greater than 4,500 ppm, as determined by EPA Method 3050A, “Acid Digestion of Sediments, Sludges and Soils (particle size reduced to 1 mm or less)”. Suppliers of this aggregate shall provide certification to the Engineer for each shipment that the total lead content of the aggregate does not exceed this value, and attach a typical test report from the same source no older than 12 months prior to the shipment.
1039.60.3.2 Aggregate Recommendation. For each contract, the epoxy supplier shall supply a letter to the Engineer specifically recommending the use of a designated aggregate and source, which has been previously approved by MoDOT Construction and Materials.

1039.60.4 Overlay System. The overlay system shall not exhibit shearing, shrinkage, expansion or scaling.

1039.60.5 Test Methods. Tests will be performed in accordance with the following methods:

<table>
<thead>
<tr>
<th>Test Methods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational Viscosity</td>
<td>ASTM 2393 Model LVT Brookfield viscometer</td>
</tr>
<tr>
<td>Epoxy equivalent</td>
<td>MoDOT Test Method TM 73</td>
</tr>
<tr>
<td>Volatile content(^a)</td>
<td>ASTM D 1259, Method B, for mixed system</td>
</tr>
<tr>
<td>Filler content</td>
<td>MoDOT Test Method TM 73</td>
</tr>
<tr>
<td>Ash content</td>
<td>ASTM D 482</td>
</tr>
<tr>
<td>Pot life</td>
<td>AASHTO T 237</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>ASTM C 881</td>
</tr>
<tr>
<td>Water absorption</td>
<td>ASTM D 570</td>
</tr>
<tr>
<td>Thermal Shear</td>
<td>MoDOT Test Method TM 72</td>
</tr>
</tbody>
</table>

\(^a\) Sample cured 4 days at room temperature and weighed on a previously weighed metal foil.

1039.60.6 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to MoDOT Construction and Materials or the County a certified test report showing specific test results in accordance with all requirements of this specification. The certified test report shall include the manufacturer’s name, brand name of material, lot tested, date of manufacture, ratio of components by volume and system tested. In addition, the manufacturer shall submit to MoDOT Construction and Materials or the County a sample representing the system for laboratory testing accompanied by a technical data sheet, an MSDS and any special installation instructions relative to the system being submitted. Upon approval of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of epoxy resin material for polymer concrete overlay. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates non-conformity with any of the requirements herein specified.

1039.60.7 Product History. The overlay system shall have a proven record of a minimum of two years on similar bridge decks within the United States. A list including the location, the name of the agency involved with the project, and a name and phone number of a contact person with that agency, shall be provided for each location used as evidence of satisfactory use.

1039.60.8 Acceptance. The manufacturer shall furnish certification to the Engineer at the destination that the material supplied is in accordance with all requirements specified and stating that the material supplied is the same system and is identically formulated to the material tested for manufacturer and brand name approval. Acceptance will be based on certification and testing.

SECTION 1039.70 POLYMER CONCRETE

1039.70.1 Scope. This specification covers polymer concrete consisting of a fast setting epoxy based solid that may contain aggregate for use at bridge expansion joints.
1039.70.2 General Requirements. The polymer concrete shall be resilient, self-adhering, water tight and shall withstand and remain bonded to the surrounding material under repeated impact and thermal cycling. The polymer concrete shall not flow or become tacky at temperatures up to 130°F, shall be resistant to ultraviolet radiation, petroleum products and abrasion, and shall be capable of curing at all temperatures above 50°F. Mixing and placement shall be in accordance with the manufacturer’s recommendations.

1039.70.2.1 The combined liquid components with no aggregate added shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Epoxy Requirements</th>
<th>Specific Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing Ratio, by Volume</td>
<td>1:1</td>
</tr>
<tr>
<td>Viscosity (ASTM D 2393), Poises, Spindle 2, 30 rpm, 25°C ± 2°C</td>
<td>9-20</td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
</tr>
<tr>
<td>Gel Time (AASHTO M-200-73), minutes</td>
<td>25-50</td>
</tr>
<tr>
<td>Elongation (ASTM D 638°), percent</td>
<td>45-55</td>
</tr>
<tr>
<td>Tensile Strength (ASTM D 638°), psi, min.</td>
<td>900</td>
</tr>
<tr>
<td>Shore D Hardness (ASTM D 2240), 77°F</td>
<td>45-75</td>
</tr>
</tbody>
</table>

*Test Method Type 1, Molded Specimens, 0.25 inches thickness

1039.70.2.2 The cured polymer concrete including aggregate, which shall be supplied by the manufacturer, shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Polymer Concrete Requirements</th>
<th>Specific Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression strength (ASTM C 579), psi, min. at 24 hours</td>
<td>2500</td>
</tr>
<tr>
<td>Bond Shear Strength (ASTM C 882), psi</td>
<td>700</td>
</tr>
<tr>
<td>Abrasion Resistance (ASTM C 501), Wear Index (Taber H-22), max.</td>
<td>1.0</td>
</tr>
<tr>
<td>Compressive Stress (OK/OHD L-6), psi</td>
<td>350</td>
</tr>
<tr>
<td>Resilience (OK/OHD L-6), percent</td>
<td>70</td>
</tr>
</tbody>
</table>

1039.70.3 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to Engineer a certified test report from an independent laboratory showing specific test results in accordance with all requirements of this specification. The certified test report shall contain the manufacturer’s name, brand name of material, lot tested, date of manufacture and ratio of components. In addition, the manufacturer shall submit a one-quart sample of each component, A and B, for laboratory testing accompanied by a technical data sheet and a material safety data sheet. With approval from the Engineer of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of polymer concretes. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

1039.70.4 Acceptance. To obtain final acceptance of this material, the manufacturer shall furnish certification to the Engineer at destination certifying that the material supplied is in accordance with all requirements specified and stating that the material is identically formulated to the material tested for manufacturer and brand name approval.
SECTION 1040
GUARDRAIL, END TERMINALS, ONE-STRAND ACCESS RESTRAINT CABLE AND THREE-STRAND GUARD CABLE MATERIAL

1040.1 Scope. This specification covers guardrail, end terminals, one-strand access restraint cable, three-strand guard cable, end terminals and all appurtenances required for installation.

1040.2 Posts and Blocks. The same type of posts and blocks shall be used in a given run, except as shown on the plans or as approved by the Engineer.

1040.2.1 Wood Posts and Blocks. Wood posts and blocks for guardrail and one-strand access restraint cable shall be in accordance with Sec 1050.

1040.2.2 Steel Posts, Plates and Rails. Steel posts, anchor plates, bearing plates, soil plates, plate washers and channel rail shall be structural steel in accordance with AASHTO M 270, Grade 36, shall be of the dimensions and weights shown on the plans and shall be galvanized in accordance with AASHTO M 111. Bolts, nuts, and washers shall be in accordance with the dimensions shown on the plans and shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Any dimensional defects and structural discontinuities shall be cause for rejection. The material to be welded shall be preheated in accordance with good welding practice and welds shall be full section and sound throughout. All welds shall be mechanically cleaned before galvanizing. No punching, drilling, cutting, or welding will be permitted after galvanizing.

1040.2.3 Plastic Blocks. Plastic guardrail blocks shall meet the dimensional requirements shown on the standard plans. The blocks shall be a homogeneous product with a uniform texture and shall have no cracking, chipping, flaking, peeling, or splintering after fabrication. The blocks will not be considered homogeneous if there are more than five voids larger than ½ inch or any voids larger than ¾ inch on any cut face. The blocks shall be of new stock. The blocks shall be of new stock, shall meet all applicable requirements of NCHRP 350 for NCHRP 350 compliant installations or MASH for MASH complaint installations, and shall meet the approval of the Engineer.

1040.2.3.1 Approval. Prior to approval and use of the plastic guardrail blocks, the manufacturer shall submit to the Engineer, the manufacturer’s name, the product brand name or model number, a copy of the NCHRP 350 or MASH test results, a copy of the FHWA eligibility letter, an MSDS and a sample block.

1040.2.3.2 Acceptance. Acceptance of the material will be based on the manufacturer’s certification and upon the results of such tests as may be performed by the Engineer.

1040.3 Steel Beam Guardrail. Guardrail beams shall be of the class and type shown on the plans. Guardrail beams shall be in accordance with AASHTO M180, Type 1 or Type 2, except as noted herein. Type 1 material shall be galvanized by the continuous method.

1040.3.1 Test Specimens. Test specimens for mechanical properties shall be prepared and tested in accordance with ASTM A 653.

1040.3.2 End Sections. End sections and terminal connectors shall be of a class and type the same as or superior to that used for the beam to which the end sections and terminal connectors are attached. The physical properties shall be in accordance with AASHTO M 180.

1040.3.3 Fabrication. The beams, end sections, and terminal connectors shall be shaped and punched as shown on the plans. The beams, end sections, and terminal connectors shall be ready for assembly when delivered. Only drilling or cutting necessary for special connections and for sampling will be permitted in the field. Warped or
deformed beams will be rejected. Beams to be erected on a radius of 150 feet or less shall be shop curved to the 
approximate curvature of the installation.

1040.3.4 Markings.

1040.3.4.1 Beams. Beam Markings shall be in accordance with AASHTO M 180, except the AASHTO specification 
number may be omitted if another designation for Class and Type is used.

1040.3.4.2 Transition Sections and Terminal Connectors. Transition sections and terminal connectors shall be 
marked in accordance with Sec 1040.3.4.1, except as follows. Durable tags securely attached to each section or 
connector may be used. If the transition section or terminal connector is Class B, indicating the Class will not be 
required. If the transition section or terminal connector is Type 2, indicating the Type will not be required. Heat 
numbers and coating designations will not be required.

1040.3.4.3 End Sections. No markings or tags are required for end sections.

1040.3.4.4 Posts. Posts shall be marked such that the marking is exposed after installation, in such a manner as to 
indicate the manufacturer.

1040.3.5 Brand Registration and Guarantee. The manufacturer shall be on the current MoDOT qualified list of 
Guardrail Fabricators. For Type I coated material, the brand registration and guarantee shall certify the material as 
being produced by the continuous galvanizing method.

1040.3.6 Acceptance. Acceptance shall be by brand registration and guarantee and any sampling deemed necessary 
by the Engineer. The Contractor or supplier shall provide equipment and personnel required to obtain samples as 
directed by the Engineer.

1040.4 Crashworthy End Terminals.

1040.4.1 Material. Only new material shall be used in the fabrication of end terminals. The major items of the 
installations shall be the best standard products of a manufacturer regularly engaged in the production of that type 
of end terminal and shall be of the manufacturer’s latest approved design. After installation, the end terminal shall 
redirect traffic face side vehicle impacts within the prescribed performance crash test criteria ranges.

1040.4.2 Manufacture’s Approval. The manufacturer shall be on the current MoDOT qualified list. Prior to approval 
and use of an end terminal, the manufacturer shall submit to Engineer the manufacturer’s name, the product brand 
name or model number, a copy of the MASH test results, a copy of the FHWA eligibility letter, and shop drawings.

1040.4.3 Acceptance. Acceptance of the material will be based on the manufacturer’s certification and upon 
satisfactory field performance.

1040.4.4 Contractor’s Certification. Prior to installation, the Contractor shall furnish to the Engineer a 
manufacturer's certification that the units furnished are identical in material and design to successfully tested units.

1040.5 End Anchors and Bridge Anchors.

1040.5.1 Steel Tube and Tube Block. Steel tubes for end anchors shall consist of structural steel tubing in 
accordance with ASTM A 500 Grade B or ASTM A 501 and shall be galvanized in accordance with AASHTO M 111. 
Structural steel tubing blocks for guardrail shall consist of steel tubing in accordance with ASTM A 500 Grade B and 
shall be galvanized in accordance with AASHTO M 111.

1040.5.2 Cable. Cable shall be ¾ inch in diameter, Type II, Class A in accordance with AASHTO M 30.
1040.5.3 Transition Cap Rail. The transition cap rail shall be in accordance with AASHTO M 270, Grade 36.

1040.5.4 Thrie Beam Rail and Transition Section. The thrie beam rail and transition section shall be galvanized in accordance with AASHTO M 180, Type 2.

1040.5.5 Approval. Cable assembly and anchor plate shall be subject to approval by the Engineer and shall have a minimum breaking strength of 20 tons.

1040.5.6 Markings. Thrie beam rail and transition sections shall be marked in accordance with Sec 1040.3.4.

1040.6 Cable and Fittings.

1040.6.1 One-Strand Access Restraint Cable.

1040.6.1.1 Cable. Cable shall be zinc coated steel wire strand; ½ inch in diameter; seven wire strand; Common, Siemens-Martín or High Strength grade; Class A coating; and be in accordance with ASTM A 475.

1040.6.1.2 Hardware. Eyebolts, turnbuckles, and clips for cable connections and end anchors shall be steel forgings in accordance with AASHTO M 102 or pearlitic malleable iron in accordance with ASTM A 220. All miscellaneous parts, comprising of cable connections, fasteners and end anchors, shall be galvanized in accordance with AASHTO M 232.

1040.6.2 Three-Strand Guard Cable.

1040.6.2.1 Cable and Connecting Hardware. The cable and connecting hardware shall be in accordance with AASHTO M 30 and AASHTO M 269. The wire rope shall be Type 1, ¾ inch diameter, 3 x 7 construction with a Class A coating. The rope, with connecting hardware, shall develop the breaking strength of a 25,000 pound single cable. Connecting hardware shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized. If mechanically galvanized, the coating, thickness, adherence, and quality requirements shall be in accordance with AASHTO M 232, Class C. Cast Steel components shall be in accordance with AASHTO M 103, Grade 70-40, Class 1. Malleable iron castings shall be in accordance with ASTM A 47. Compensating devices shall have a spring constant of 0.46 pounds per inch, plus or minus 0.03 pounds per inch, and permit 6 inches of travel, plus or minus 1 inch. All threaded parts on compensating cable end assemblies shall be in accordance with ASTM F 568 Class 4.6, ¾ - 10 threads. Socket baskets shall be designed for use with the cable anchor wedge as shown on the plans. Guard cable anchor brackets shall be manufactured from an AASHTO M 270, Grade 250 steel plate, and zinc-coated in accordance with AASHTO M 111. Dimensional tolerances not shown on the plans shall be consistent with the proper functioning of the part, including the part's appearance and accepted manufacturing process.

1040.6.2.2 Cable Brackets. Steel used in the fabrication of the bracket shall be in accordance with ASTM A 36. The bracket shall be galvanized after fabrication in accordance with AASHTO M 111. All fittings, including splices, shall be designed to use the wedge detail and shall be of such section as to develop the full strength of the ¾ inch, 25,000 pound round cable. Designs for a combination or single-unit compensating device and turnbuckle assembly shall be submitted for approval. Compensating devices shall have a spring rate of 0.46 pounds per inch, plus or minus 0.03 pounds per inch, and permit 6 inches of travel, plus or minus 1 inch. All parts, except cable wedge, shall be hot-dip zinc coated in accordance with AASHTO M 232 or ASTM B 695.

1040.6.2.3 Hook Bolts, Hex Bolts, Nuts and Washers. Hook bolts, hex bolts, and washers shall be in accordance with ASTM A 307. Cable hook nuts shall be 5/16 – 18 threads and in accordance with ASTM A 563. Hook bolts, as installed, shall develop an ultimate pull open strength of 450 to 1,000 pounds applied in a direction normal to the axis of the post. Hooked anchor studs shall be in accordance with AASHTO M 314, except the threads and nominal
diameter shall be 3/4 - 10 and in accordance with ASTM 568 Class 4.6. All items shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized in accordance with AASHTO M 232, Class C.

1040.7 Certification. The Contractor shall furnish manufacturer's certification for all material governed by this specification. Specifically, the certifications shall indicate compliance with the requirements of each applicable section and as set forth in Table I.

1040.8 Repair of Galvanizing. Galvanized material shall be handled in a manner to avoid damage to the surface. No field punching, drilling, cutting or welding will be permitted after galvanizing. Any galvanized material on which the spelter coating has been damaged will be rejected or may be repaired in accordance with Sec 712 with the approval of the Engineer.

<table>
<thead>
<tr>
<th>Item</th>
<th>Galvanizing Standard</th>
<th>Steel Grade</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Post and Blocks</td>
<td>-</td>
<td>-</td>
<td>a</td>
</tr>
<tr>
<td>Steel Posts, Plates and Brackets</td>
<td>AASHTO M 111</td>
<td>AASHTO M 270, Grade 36</td>
<td>b</td>
</tr>
<tr>
<td>Plastic Blocks</td>
<td>-</td>
<td>-</td>
<td>g</td>
</tr>
<tr>
<td>Guardrail Beam</td>
<td>Sec 1040.3.4.1</td>
<td>Sec 1040.3.4.1</td>
<td>b, c</td>
</tr>
<tr>
<td>Bolts, Nuts and Washers</td>
<td>AASHTO M 232</td>
<td>ASTM A 307</td>
<td></td>
</tr>
<tr>
<td>End Terminals Systems</td>
<td>-</td>
<td>-</td>
<td>f</td>
</tr>
<tr>
<td>End Anchors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubes</td>
<td>AASHTO M 111</td>
<td>ASTM A 500/ASTM A 501</td>
<td>b</td>
</tr>
<tr>
<td>Transition Cap Rail</td>
<td>AASHTO M 111</td>
<td>AASHTO M 270, Grade 36</td>
<td></td>
</tr>
<tr>
<td>One-Strand Access Restraint Cable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable</td>
<td>AASHTO M 30</td>
<td>AASHTO M 30</td>
<td>b</td>
</tr>
<tr>
<td>Hardware</td>
<td>AASHTO M 232</td>
<td>AASHTO M 102/ASTM A 220</td>
<td>b</td>
</tr>
<tr>
<td>Three Strand Guard Cable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable</td>
<td>AASHTO M 30</td>
<td>AASHTO M 30 &amp; AASHTO M 269</td>
<td>b</td>
</tr>
<tr>
<td>Hardware</td>
<td>AASHTO M 232</td>
<td>AASHTO M 102/ASTM A 220</td>
<td>d</td>
</tr>
<tr>
<td>Cast Steel Components</td>
<td>AASHTO M 232</td>
<td>AASHTO M 103</td>
<td>d</td>
</tr>
<tr>
<td>Malleable Iron Castings</td>
<td>AASHTO M 232</td>
<td>ASTM A 47</td>
<td>e</td>
</tr>
<tr>
<td>Anchor Brackets</td>
<td>AASHTO M 111</td>
<td>AASHTO M 270</td>
<td></td>
</tr>
<tr>
<td>Cable Brackets</td>
<td>AASHTO M 111</td>
<td>AASHTO M 270, Grade 36</td>
<td>d</td>
</tr>
<tr>
<td>Hook and Hex Bolts</td>
<td>AASHTO M 232</td>
<td>ASTM A 307</td>
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</tr>
<tr>
<td>Hook Nuts</td>
<td>AASHTO M 232</td>
<td>ASTM A 563</td>
<td></td>
</tr>
<tr>
<td>Hooked Anchor Studs</td>
<td>AASHTO M 232</td>
<td>AASHTO M 314</td>
<td></td>
</tr>
</tbody>
</table>

(a) Certification shall state that the material is in accordance with Sec 1050 and shall include a listing of the material supplied and a certified test report as detailed in Section 7.2 of AWPA, Standard M2, attesting to complete compliance with this specification.

(b) Certification shall include, or have attached, specific results of laboratory tests for physical and chemical properties from samples representative of the material.

(c) Shall have Brand Registration and Guarantee on file, including certification indicating the coating is either Type 1 by Continuous Galvanizing Method or Type 2.
(d) All threaded parts of compensating cable end assemblies and hooked anchor studs shall be in accordance with ASTM F 568.

(e) All fittings for cable bracket, except the cable wedge, shall be in accordance with AASHTO M 232 or AASHTO M 298.

(f) Certification shall state the name of the manufacturer and that the units furnished are identical in material and design as those tested for performance in accordance with Sec 606.30.

(g) Certification shall state that the materials furnished are identical in chemistry, mechanical properties and geometry as those that passed the NCHRP 350 crash test, and as those that were approved by the Missouri Department of Transportation.
**SECTION 1041**

**POLYPROPYLENE CULVERT PIPE**

**1041.1 Scope.** This specification covers polypropylene culvert pipe intended for use in the construction of culverts, sewers and similar uses.

**1041.2 Basis of Acceptance.** Acceptance of polypropylene culvert pipe will be based upon the pipe being in accordance with this specification. Pipe shall be provided from an approved manufacturer, and will be accepted based on certification, identification markings and results from tests required by the Engineer.

**1041.3 Material.** All polypropylene culvert pipe, couplings and fittings shall be in accordance with ASTM F 2736 for double wall and ASTM F 2764 for triple wall, except as follows.

**1041.3.1** Section properties shall be within the following limits:

<table>
<thead>
<tr>
<th>Nominal Size S (in.)</th>
<th>Effective Pipe Wall Area $A_{eff}$ (in.$^2$/in.)</th>
<th>Pipe Wall Centroid to Inside Face $y_c$ (in.)</th>
<th>Pipe Wall Moment of Inertia $I$ (in.$^4$/in.)</th>
<th>Area Ratio $A_{eff}/A_g$</th>
<th>Extreme Fiber Ratio $y_c/c$</th>
<th>Inside Diameter $D_i$ (in.)</th>
<th>Outside Diameter $D_o$ (in.)</th>
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<tbody>
<tr>
<td>Double Wall</td>
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<tr>
<td>12</td>
<td>0.168</td>
<td>0.445</td>
<td>0.0314</td>
<td>0.803</td>
<td>0.586</td>
<td>11.97</td>
<td>14.65</td>
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<tr>
<td>15</td>
<td>0.216</td>
<td>0.537</td>
<td>0.0538</td>
<td>0.821</td>
<td>0.687</td>
<td>14.85</td>
<td>17.81</td>
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<tr>
<td>18</td>
<td>0.217</td>
<td>0.569</td>
<td>0.0747</td>
<td>0.777</td>
<td>0.549</td>
<td>17.82</td>
<td>21.42</td>
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<tr>
<td>24</td>
<td>0.241</td>
<td>0.710</td>
<td>0.1318</td>
<td>0.723</td>
<td>0.558</td>
<td>23.85</td>
<td>28.34</td>
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<tr>
<td>30</td>
<td>0.248</td>
<td>0.882</td>
<td>0.2732</td>
<td>0.661</td>
<td>0.475</td>
<td>29.70</td>
<td>35.81</td>
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<tr>
<td>Triple Wall</td>
<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>30</td>
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<td>1.107</td>
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<td>0.681</td>
<td>29.70</td>
<td>35.81</td>
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<tr>
<td>36</td>
<td>0.315</td>
<td>1.363</td>
<td>0.4808</td>
<td>0.653</td>
<td>1.000</td>
<td>35.39</td>
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<td>42</td>
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<td>0.9460</td>
<td>0.542</td>
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<td>60</td>
<td>0.541</td>
<td>1.627</td>
<td>1.2088</td>
<td>0.739</td>
<td>0.812</td>
<td>58.65</td>
<td>67.17</td>
</tr>
</tbody>
</table>

$^a$ $Ag$ equals gross area of pipe wall per unit length of pipe (in.$^2$/in.).

$^b$ $c$ equals the distance from the pipe wall centroid to the outermost fiber (in.).

**1041.3.2** The pipe shall not be perforated unless otherwise specified.

**1041.3.3** Field joints of polypropylene pipe shall provide circumferential and longitudinal strength to maintain the pipe alignment, prevent separation of pipe and prevent infiltration of fill material. Coupling bands, if used, shall be of the same base material as the pipe. Prior to use, the design of coupling bands and fastening devices shall be submitted to and approved by Engineer. Final acceptance of coupling bands and fastening devices will be based on field performance.

**1041.3.4** The manufacturer shall provide to the Engineer an itemized statement of the sizes, section properties and lengths of pipe in each shipment.

**1041.4 Sampling, Testing and Acceptance Procedures.** Manufacturers furnishing pipe to St. Charles County projects shall be qualified as herein described. All pipe will be subject to inspection by the Engineer at the source of
manufacture, at an intermediate shipping terminal or at the destination. The Engineer shall be permitted free access to all facilities and records as required to conduct inspection and sampling in accordance with Sec 106.

1041.4.1 Sampling of Material. Random sampling of the pipe will be conducted by the Engineer to verify if the pipe and material are in accordance with these specifications. Samples of polypropylene pipe will be obtained from fabricated culvert sections in accordance with ASTM F2736 or ASTM F2764 at a frequency determined by the Engineer.

1041.4.2 Inspection. Inspection will include an examination of the pipe for markings, deficiency in specified diameter, net length of fabricated pipe and any evidence of poor workmanship. The inspection may include taking samples.

1041.4.3 Testing. Specimen testing size and method of tests shall be in accordance with ASTM F2736 or ASTM F2764. The Contractor or manufacturer shall provide the equipment and personnel to cut a sample from a section of pipe. The sample shall include the markings or a record of the markings for that section of pipe.

1041.4.4 Unacceptable Material.

1041.4.4.1 Any individual section of pipe failing to meet the marking, diameter, length or workmanship requirements of these specifications will be unacceptable. If 10 percent of the pipe in any lot fails to meet these requirements, the entire shipment of that pipe size may be rejected.

1041.4.4.2 If a test specimen taken in accordance with Sec 1041.4.3 fails to meet the requirements of ASTM F2736 or ASTM F2764, the pipe sampled will be rejected and the lot will be resampled. A resample will be of the same size as the original sample. The resample shall be in accordance with these specifications, or the entire shipment will be rejected.

1041.5 MoDOT Certification. When the pipe producer / supplier is to be considered for approval, the manufacturer's product will be listed on MoDOT's Pre-Accepted List (PAL) Polypropylene Pipe Field.

1041.6 Storage and Handling. Polypropylene pipe are lightweight and easy to use. While no special care is needed in handling and installation, the Contractor shall follow the following handling requirements:

a) Follow all applicable safety regulations when handling pipe;

b) The pipe shall not be dropped from the delivery truck into an open trench, or onto uneven surfaces;

c) Avoid dragging or striking the pipe against another pipe or object;

d) Avoid dragging the pipe across the ground;

e) Do not drive over the pipe prior to installation; and

f) Inspect the pipe and joining systems before installation.

1041.6.1 Stacking and Storage Height. Polypropylene drainage products are available palletized allowing for convenient transporting and orderly storage. If the products were not received on a pallet, the pipe should be carefully stacked. One method commonly used is to secure the bottom lengths of pipe together side-by-side, or use stop blocks, and then place additional pipe on top. Where pipe is stock piled, the total pile height shall not exceed 5 feet and the pipe must be adequately restrained to prevent pile collapse. Do not walk on stock piled pipe.
1041.6.2 Cold and Hot Weather Storage Protection. No significant handling or installation precautions required unless specified by the manufacturer.

1041.6.3 Protection from Ultraviolet Light. Ultraviolet (UV) Stabilizers shall be added to the polypropylene to protect against ultraviolet light. No additional protection is required unless specified by the manufacturer.

1041.7 Bill of Lading. A bill of lading or delivery receipt for each shipment of pipe shall be furnished to the Engineer at the shipping and destination points. The bill of lading shall contain an itemized statement of the sizes and lengths of pipe for that shipment. The bill of lading shall contain a certified statement. The certified statement shall be signed by an authorized representative of the manufacturer and shall state the following:

“This certifies that the pipe, bands and end sections in this shipment are in accordance with St. Charles County specifications, were fabricated at an approved plant and were fabricated from the following brand names:”
SECTION 1042
ROADWAY SIGN MATERIAL

1042.1 Scope. This specification covers the material used in signs and fastening devices, and the fabrication of signs.

1042.2 Material. Material shall be of new stock and shall be in accordance with the following, unless otherwise shown on the plans.

1042.2.1 Signs.

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Flat Sheets</td>
<td>ASTM B 209, 6061-T6 or 5052-H38</td>
</tr>
<tr>
<td>Aluminum Extruded Sign Panels</td>
<td>ASTM B221, 6063-T6</td>
</tr>
</tbody>
</table>

1042.2.2 Sign Appurtenances.

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Post Clip</td>
<td>ASTM B 108, 356-T6</td>
</tr>
<tr>
<td>Aluminum Bolts</td>
<td>ASTM B 211, 2024-T4 or 6061-T6</td>
</tr>
<tr>
<td>Aluminum Nuts</td>
<td>ASTM B 211, 2024-T4, 6061-T6, 6262-T9 or 2017-T4</td>
</tr>
<tr>
<td>Aluminum Flat Washers</td>
<td>ASTM B 209, or Alclad 2024-T4 or 2024-T4</td>
</tr>
<tr>
<td>Aluminum Lock Washers</td>
<td>ASTM B 211, 7075-T6</td>
</tr>
<tr>
<td>Aluminum Lock Nuts (Nylon Insert)</td>
<td>ASTM B 211, 2017-T4</td>
</tr>
<tr>
<td>Aluminum Edge Molding</td>
<td>ASTM B 221,6063-T6</td>
</tr>
<tr>
<td>Stainless Steel Bolts, Nuts, Screws and Washers</td>
<td>ASTM A 320 or SAE J405D, Austenitic Steel, Min. Yield 30,000 psi</td>
</tr>
</tbody>
</table>

1042.2.3 Certification. A manufacturer or supplier’s Certification of Metal used for signing material listed above shall be furnished to the Engineer at the fabrication plant at the time of material inspection. The Contractor shall furnish to the Engineer the fabricator’s certification in accordance with Sec 903.3.3.6.

1042.2.4 Structural Signs. Structural signs shall be fabricated of 0.081 inch minimum extruded aluminum panels and mounted as shown on the plans. The maximum allowable deviation from flatness shall not exceed 0.010 inch per inch width of the panel. Shop drawings for approval from the Engineer will be required for any variation in the assembly or mounting details.

1042.2.5 Sheet Signs. Flat sheet signs shall be fabricated as shown on the plans from sheet aluminum of the specified thickness. Flat sheet signs shall not have holes except those drilled or punched for proper mounting.

1042.2.6 Washers. Nylon washers recommended by the sign sheeting manufacturer shall be used between the bolt heads and sign faces on flat sheet aluminum signs. The washers shall be for use with 3/8 inch bolts and shall have a minimum outside diameter of 3/4 inch, and a nominal thickness of 1/16 inch.

1042.2.7 Retroreflective Sheeting. Retroreflective sheeting shall be in accordance with latest versions or ASTM D 4956 and AASHTO M 268, except as noted herein. Color and luminance values for all St. Charles County types of reflective sheeting shall be in accordance with ASTM D 4956. Retroreflective sheeting shall have sufficient adhesion, strength and flexibility such that the sheeting can be handled, processed and applied according to the manufacturer’s recommendations without appreciable stretching, tearing, cracking or other damage. Adhesive performance for retroreflective sheeting shall be in accordance with ASTM D 4956. The sheeting surface shall be in
condition to be readily screen processed and compatible with transparent overlay films, plus recommended transparent and opaque screen process colors. The retroreflective sheeting manufacturer shall furnish information as to the type of solvent or solvents that may be used to clean the surface of the sheeting without detrimental loss of performance and durability. Retroreflective sheeting having a datum mark on the surface shall be oriented vertically. ASTM D 4956 Type IX, XI or AASHTO M 268 Type C or D retroreflective sheeting applied as legend and border for specific signing applications, without a datum mark on the surface of the sheeting, shall be evaluated for rotational sensitivity per AASHTO M 268, Section 3.3. Retroreflective sheeting products that do not meet the rotational sensitivity requirements of Section 3.3 shall follow guidelines detailed in AASHTO M 268 Section 3.3.1 and fabricated per AASHTO M 268 Section 3.3.2.

1042.2.7.1 ASTM D 4956 Type I, Class 1 retroreflective sheeting shall be enclosed lens glass-bead or prismatic sheeting.

1042.2.7.2 Sign Sheeting. Background sheeting applied to flat sheet and extruded panel signs shall be in accordance with ASTM D 4956 Type IV, Class 1. All yellow, orange and yellow green sheeted signs shall be fabricated with ASTM D 4956 Type IX, XI or AASHTO M 268 Type C or D fluorescent yellow, fluorescent orange and fluorescent yellow green sheeting respectively. Retroreflective sheeting shall be high intensity that is an unmetallized micro prismatic reflective material.

1042.2.7.3 Channelizers. All reflective sheeting for channelizers and drum-like channelizers shall be in accordance with ASTM D 4956 Type IX or XI for fluorescent orange sheeting and in accordance with ASTM D 4956 Type IV for orange or white sheeting. All retroreflective marking on channelizers shall be in accordance with ASTM D 4956, Supplemental Requirements, and Section S2. Reflective sheeting applied to channelizers shall be reboundable in accordance with ASTM D 4956. Retroreflective marking on cones will not be required.

1042.2.7.4 Advanced Warning Rails. All reflective sheeting for advanced warning rails shall be in accordance with ASTM D 4956 Type IV.

1042.2.7.5 Delineators. All retroreflective sheeting for delineators shall be in accordance with ASTM D 4956 Type IX or XI requirements, except permanent and temporary tubular delineators, which shall be ASTM D 4956 Type IV requirements. All permanent and temporary tubular delineators’ reflective sheeting shall be reboundable in accordance with ASTM D 4956.

1042.2.7.6 Retroreflective sheeting applied as legend and border shall be in accordance with ASTM D 4956, Type IX, XI or AASHTO Type C or D, Class 1. Retroreflective sheeting shall be an unmetallized cube corner microprismatic reflective material.

1042.2.7.7 Screen Print and Overlay. For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficient of retroreflection (RA) shall be no less than 70 percent of the original values for the corresponding color.

1042.2.8 Outdoor Exposure. Retroreflective sheeting, except for work zone signs, shall be submitted by the manufacturer to NTPEP for two years of 45-degree south-facing outdoor exposure. Retroreflective sheeting for work zone signs shall be submitted by the manufacturer to NTPEP for an exposure time of one year. Results shall be published by NTPEP and available for St. Charles County review. For all NTPEP test decks, retroreflective sheeting shall have a coefficient of retroreflection at least 50 percent of the specified value for ASTM D 4956 Type I or 80 percent of the original reading for ASTM D 4956 Type IV, IX or XI.

1042.2.9 Manufacturer and Brand Name Approval. The manufacturer shall make available, upon request, NTPEP test results from all test decks, and certification to MoDOT Construction and Materials or the County, showing reflective material is in accordance with ASTM D 4956 specification. In addition, the manufacture shall, upon request, submit samples representing the retroreflective sheeting tested by NTPEP, and with compatible inks. These
samples shall be accompanied by a product data sheet, an MSDS, technical bulletins on sign fabrication and any special fabrication instructions relative to the retroreflective sheeting submitted. Samples of retroreflective sheeting shall 10 x 10 inches and applied to an aluminum substrate.

1042.2.9.1 Materials that fail to provide satisfactory field performance will be evaluated and may be disqualified from future use on fabricated signs for St. Charles County. All corrective actions made by St. Charles County will control.

1042.2.10 Type of Characters. Letters, numerals, arrows, symbols, borders and other features of the sign message shall be of the type, size and series shown on the plans or as specified by the Engineer. Completed letters, numerals and other units shall be formed to provide a continuous stroke width with smooth edges, and shall yield a flat surface free of air bubbles, wrinkles or other blemishes as determined by the Engineer. Units of the sign message shown on the plans shall meet the requirements for the specified type.

1042.2.10.1 Screen Print, Transparent Overlay and Opaque Black Film.

1042.2.10.1.1 The letters, numerals, arrows, symbols and borders shall be applied to the background of the sign by the direct or reverse screen process. Messages and borders of a color darker than the sign field shall be applied to the retroreflective sheeting by the direct process. Messages and borders of a color lighter than the sign field shall be produced by the reverse screen process. Inks used in the silkscreen process shall be of the type to produce the desired color and durability when applied on retroreflective sheeting. Silkscreen inks shall be used in accordance with the manufacturer's recommendations. The ink shall produce the desired color when applied on retroreflective sheeting background and shall dry to a good film without running, streaking or sagging. The screening shall be done in a manner that results in a uniform color and tone, with sharply defined edges of legend and border without blemishes on the sign field that will affect the intended use. Signs after screening shall be dried in accordance with the manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected.

1042.2.10.1.2 Transparent overlay films may be used as a replacement for the reverse screen process, as recommended by the sheeting manufacturer.

1042.2.10.2 Direct Applied Characters. The letters, numerals, symbols, borders and other features of the sign message shall be cut from the color and type of sheeting shown on the plans, and applied to the sign field in accordance with the sheeting manufacturer’s recommendations.

1042.2.10.3 Allowable Variations. The design height of rounded letters or numerals shall be 1/64 inch of height greater than normal height, both on top and bottom of letter or numeral, where rounded. The loop portion of letters such as f, g and y, shall conform to the dimensions shown on the plans with the allowable tolerance. The following variations in dimensions of letters and numerals, regardless of character type, will be acceptable with all measurements made to the nearest 1/8 inch.

<table>
<thead>
<tr>
<th>Nominal Height, inches</th>
<th>Variation in Height, inches</th>
<th>Variation in Width, inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 thru 12</td>
<td>-1/8 to +3/8</td>
<td>-1/4 to +1/4</td>
</tr>
<tr>
<td>Over 12</td>
<td>-1/8 to +3/8</td>
<td>-3/8 to +3/8</td>
</tr>
</tbody>
</table>

1042.3 Sign Fabrication. A sign shall consist of aluminum flat sheets or extruded panels retroreflectorized on the face side with all letters, numerals, symbols, borders, corners and route shields mounted on the face, and shall include all necessary mounting devices shown on the plans. Signs equal to or greater in width than six feet are considered structural (ST) and shall be fabricated on extruded panels. Signs less than six feet in width will be
considered sheet (SH) signs and shall be fabricated with flat sheet. Any exceptions to these fabrication standards will be indicated on the plans.

**1042.3.1** All signs shall be of the highest quality with consistent daytime and nighttime color and retroreflectivity throughout the sign and produced as follows.

**1042.3.1.1** All aluminum substrate shall be given a chromate conversion coating in accordance with ASTM B 449, Class 2, and shall be prepared by one of the Treatment Sequence Options described in ASTM B 449, Appendix X2. The chemicals and solvents shall be applied in strict accordance with the manufacturer’s recommendations. Sufficient laboratory facilities to test and control the concentration of the solutions used shall be maintained at the treating plant. A log of the concentration of treating solutions shall be maintained. Treated panels shall be handled in such a manner as to prevent contamination. Panels shall be stored in a dry, clean area free from dust, acid fumes or vapors. When aluminum is shipped to a secondary location for retroreflectorizing, adequate precautions shall be taken to ensure that the material arrives at the destination uncontaminated.

**1042.3.1.2** All materials used to fabricate a sign legend, including retroreflective and non-retroreflective sheeting, used for background, letters, numerals, arrows, symbols, borders and other features of the sign message shall be from a single manufacturer.

**1042.3.1.3** Retroreflective sheeting splices on structural signs shall be kept to a minimum. Rolled overlap splices in accordance with the sheeting manufacturer’s recommendations may be used, with no more than one allowed per panel. Retroreflective sheeting shall be placed on the individual extruded panels in accordance with the manufacturer’s recommendations. The sign panels may be clear coated or edge sealed after application of the retroreflective sheeting, if recommended by the sheeting manufacturer. If edge sealer is used, the sealer shall be applied to all splices and edges. The completed sign shall have good color matching of retroreflective sheeting and shall be free from air bubbles, wrinkles or other blemishes.

**1042.3.1.4** Retroreflective sheeting applied to standard flat sheet signs shall not have splices on signs where the smallest dimension is less than 4 feet. One vertical overlap splice approximately 1/4 inch wide will be allowed on standard flat sheet signs where the smallest dimension is greater than 4 feet. Any special flat sheet signs requiring splicing other than noted for the standard flat sheet signs shall be as approved by the Engineer. The sign panels may be clear coated or edge sealed after application of the retroreflective sheeting if recommended by the sheeting manufacturer. If clear finish is used, the finish shall be applied after screening of messages and borders. If edge sealer is used, the sealer shall be applied to all splices and edges. The completed sign face shall be free from air bubbles, wrinkles or other blemishes.

**1042.3.2** Nuts on panel bolts used to connect extruded panels together to form a structural sign shall be torqued to 220 - 230 inch-pounds.

**1042.3.3** Signs will be accepted on certification from the manufacture assuring all fabrication and sheeting specifications are in compliance with all applicable requirements specified herein. Periodic shop inspections of sign fabrication will be made at the discretion of St. Charles County, to include Contractor furnished signs for St. Charles County projects. Routine shop inspections will include inspection and sampling of materials, inspection of treatment and fabrication processes, and of any signs completed at time of inspection. Inspections on delivered signs for maintenance operations will be conducted for quality assurance purposes by the appropriate district inspectors. Signs may be rejected at the fabrication shop and/or upon delivery based on unsatisfactory workmanship and/or material applications or based on any aspect of the product that is not in accordance with the specifications. The Contractor will be charged with the transportation costs of sign inspectors for trips from St. Charles, Missouri to which the inspectors must travel for signs provided to St. Charles County projects. Transportation costs will be deducted by the Engineer from monies due the Contractor.
1042.3.4 Signs shall be packaged and shipped according to the reflective sheeting manufacturer’s recommendations. Signs fabricated and shipped to St. Charles County for maintenance operations shall be shipped in accordance with manufacturer’s recommendations and in a manner that meets the requirements of the Engineer. All signs shall include decals indicating sign production date, lot number of reflective sheeting used in the production of sign and other information necessary for proper sign fabrication. Upon shipment of signs to St. Charles County, certifications shall be submitted thereafter to the Engineer. Required paperwork shall include a certification statement indicating signs meet all applicable requirements herein to include aluminum standard and extruded panel, reflective sheeting (manufacturer, series and color), and hardware certifications. Material quantities, such as square foot of flat sheet, extruded panels, if produced, reflective sheeting and a shipping list of all signs shall be included in the certification packet.
SECTION 1043
FENCE MATERIAL

1043.1 Scope. This specification covers the material required in the construction of chain-link fence and woven wire fence.

1043.2 Chain Link Fence Material. Material used in the construction of fences and gates shall consist of chain-link fence fabric, posts, rails, ties, bands, bars, rods, tension wire and other fittings and hardware designed to support the fabric in a vertical, taut position.

1043.2.1 Zinc Coated Steel Fabric. Zinc coated steel fabric shall be in accordance with AASHTO M 181, Type 1, Class D, with the following exceptions. The weight of zinc coating shall be at least 2.0 ounces per square foot of uncoated wire surface, determined from the average of all specimens representing the lot and no less than 1.8 ounces per square foot on an individual specimen. Sections of fencing with excessive lumps, beads and drops of zinc will be removed before determining weight of coating.

1043.2.2 Aluminum Coated Steel Fabric. Aluminum coated steel fabric shall be in accordance with AASHTO M 181, Type 2, with the following exceptions. An individual specimen shall have at least 0.30 ounce per square foot of uncoated wire surface on 0.148 or 0.192 inch specified diameter wire and no less than 0.25 ounce per square foot on 0.120 inch specified diameter wire.

1043.2.3 Vinyl Coated Steel Fabric. Vinyl coated steel fabric shall be in accordance with AASHTO M 181, Type IV, Class A or Class B. In addition to the referenced colors, brown will also be acceptable.

1043.2.4 Aluminum Alloy Fabric. Aluminum alloy fabric shall be in accordance with AASHTO M 181, Type III.

1043.2.5 Posts, Braces, Rails and Gate Frames. These members shall be in accordance with AASHTO M 181, Grade 1 or Grade 2, and of the shape and dimension shown on the plans. These members may be used with either Type I, Type II, Type III or Type IV fabric.

1043.2.5.1 Zinc Coated Steel Members. Zinc coated steel members shall be in accordance with ASTM F 1043, heavy industrial fence Group IA, with Type A interior and exterior coating, and the plans.

1043.2.5.2 Zinc Plus Organic Coated Steel Members. Zinc plus organic coated steel members shall be in accordance with ASTM F 1043, heavy industrial fence Group IC, with Type B or D interior coating and Type B exterior coating, and the plans.

1043.2.5.3 Aluminum Alloy Members. Aluminum alloy members shall be in accordance with ASTM F 1043, heavy industrial fence Group IB, and the plans.

1043.2.6 Tension Wire. Tension wire shall be in accordance with AASHTO M 181 Type I, Class I.

1043.2.7 Fabric Fasteners. Fabric fasteners shall consist of wire ties, hog rings and C-clips. Fasteners for use with zinc or aluminum coated steel fabric shall be in accordance with Sec 1043.2.7.1 or Sec 1043.2.7.2; those for use with aluminum alloy fabric shall be in accordance with Sec 1043.2.7.2; and those for use with vinyl coated steel fabric shall be in accordance with Sec 1043.2.7.3. Fasteners shall be capable of withstanding a 180-degree bend over the fasteners own diameter without fracture of the wire or loss of adherence of coating. The wire shall have a finished or coated diameter of no less than 0.143 inch, except C-clips for attaching fabric to H section posts shall have a finished or coated diameter of no less than 0.187 inch. Aluminum alloy C-clips will not be permitted for fastening fabric to H section posts.
1043.2.7.1 Zinc or Aluminum Coated Fabric Fasteners. Wire shall be zinc coated at a rate of no less than 0.70 ounce per square foot or aluminum coated at a rate of no less than 0.30 ounce per square foot.

1043.2.7.2 Aluminum Alloy Fabric Fasteners. Wire shall be of aluminum alloy having a minimum tensile strength of 16,000 psi.

1043.2.7.3 Vinyl Coated Fabric Fasteners. Wire may be of steel or aluminum alloy and shall be uniformly coated with the same vinyl material as used to coat the fence fabric. Vinyl coating thickness shall be a minimum of 0.010 inch. Aluminum alloy wire shall have a minimum tensile strength of 16,000 psi.

1043.2.8 Miscellaneous Fittings and Hardware. Miscellaneous fittings and hardware shall be in accordance with AASHTO M 181. Aluminum alloy fittings shall not be used with zinc coated steel posts, rails or gate frames.

1043.2.9 Gates. Frames shall be fastened at the corners by clamps and braces, or by welding. If corners are to be welded, the ends of the vertical members shall be hemispherically notched to fit snugly to the horizontal members. The joint shall be uniformly and continuously fillet welded. The welded area and adjacent damaged coating shall be recoated by the hot-dip process or metallizing process; or covered with two coats of zinc-rich paint. The material for repair of welded areas and applications shall meet the approval of the Engineer. Each gate frame shall be cross-braced with no less than two 3/8 inch adjustable truss rods. The filler for gates shall be chain-link fabric of the same kind used for the fence. This filler shall be attached to the frame with stretcher bars and wire ties or clamps. Gates 6 feet high or less shall be equipped with two hinges, and gates more than 6 feet high shall have three hinges. All gates, walks and drives, shall be equipped with a latch and locking attachment. Gatekeepers and center rests of an approved design shall be installed for double drive gates.

1043.2.10 Barbed Wire. Barbed wire for use with chain-link fence shall be zinc-coated steel, aluminum-coated steel or aluminum alloy, and shall be in accordance with AASHTO M 280, with the following exceptions. Zinc-coated barbed wire shall consist of two No. 12 1/2, 13 1/2 or 15 1/2 gauge line wires twisted with 4-point barbs uniformly spaced approximately 4 or 5 inches apart in accordance with and the minimum weight of coating shall be 0.80 ounce per square foot of uncoated wire surface for all gauges. Aluminum-coated barbed wire shall be in accordance with the requirements for zinc-coated barbed wire, except that the coating shall be aluminum alloy. The weight of coating per square foot of surface shall be no less than 0.25 ounce for both line wires and barbs. However, barbs of suitable aluminum alloy will be permitted. Aluminum alloy barbed wire shall be aluminum alloy 5052-H38, ASTM B211. Aluminum alloy barbed wire shall consist of two 0.110 inch line wires twisted with 4-point 0.080 inch diameter wire barbs spaced 5 inches apart.

1043.3 Woven Wire Fence Material. Woven wire fence shall be composed of woven wire, barbed wire, brace wire, posts, ties, fittings and hardware.

1043.3.1 Fabric. Fabric shall be made of zinc-coated or aluminum-coated steel wire. Zinc coated fabric shall be in accordance with AASHTO M 279, for Design Number 939-6-11, Grade 60 or 939-6-12.5, Grade 125. The minimum weight of zinc coating shall be Class 3 for all gauges. Line wires shall have tension curves. Aluminum-coated fabric shall be in accordance with the requirements for zinc-coated fabric, except that the coating shall be aluminum alloy applied at the rate of no less than 0.25 ounce per square foot of uncoated wire surface.

1043.3.2 Barbed Wire. Barbed wire for use with zinc-coated steel fabric or aluminum-coated steel fabric shall be in accordance with Sec 1043.2.10.

1043.3.3 Wood Posts. Wood posts and braces shall be in accordance with Sec 1050.

1043.3.4 Steel Posts. Steel posts and braces shall be in accordance with Sec 1043.2.5. Corner, end and pull posts shall be pipe of the sizes and weights shown on the plans. Line posts shall be of the lengths and shapes shown on
the plans. Posts shall have a nominal weight of 1.33 pounds per linear foot and a minimum weight of 1.28 pounds per linear foot, exclusive of anchor plate.

1043.3.5 Post Tops and Miscellaneous Hardware. Post tops and miscellaneous fittings and hardware shall be in accordance AASHTO M 181.

1043.3.6 Brace Wire. Brace wire shall be no less than 0.143 inch in diameter and shall be of material in accordance with Sec 1043.3.1.

1043.3.7 Staples. Staples shall be of the screw shank-type or equivalent, a minimum of 1 1/4 inches long, galvanized, and of good commercial quality.

1043.3.8 Wire Ties. Wire used for ties shall be in accordance with Sec 1043.2.7, except that the wire may have a minimum diameter of 0.115 inch.

1043.3.9 Gates. Gates for woven wire fence shall be in accordance with Sec 1043.2.9, except that the filler shall be woven wire fabric meeting these specifications.

1043.3.10 Wrought Iron. Wrought iron railings and fittings shall be in accordance with ASTM A 73 and be fabricated of materials approved by the Engineer.

1043.4 Workmanship and Finish. Fabrication of chain-link or woven wire fencing material furnished under these specifications shall be in accordance with the sizes, shapes and dimensions shown on the plans. Excessive roughness, blisters, sal-ammoniac spots, bruises, flaking, voids in coating, frozen knuckles or other defects, if present to any considerable extent, will be considered cause for rejection. Polyvinyl chloride coating shall be without voids, tears, cracks or cuts that reveal the substrate. Welded seam pipe shall have smooth welds, without skips or gaps. Non-uniform or damaged organic topcoats will be considered cause for rejection whether caused by fabrication, shipping or handling on the job. All burrs at the ends of posts and rails shall be removed.

1043.5 Sampling and Testing.

1043.5.1 Sampling. Sampling of material shall be in accordance with MoDOT’s EPG 106.3.1.

1043.5.2 Testing. When fencing material is tested, tests shall be in accordance with the following methods.

1043.5.2.1 Weight. Weight of hot-dip zinc coatings shall be determined in accordance with AASHTO T 65 or, at the option of the Engineer, material may be accepted on the basis of magnetic gauge determinations conducted in accordance with ASTM E 376. Weight of aluminum coating shall be determined in accordance with AASHTO T 213 or, at the option of the Engineer, material may be accepted on the basis of magnetic gauge determinations conducted in accordance with ASTM E 376.

1043.5.2.2 Thickness. Thickness of zinc-rich organic coating shall be determined by magnetic gauge determinations conducted in accordance with ASTM E 376. Thickness of organic topcoat shall be determined by first determining the total thickness of the organic topcoat and exterior hot-dip zinc coating by magnetic gauge determinations conducted in accordance with ASTM E 376, then chemically stripping the organic topcoat and determining the thickness of only the exterior hot-dip zinc in accordance with AASHTO T 65 or ASTM E 376. The difference between the two measurements shall be the thickness of the organic topcoat.

1043.5.2.3 Tensile Strength. Tensile strength or breaking load shall be in accordance with AASHTO T 68.

1043.6 Inspection. The Engineer shall have access at all times to all parts of the manufacturer’s or fabricator’s works that concern the manufacture or fabrication of material furnished under this specification. Each product or article
furnished under this specification will be subject to inspection at the factory, fabricating plant, in laboratories of the Engineer’s choosing, or at the point of delivery. The Engineer reserves the right to sample and test each product or article subsequent to acceptance at the place of manufacture or fabrication to determine conformance with the requirements of this specification or to verify certification.

1043.7 Certification. Certifications will be required as follows.

1043.7.1 Vinyl Coated Material. The Contractor shall submit to the Engineer certification that the vinyl material and vinyl coated fabric meet the requirements of these specifications. If vinyl coated items other than chain-link fabric are furnished, certification will also be required.

1043.7.2 Aluminum Alloy Material. The Contractor shall submit to the Engineer certification that the material is in accordance with the requirements specified. The certificate shall include or have attached a list or description of typical physical properties representative of the material.

1043.7.3 Organic Topcoated Material. The Contractor shall submit to the Engineer certification that the material is in accordance with the requirements specified and that the material is the same as prequalified by the Engineer.

1043.8 Packaging and Marking. Packaging and marking of the material shall provide ease of handling, storage and identification.

1043.8.1 Each length of chain-link fabric, woven wire fabric or barbed wire shall be tightly rolled and firmly tied. Each roll shall carry a tag showing, as applicable to the product, the length, kind of base metal, type of coating, specified wire size, mesh size, design (style), height or width of fabric, and the producer name, brand or trademark of the manufacturer.

1043.8.2 Each bundle or container of posts, hardware and fittings shall be marked with the name, brand or trademark of the manufacturer, type of material (steel, cast iron, aluminum alloy number, etc.), type of coating and any additional data required for proper identification or to determine apparent conformance to specified quality requirements.
SECTION 1044
POSTS FOR MARKERS AND DELINEATORS

1044.1 Scope. This specification covers galvanized steel and flexible posts used for mounting mile and object markers, delineators, drain and right of way markers signs and other similar purposes.

1044.2 Steel Posts. Posts shall be rerolled rail steel, in accordance with the mechanical requirements of ASTM A 499, Grade 60, and to the chemical requirements of ASTM A 1.

1044.2.1 Shape and Dimensions. Posts shall be of a channel or modified channel section. Posts for mile markers, object markers and delineators shall be of the dimensions and weights shown on the plans.

1044.2.2 Drainage and Right of Way Markers. Posts for drainage and right of way markers shall weigh no less than 1.80 or more than 2.25 pounds per foot, all tolerances included, and shall be of the lengths shown on the plans. Permissible variations in length will be a maximum of one inch under and 2 inches over that shown on the plans. Posts shall have no less than five drilled or punched 3/8 inch holes along the centerline of the web. Holes shall be on 2 inch centers, beginning one inch from the top of posts. Anchors or pointed ends on posts will not be required.

1044.2.3 Fiberglass Composite Right of Way Markers. Fiberglass reinforced polymer composite posts for right of way markers shall be 3 and 3/4 inches wide of a multi rib design weighing no less than 0.35 pounds per foot and shall be of the color and length as shown on the plans. The markers shall have a right of way decal meeting the description as shown on the plans. The markers shall be pointed on one end for installation into the ground to the depth as shown on the plans.

1044.2.4 Galvanizing. Posts shall be galvanized after fabrication in accordance with AASHTO M 111.

1044.3 Channel Post Delineator. Channel post for delineators shall be manufactured from ductile ASTM A 36 or ASTM A 1011 Gr 60 and as shown on the plans. Posts shall be hot dipped galvanized after manufacture in accordance with Sec 1080. Damaged coating shall be repaired in accordance with Sec 1081. The Contractor shall furnish to the Engineer three copies of the fabricator’s certification that the material supplied is in accordance with the requirements specified.

1044.4 Square Steel Perforated Posts.

1044.4.1 Material.

1044.4.1.1 Steel. Steel shall be in accordance with ASTM A 1011, Grade 50, for hot rolled carbon sheet steel, structural quality. The average minimum yield strength after cold-forming shall be a minimum of 50,000 psi.

1044.4.1.2 Coating. Posts shall be galvanized in accordance with ASTM A 653, G90. The corner weld shall be zinc coated after the scarfing operation. The steel shall also be coated with a chromate conversion coating and a clear organic polymer topcoat. Both the interior and the exterior of the post shall be galvanized.

1044.4.2 Dimensions.

1044.4.2.1 Dimensional Tolerances. All dimensional tolerances shall be in accordance with ASTM A 513, excepted as noted.

1044.4.2.2 Length. The length of each post shall be as shown on the plans.

1044.4.2.3 Weight Per Foot. The weight per foot shall be in accordance with the following or as specified:
### Square Steel Perforated Post Requirements

<table>
<thead>
<tr>
<th>Size</th>
<th>Thickness</th>
<th>Weight</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. x 2 in.</td>
<td>12 Gage</td>
<td>2.42 lbs/foot</td>
<td>± 0.12 lbs/ft</td>
</tr>
</tbody>
</table>

#### 1044.4.3 Cross Section
The cross section of the post shall be square tube formed of 12 gage steel, carefully rolled to size and shall be welded directly in the corner by high frequency resistance welding and externally scarfed to agree with corner radii.

#### 1044.4 Hole Punching
All holes shall be 7/16 ± 1/64 inch in diameter on one inch centers on all four sides down the entire length of the post. The holes shall be on the centerline of each side in true alignment and opposite each other directly and diagonally.

#### 1044.5 Telescoping Properties
Finished posts for telescoping post systems shall be in accordance with the general dimensional requirements and shall permit consecutive square tubes to telescope freely, for no less than 10 feet without the necessity of matching any particular face to any other face. The finished posts shall be straight, and shall have a smooth, uniform finish. All holes and ends shall be free from burrs, and ends shall be cut square.

#### 1044.6 Bases
If bases are specified on the plans, one of the following FHWA accepted “Breakaway Anchor” systems shall be used.

a) Single. The anchor shall be one size larger than the signpost and driven using an appropriate sized drive cap. All anchors shall be driven into the ground leaving one to two holes exposed for signpost connection.

b) Two-Piece. An additional 18 inch outer sleeve, one size larger than the anchor, shall be used to double the anchor wall thickness at the critical bending area.

#### 1044.7 Connecting Bolts and Nuts
Bolts used to connect posts to bases shall be 5/16 inch, 18NC threads, bent-truss head bolts in accordance with ASTM A 307, Grade A. The bolts shall be mechanically zinc galvanized in accordance with ASTM B 695, Class 25. The nuts shall be 5/16 inch, 18NC threads, serrated flange nuts in accordance with ASTM A 194 and zinc electroplated in accordance with ASTM B 633.

#### 1044.8 Certification
The fabricator shall furnish to the Engineer, a certification stating that the posts furnished comply with all requirements of this specification. The certification shall include or have attached specific results of tests of the mechanical and chemical properties. The certification shall accompany each shipment of the material to the destination.

#### 1044.9 Acceptance
Acceptance of posts furnished under this specification will be based on Sec 1040.2 and on the results of any tests deemed necessary by the Engineer at destination to ascertain compliance with these specifications. If requested, two posts shall be furnished for testing purposes from such lots as the Engineer may determine.
SECTION 1045
PAINT FOR STRUCTURAL STEEL

1045.1 Scope. This specification covers paint, paint material and coating systems for use on structural steel.

1045.2 Paint and Paint Material.

1045.2.1 General. All single component paints shall be ready-mixed at the factory to comply with the specification formula for the type of paint ordered; shall be well ground to a uniform consistency and smooth texture; shall be free from dirt, water and other foreign matter; shall be of such consistency to have good application, covering and leveling properties; and shall dry within the specified period to a good film without running, streaking or sagging.

1045.2.1.1 Any paint that has livered or hardened or thickened to any extent in the container, or in which the pigment has settled such that the paint cannot be readily broken up with a paddle to a smooth uniform paint of good application consistency, will be rejected.

1045.2.1.2 All percentages and proportions shall be on a weight basis unless otherwise stated.

1045.2.1.3 All VOC content requirements specified shall be a maximum when thinned for application.

1045.2.2 Sampling. Each batch or lot of paint shall be sampled and approved prior to use. Each batch or lot of each component of multiple-component paints shall be sampled and approved prior to use.

1045.2.3 Packaging and Labeling. The lining of the containers shall not react with the paint. All components shall bear a label on which shall be clearly shown the name of the manufacturer, the kind of paint, lot number, shelf life, date of manufacture and net weight of contents. The lot number and date of manufacture shall be stamped, stenciled or painted directly onto the container using a weatherproof, durable material.

1045.2.4 Determination of Quantities. Quantities of paint shall be determined by volume. One gallon shall equal 231 cubic inches at 77°F.

1045.3 High Solids Inorganic Zinc Silicate Coating

1045.3.1 Description. High solids inorganic zinc coating shall be a solvent base multiple-component material which, when mixed and applied in accordance with Sec 1081, cures without the use of a separate curing solution. High solids inorganic zinc coating shall be in accordance with AASHTO M 300, Type IA. The VOC content shall not exceed 3.50 pounds per gallon. If thinning is necessary for application, the maximum VOC content after thinning shall not exceed 3.50 pounds per gallon.

1045.3.2 Manufacturer and Brand Name Approval. Prior to approval and use of high solids inorganic zinc, the manufacturer shall submit to the Engineer a certified test report from an approved testing laboratory showing specific test results conforming to all quantitative and resistance test requirements of these specifications. The certified test report shall also contain the exact ratio, by weight, of each component of the coating used for the tests, the lot tested, the manufacturer's name, brand name of coating and date of manufacture. Upon approval from the Engineer of this certified test report, further resistance tests will not be required, except as hereinafter noted, of that manufacturer for that brand name of coating. New certified test results shall be submitted any time the manufacturing process or the coating formulation is changed, and may be required by the Engineer when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified. All resistance testing shall be performed on duplicate sets of test panels, and upon completion of the prescribed exposure testing, the manufacturer shall submit one set of the exposed panels to the Engineer.
1045.3.3 **Alternate Approval.** If approved by the Engineer, compliance with all specified requirements for the system under NTPEP or Northeast Protective Coating Committee (NEPCOAT), in addition to the physical property requirements of this specification, may be substituted for the manufacturer and brand name approval requirements of [Sec 1045.3.2](#). The manufacturer shall provide documentation identifying specific products evaluated, along with the manufacturer’s code numbers and/or report code numbers.

1045.4 **High Solids Epoxy System G Intermediate Coating.**

1045.4.1 **Description.** The coating shall be a multiple-component, modified epoxy primer with an amine/amide-type curing system compatible as an intermediate coat over high solids inorganic zinc primer and suitable for topcoating with polyurethane.

1045.4.2 **Mixed Coating.** The color shall be gray (Federal Standard 595b No. 26373) or brown (Federal Standard 595b No. 30045) unless otherwise specified. The color of the intermediate coat shall match the color of the finish coat, unless otherwise approved by the Engineer. The physical properties of the mixed paint shall be as follows:

<table>
<thead>
<tr>
<th>High Solids Epoxy System G Intermediate Coating</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Krebs-Stormer, 77°F KU</td>
<td>80-130</td>
</tr>
<tr>
<td>VOC Content, max., lb/gal</td>
<td>3.50</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>4</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, mils wet, min.</td>
<td>8</td>
</tr>
<tr>
<td>Dry to Touch, hours, max.</td>
<td>3</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>6</td>
</tr>
</tbody>
</table>

1045.4.3 **Packaging and Labeling.** Packaging and labeling shall be in accordance with [Sec 1045.2.3](#).

1045.4.4 **Manufacturer and Brand Name Approval.** Prior to approval and use of the specified coating system, the manufacturer shall submit to the Engineer a one-gallon unit of each coat of the coating system proposed. The manufacturer shall also submit a certified test report from an approved independent testing laboratory showing specific test results obtained on the specified coating system for Relative Humidity Resistance ASTM D 1735 or D 2247, 3000 hours, Salt Fog Resistance ASTM B 117, 3000 hours and Accelerated Weathering ASTM G 153 Cycle 1 (Carbon Arc), 4000 hours. ASTM G 155, Cycle 2, Xenon Arc or G 154, Cycle 2 QUV (Fluorescent UV-Condensation Type using Type A lamps) may be used as an alternate to Carbon Arc.

1045.4.4.1 All coats of the system to be tested shall be applied to steel test panels that have been prepared according to AASHTO M 300. Each coat of the system shall be from the same manufacturer. Test panels for salt fog exposure shall be scribed as specified in ASTM D 1654 and, when rated according to ASTM D 1654, each panel shall receive a rating of 7 or greater. Test panels shall not exhibit more than slight rusting, undercutting, discoloration, fading, blistering, chalking, loss of gloss or change in color. Accelerated weathering resistance testing shall be performed on test panels that have received finish coats in the specified colors for which approval is being requested. After 4000 hours of testing for accelerated weathering resistance, each color of the finish coat shall show a difference in color of no greater than 3 ΔE, when compared to the control panel. Color change measurements shall be made in accordance with Section 6.2 CIE 1976 L*a*b* of ASTM D 2244. All resistance testing shall be performed on duplicate sets of test panels, and upon completion of the prescribed exposure testing, the manufacturer shall submit one set of the exposed panels to the Engineer.

1045.4.4.2 The manufacturer shall provide documentation that the specified coating system has performed satisfactorily for three years. The document shall include the name, address and telephone number of the proprietary agency and location of the structures. Upon approval of the coating by the Engineer, further submittals for preliminary approval will not be required of that manufacturer for that brand name of coating, except as
hereinafter noted. A new sample, new testing data and new test panels shall be submitted any time the manufacturing process or the batching proportions are changed. The Engineer may withdraw manufacturer and brand name approval when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified. All data submitted for preliminary approval will be considered confidential to St. Charles County.

1045.4.5 Alternate Approval. If approved by MoDOT Construction and Materials or the County, compliance with all specified requirements for the system under NTPEP or NEPCOAT, in addition to the physical property requirements of this specification, may be substituted for the manufacturer and brand name approval requirements of Sec 1045.4.4. If approval is requested under NTPEP or NEPCOAT, the accelerated weathering requirements stated in Sec 1045.4.4 will apply. The manufacturer shall provide documentation identifying specific products evaluated, along with the manufacturer’s code numbers and/or report code numbers.

1045.5 Polyurethane System G Finish Coating.

1045.5.1 Description. The coating shall be a multiple-component, aliphatic acrylic polyurethane suitable for use over High Solids Epoxy Intermediate Coat. The coating shall cure to a semi-gloss to high gloss, abrasion resistant surface and shall provide an easily cleanable finish.

1045.5.2 Mixed Coating. The mixed coating properties shall be as follows:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color, Federal Standard 595b</td>
<td>Gray 26373 Brown 30045</td>
</tr>
<tr>
<td>Viscosity, Krebs-Stormer, 77°F, KU</td>
<td>65-96</td>
</tr>
<tr>
<td>VOC Content, lb/gal, max.</td>
<td>3.50</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>6</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, mils wet, min.</td>
<td>8</td>
</tr>
<tr>
<td>Dry to Touch, hours, max.</td>
<td>4</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>8</td>
</tr>
</tbody>
</table>

1045.5.3 Packaging and Labeling. Packaging and labeling shall be in accordance with Sec 1045.2.3.

1045.5.4 Manufacturer and Brand Name Approval. Manufacturer and brand name approval shall be in accordance with Sec 1045.4.4 or Sec 1045.4.5. If approval is requested under Sec 1045.4.5, the accelerated weathering requirements stated in Sec 1045.4.4 will apply. The manufacturer shall provide documentation identifying specific products evaluated, along with the manufacturer’s code numbers and/or report code numbers.

1045.6 Waterborne Acrylic System H Intermediate and Finish Coating.

1045.6.1 Description. The intermediate coating shall be a single component waterborne acrylic compatible as a coating over high solids inorganic zinc primers. The finish coating shall be a single component waterborne acrylic suitable for use over a waterborne acrylic intermediate coating. The finish coating shall cure to a tough, abrasion resistant surface that performs well in weathering exposures. The gray finish coat shall cure to a semi-gloss finish and the brown finish coat shall cure to a low-gloss finish.

1045.6.2 Mixed Coating. The color of the intermediate coat shall be gray (Federal Standard 595b No. 26373) or brown (Federal Standard 595b No. 30045) unless otherwise specified. The color of the intermediate coat will normally be required to match the color of the finish coat. The mixed coating properties shall be as follows:
### Waterborne Acrylic System H Intermediate and Finish Coating

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color, Finish Coat, Federal Standard 595b</td>
<td>Gray 26373, Brown 30045</td>
</tr>
<tr>
<td>Viscosity, Krebs-Stormer, 77°F (25°C), KU</td>
<td>80-100</td>
</tr>
<tr>
<td>VOC Content, lb/gal (g/L), max.</td>
<td>3.50</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>7</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, mils wet, min.</td>
<td>8</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>2</td>
</tr>
</tbody>
</table>

#### 1045.6.3 Packaging and Labeling
Packaging and labeling shall be in accordance with [Sec 1045.2.3](#).

#### 1045.6.4 Manufacturer and Brand Name Approval
Prior to approval and use of waterborne acrylic intermediate and finish coats, the manufacturer shall obtain manufacturer and brand name approval in accordance with [Sec 1045.4.4](#) or [Sec 1045.4.5](#), except that, after the 4000 hour testing for accelerated weathering resistance, the Federal Standard 595b 30045 (brown) color of the finish coat shall show a difference in color of no greater than 4 °E when compared to the control panel. If approval is requested under [Sec 1045.4.5](#), the accelerated weathering requirements stated in [Sec 1045.4.4](#) will apply. The manufacturer shall provide documentation identifying specific products evaluated, along with the manufacturer’s code numbers and/or report code numbers.

#### 1045.7 Polysiloxane System I Finish Coating

#### 1045.7.1 Description
The coating shall be a multiple-component, Polysiloxane suitable for use over High Solids Inorganic Zinc, or High Solids Epoxy Intermediate Coating. The coating shall cure to a semi-gloss to high gloss, abrasion resistant surface and shall provide an easily cleanable finish.

#### 1045.7.2 Mixed Coating
The mixed coating properties shall be as follows:

<table>
<thead>
<tr>
<th>Polysiloxane System I Finish Coating</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Property</td>
<td></td>
</tr>
<tr>
<td>Color, Finish Coat, Federal Standard 595b</td>
<td>Gray 26373, Brown 30045</td>
</tr>
<tr>
<td>Viscosity, Krebs-Stormer, 77°F, KU</td>
<td>Within Manufactures submitted range</td>
</tr>
<tr>
<td>VOC Content, lb/gal (g/L), max.</td>
<td>2.0</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>6</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, mils wet, min.</td>
<td>8+</td>
</tr>
<tr>
<td>Dry to Touch, hours, max.</td>
<td>3</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>8</td>
</tr>
</tbody>
</table>

#### 1045.7.3 Packaging and Labeling
Packaging and labeling shall be in accordance with [Sec 1045.2.3](#).

#### 1045.7.4 Manufacturer and Brand Name Approval
Manufacturer and brand name approval shall be in accordance with [Sec 1045.4.4](#) or [Sec 1045.4.5](#). If approval is requested under [Sec 1045.4.5](#), the accelerated weathering requirements stated in [Sec 1045.4.4](#) will apply. The manufacturer shall provide documentation identifying specific products evaluated, along with the manufacturer’s code number and/or report code numbers.

#### 1045.8 Aluminum Epoxy-Mastic Primer
1045.8.1 Description. The coating shall be a one-coat system aluminum epoxy-mastic primer designed for adhesion to rusty steel, aged galvanized steel and other uses. Aluminum epoxy-mastic primer will not be permitted for use on any surface that is to be in contact with fresh concrete. The epoxy-mastic shall be a two component, modified epoxy-primer containing metallic-aluminum flake.

1045.8.2 Pigment. The primary pigment shall be metallic-aluminum.

1045.8.3 Vehicle. The vehicle shall be an epoxy-type. The curing agent shall have suitable insensitivity to moisture to allow trouble-free application.

1045.8.4 Mixed Coating.

1045.8.4.1 The coating shall be well-ground, not caked, skinned or badly settled in the container. The mixed coating, when applied in one coat, shall be capable of achieving 5 mils dry film thickness without runs or sags.

1045.8.4.2 The mixed coating properties shall be as follows:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry to touch, hours, max.</td>
<td>24</td>
</tr>
<tr>
<td>Dry hard, days, max.</td>
<td>5(^a)</td>
</tr>
<tr>
<td>VOC Content, lb/gal, max.</td>
<td>3.50</td>
</tr>
</tbody>
</table>

\(^a\) When air-cured at a temperature of 75°F or above to a hard, tough film by evaporation of solvent and chemical reaction.

1045.8.5 Resistance Tests. Test panels of steel in accordance with ASTM D 609, and having dimensions of 2 x 5 x 1/8 inch shall be prepared by sandblasting all surfaces to a white metal condition in accordance with Structural Steel Painting Council SP5 (SSPC-SP5-82). The cleaned panels shall then be exposed to outdoor weather for 30 days or until uniform rusting occurs. The panel shall then be hand cleaned with a wire brush in accordance with SSPC-SP2-82. A 6-mil dry coating of the epoxy-mastic shall then be applied in one coat in accordance with the manufacturer’s current recommendations. The coating shall be cured as recommended by the manufacturer. Fresh Water, Salt Water, and Weathering and Salt Fog resistance tests, as detailed herein, shall be performed on one or more test panels. The material will not be approved if any individual test panel fails any of the resistance tests specified herein.

1045.8.5.1 Fresh Water Resistance. Panels shall be scribed down to base metal with an "X" of at least 2 inch legs, and shall be immersed in fresh tap water at 75 ± 5°F. The panels shall show no rusting, blistering or softening beyond 1/16 inch from the scribe mark, when examined after 30 days. Discoloration of the coating will be permitted.

1045.8.5.2 Salt Water Resistance. Panels shall be scribed down to base metal with an "X" of at least 2 inch legs and immersed in five percent sodium chloride at 75 ± 5°F. The panels shall show no rusting, blistering or softening beyond 1/16 inch from the scribe mark upon examination after 7, 14 and 30 days. Discoloration of the coating will be permitted. The sodium chloride solution shall be replaced with fresh solution after each examination.

1045.8.5.3 Weathering and Salt Fog Resistance. Panels shall be tested in the weatherometer in accordance with ASTM G 154 QUV (Fluorescent UV-Condensation Tape using Type A Lamps) for 300 hours using a test cycle consisting of four hours light followed by four hours condensation. After this period, the panels shall be removed and scribed with an "X" of at least 2 inch legs down to base metal. The test panels shall then be tested in accordance with ASTM B 117. After 1,000 hours of continuous exposure, the coating shall show no loss of bond, nor shall the coating show rusting or blistering beyond 1/16 inch from the center of the scribe mark.

1045.8.6 Packaging and Labeling. Packaging and labeling shall be labeled in accordance with Sec 1045.2.3.
1045.8.7 Approval and Prequalification.

1045.8.7.1 Manufacturer and Brand Name Approval. Prior to approval and use of the epoxy-mastic primer, the manufacturer shall submit to MoDOT Construction and Materials or the County a one-gallon sample of the coating and a certified test report from an approved independent testing laboratory showing specific test results conforming to all quantitative and resistance test requirements of these specifications. The certified test report shall contain the exact ratio, by weight, of the pigment component to the vehicle component of the epoxy-mastic used for the tests, the lot tested, the manufacturer's name, brand name of the epoxy-mastic, and date of manufacture. In addition, the manufacturer shall submit a complete set of tested panels that have undergone each required resistance test. The set of panels submitted shall include one untested control panel that has been prepared in accordance with Sec 1045.8.5. Upon approval by MoDOT Construction and Materials or the County of this certified test report, further resistance tests will not be required of that manufacturer for that brand name of epoxy-mastic primer, except as noted. New certified test results shall be submitted any time the manufacturing process or the epoxy-mastic formulation is changed, and may be required by the Engineer when sampling and testing of material offered for use indicates nonconformance to any of the requirements specified herein.

1045.8.7.2 Final Acceptance. Final acceptance of the epoxy-mastic primer will be based on a manufacturer's certification submitted by the Contractor to the Engineer and on results of tests conducted on samples of the material. Each lot of each component will be sampled and tested prior to approval or use of the material.

1045.9 Gray Epoxy-Mastic Primer.

1045.9.1 Description. This specification covers a one-coat gray epoxy-mastic primer system designed for adhesion to rusty steel, aged galvanized steel and other uses, including uses in contact with freshly poured Portland cement concrete. The epoxy-mastic shall be a multiple-component modified epoxy containing gray pigmentation, and shall be in accordance with the requirements specified herein.

1045.9.2 Pigment. The pigmentation shall be any pigment or combination of pigments formulated to offer the intended protective properties to the cured coating, and shall be totally non-reactive to the constituents contained in both cured and uncured Portland cement concrete.

1045.9.3 Vehicle. The vehicle shall be an epoxy type. The curing agent shall have suitable insensitivity to moisture to allow trouble-free application.

1045.9.4 Mixed Coating.

1045.9.4.1 The provisions of Sec 1045.8.4.1 will apply.

1045.9.4.2 The mixed coating properties shall be as follows:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color, Federal Standard 595b</td>
<td>Gray 26373</td>
</tr>
<tr>
<td>Viscosity, (Krebs-Stormer, 77°F) KU</td>
<td>90 - 120</td>
</tr>
<tr>
<td>Volatile Organic Content, lb/gal, max.</td>
<td>3.50</td>
</tr>
<tr>
<td>Dry to touch, hours, max.</td>
<td>24</td>
</tr>
<tr>
<td>Dry hard, days, max.</td>
<td>7a</td>
</tr>
</tbody>
</table>

*When air-cured at a temperature of 75°F or above to a hard, tough film by evaporation of solvent and chemical reaction.
1045.9.5 Resistance Tests. Test requirements and approval criteria shall be in accordance with Sec 1045.8.5.

1045.9.6 Packaging and Labeling. Packaging and labeling shall be in accordance with Sec 1045.2.3.

1045.9.7 Approval and Prequalification.

1045.9.7.1 Manufacturer and Brand Name Approval. Manufacturer and brand name approval shall be in accordance with Sec 1045.8.7.1.

1045.9.7.2 Final Acceptance. Final acceptance will be in accordance with Sec 1045.8.7.2.

1045.10 Calcium Sulfonate System.

1045.10.1 Description. This specification covers calcium sulfonate sealer, calcium sulfonate primer and various colors of calcium sulfonate topcoat paints for steel. The color of topcoat will be specified in the contract and shall be in accordance with all requirements specified herein.

1045.10.1.1 The primary resin used to manufacture each coat of the calcium sulfonate system shall be a modified overbased crystalline calcium sulfonate that creates a highly polar complex capable of protecting the underlying steel from corrosion. In addition to the calcium sulfonate complex, the paint shall contain film forming oleoresinous compounds that act to reduce tack in the dry film.

1045.10.1.2 The coating material shall be uniform, stable in storage, and free from grit and coarse particles.

1045.10.2 Calcium Sulfonate Rust Penetrating Sealer.

1045.10.2.1 General. The sealer, after allowing a minimum drying time, may be recoated with an approved primer or topcoat. The sealer will be suitable for any steel structure that has developed pack rusting in overlapping steel plates, joints or at bolted areas. This coating shall be used on in-place structures as part of a long-term maintenance program, and as such shall be applied in accordance with SSPC-PA1, Shop, Field and Maintenance Painting.

1045.10.2.2 Properties. The mixed coating properties shall be as follows:

<table>
<thead>
<tr>
<th>Calcium Sulfonate Rust Penetrating Sealer</th>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Color</td>
<td>Red iron oxide</td>
</tr>
<tr>
<td></td>
<td>Modified Crystalline Overbased Calcium Sulfonate, percent by weight, min.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Coarse Particles and Skins as retained on No. 325 mesh sieve, percent, max.</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Viscosity, #4 Ford Cup, Seconds</td>
<td>50 - 70</td>
</tr>
<tr>
<td></td>
<td>VOC Content, lbs/gal., max.</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Drying Time, hours to recoat</td>
<td>2 - 6</td>
</tr>
<tr>
<td></td>
<td>Flash Point, F, max</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Salt Fog Resistance, 500 hours (Coating applied at 1-2 mils dry film over SSPC-SP5 cold rolled steel)</td>
<td>No more than 1% rust undercutting, blistering or peeling.</td>
</tr>
</tbody>
</table>

1045.10.3 Calcium Sulfonate/Alkyd Primer.
1045.10.3.1 General. This primer shall be used in non-abrasion exposures to provide a firm, corrosion resistant, highly adherent film. This primer may be used for in-place structures but shall not be used as a shop-applied primer.

1045.10.3.2 Properties. The mixed coating properties shall be as follows:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Red iron oxide</td>
</tr>
<tr>
<td>Modified Crystalline Overbased Calcium Sulfonate, percent by weight, min.</td>
<td>15</td>
</tr>
<tr>
<td>Coarse Particles and Skins as retained on No. 325 mesh sieve, percent, max.</td>
<td>1.0</td>
</tr>
<tr>
<td>Viscosity, 77°F, KU</td>
<td>90 – 120</td>
</tr>
<tr>
<td>VOC Content, lbs/gal, max.</td>
<td>3.50</td>
</tr>
<tr>
<td>Fineness of Grind, Hegman Units, min.</td>
<td>5</td>
</tr>
<tr>
<td>Drying Time, Hours (3 to 4 Mil Dry Film):</td>
<td></td>
</tr>
<tr>
<td>Dust Dry</td>
<td>1 – 4</td>
</tr>
<tr>
<td>Tack Free</td>
<td>5 – 12</td>
</tr>
<tr>
<td>Dry Firm</td>
<td>24 – 48</td>
</tr>
<tr>
<td>Sag Resistance, Mils</td>
<td>12+</td>
</tr>
<tr>
<td>Salt Spray Resistance, 1500 hours (4 mil dry film over SSP-SP-5 blasted cold rolled steel – 1 to 2 mil profile)</td>
<td>No more than 1 % under-cutting, blistering or peeling.</td>
</tr>
</tbody>
</table>

1045.10.4 Calcium Sulfonate/Alkyd Topcoat.

1045.10.4.1 General. Calcium sulfonate/alkyd topcoat shall be a medium to light gray, brown, green or tan low gloss coating as specified in the contract for use over calcium sulfonate/alkyd penetrating sealer or calcium sulfonate/alkyd primer. This paint shall be used as a topcoat for a calcium sulfonate/alkyd corrosion inhibitive primer, and shall be applied in accordance with SSPC-PA 1, Shop, Field, and Maintenance Painting. The topcoat may be used for in-place structures and shall not be used as a shop-applied finish.

1045.10.4.2 Properties. The mixed coating properties shall be as follows:
Calcium Sulfonate/Alkyd Topcoat

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color, Federal Standard 595b</td>
<td>Brown 30045, Gray 26373, Tan 23522, Green 24260</td>
</tr>
<tr>
<td>Modified Crystalline Overbased Calcium Sulfonate, per cent by weight, min.</td>
<td>15</td>
</tr>
<tr>
<td>Coarse Particles and Skins as retained on No. 325 mesh sieve, percent, max.</td>
<td>1.0</td>
</tr>
<tr>
<td>Viscosity, 77°F, KU</td>
<td>90-130</td>
</tr>
<tr>
<td>Fineness of Grind, Hegman Units, min.</td>
<td>5</td>
</tr>
<tr>
<td>Drying Time, 2-3 mils, hours</td>
<td></td>
</tr>
<tr>
<td>Dust Dry</td>
<td>1 - 4</td>
</tr>
<tr>
<td>Tack Free</td>
<td>5 - 12</td>
</tr>
<tr>
<td>Dry Firm</td>
<td>24 – 48</td>
</tr>
<tr>
<td>VOC Content, lbs/gal max.</td>
<td>3.5</td>
</tr>
<tr>
<td>Sag Resistance, Mils</td>
<td>12+</td>
</tr>
<tr>
<td>QUV Weathering Resistance, 1000 hrs. (4 mil dry film over SSP-SP-5 blasted cold rolled steel - 1-2 mil profile)</td>
<td>No excessive chalking, blistering, or change in color.</td>
</tr>
<tr>
<td>Salt Spray Resistance, 1000 hrs (4 mil dry film over SSP-SP-5 blasted cold rolled steel – 1-2 mil profile)</td>
<td>No more than 1 % rust undercutting, blistering or peeling.</td>
</tr>
</tbody>
</table>

1045.10.5 Test Methods. The test methods used to verify compliance with the properties specified in Sec 1045.10.2, Sec 1045.10.3 and Sec 1045.10.4 shall be as follows:

<table>
<thead>
<tr>
<th>American Standards for Testing and Materials (ASTM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G154 Practice for Operating Light- and Water-Exposure Apparatus</td>
</tr>
<tr>
<td>B117 Salt Spray (Fog) Testing</td>
</tr>
<tr>
<td>D562 Consistency of Paints Using the Stormer Viscometer</td>
</tr>
<tr>
<td>D1200 Viscosity of Paints, Varnishes and Lacquers by Ford Viscosity Cup</td>
</tr>
<tr>
<td>D1210 Fineness of Dispersion of Pigment-Vehicle Systems</td>
</tr>
<tr>
<td>D1475 Density of Paint, Varnish, Lacquer and Related Products</td>
</tr>
<tr>
<td>D3278 Flash Point of Liquids by Seta Flash Closed Tester</td>
</tr>
<tr>
<td>D3960 VOC Content of Paints</td>
</tr>
<tr>
<td>Federal Test Method Standard No. 141</td>
</tr>
<tr>
<td>Method 4061 Drying Time</td>
</tr>
<tr>
<td>Method 4494 Sag Test (multi-notch blade)</td>
</tr>
</tbody>
</table>

1045.10.6 Pigment Settlement. The paint shall have perfect suspension (10 rating) when tested as specified in ASTM D 869, when stored for six months.

1045.10.7 Working Properties. The paint shall be uniform and easily spray-applied when tested in accordance with Federal Standard No.141, Method 4331. The primer and topcoat shall show no streaking, running or sagging after drying.

1045.10.8 Storage. The paint shall show no thickening, curdling, gelling or hard caking when tested as specified in Federal Standard No.141, Method 3011 after storage for six months from date of delivery in tightly covered containers at a temperature of at least 50°F and no more than 110°F.
1045.10.9 Packaging and Labeling. Packaging and labeling shall be in accordance with Sec 1045.2.3.

1045.10.10 Approval and Prequalification.

1045.10.10.1 Manufacturer and Brand Name Approval. Prior to approval and use of the calcium sulfonate coating system, the manufacturer shall submit to MoDOT Construction and Materials or the County a one-gallon sample of each coat of the proposed coating system. The manufacturer shall also submit a certified test report from an approved independent laboratory showing specific test results as follows:

(a) Calcium Sulfonate Penetrating Sealer. Salt spray resistance of steel panels prepared and tested in accordance with Sec 1045.10.2.2.

(b) Calcium Sulfonate Primer. Salt spray resistance of steel panels prepared and tested in accordance with Sec 1045.10.3.2.

(c) Calcium Sulfonate Topcoat. Salt spray resistance and QUV weathering resistance in accordance with Sec 1045.10.4.2.

1045.10.10.2 Final Acceptance. Final acceptance of calcium sulfonate penetrating sealer, calcium sulfonate primer and calcium sulfonate topcoat will be based on the manufacturer’s certification submitted by the Contractor to the Engineer, and on results of tests conducted on samples of the material. Each lot will be sampled and tested prior to approval and use.
1046.1 **Scope.** This specification covers material requirements for pipe liner.

1046.2 **Material.** Pipe liner shall be in accordance with one of the following.

(a) HDPE pipe in accordance with ASTM F 714, maximum DR 32.5.

(b) HDPE pipe in accordance with ASTM D 1248, Type III, Category 5, Class C, Grade P34. This pipe liner shall have approved dimensions on file with MoDOT Construction and Materials or the County.

(c) HDPE pipe in accordance with ASTM F 894 open profile, Class RSC 100 or RSC 160.

(d) PVC pipe in accordance with ASTM F 949, except that the PVC pipe and fittings shall be made of a PVC compound having a minimum call classification of 12454B, in accordance with ASTM D 1784. The joining method for PVC pipe shall be by elastomeric material in accordance with ASTM F 949.

1046.3 **Pipe Marking.** Each length of pipe liner furnished shall be permanently marked by the manufacturer with the manufacturer’s name and applicable ASTM designation.

1046.4 **Certification and Acceptance.** The Contractor shall furnish a manufacturer’s certification to the Engineer that the pipe liner was manufactured, tested, and is in accordance with this specification. Acceptance of the material will be based on the manufacturer’s certification and statement, pipe liner identification markings and upon the results of such tests as may be performed by the Engineer.

1046.5 **Inspection.**

1046.5.1 The Engineer may inspect the fabricated pipe liner at the manufacturing plant, intermediate distribution point or destination. The manufacturer shall furnish to the Engineer an itemized statement of the sizes and lengths of pipe liner in each shipment. The Engineer shall have access to the manufacturing plant or intermediate distribution point for inspection. Each facility shall provide the means to safely inspect all aspects of production or storage. Any previously rejected pipe liner included in a later lot will be cause for rejection of the entire lot. A lot will be defined as all the material presented for inspection at one time.

1046.5.2 Inspection will include an examination of the pipe liner for markings, variance from specified diameter, net length of fabricated pipe liner, and any evidence of poor workmanship. The inspection may include taking samples.

1046.6 **Rejection.**

1046.6.1 Any individual section of pipe liner failing to meet the marking, diameter, length or workmanship requirements of these specifications will be rejected.

1046.6.2 If a pipe liner fails to meet the requirements, the pipe liner sampled will be rejected and the lot will be resampled. A resample will be of the same size as the original sample. The resample shall comply in all respects or the entire shipment will be rejected.
SECTION 1047
POLYETHYLENE CULVERT PIPE

1047.1 Scope. This specification covers polyethylene culvert pipe used for the construction of culverts and other uses specified in the contract documents.

1047.2 Basis of Acceptance. Acceptance of polyethylene culvert pipe will be based on the pipe being provided by a qualified manufacturer, certification, manufacturer quality control documentation, identification markings and tests on samples of the material as required by the Engineer.

1047.3 Material. Polyethylene culvert pipe, couplings and fittings shall be in accordance with AASHTO M 294 for corrugated or AASHTO MP 20 for steel reinforced. In case of conflict with AASHTO M 294 or AASHTO MP 20, these specifications shall govern.

1047.3.1 Section properties shall be within the following limits:

<table>
<thead>
<tr>
<th>Nominal Size S (in.)</th>
<th>Effective Pipe Wall Area $A_{eff}$ (in.²/in.)</th>
<th>Pipe Wall Centroid to Inside Face $y_c$ (in.)</th>
<th>Pipe Wall Moment of Inertia $I_y$ (in.⁴/in.)</th>
<th>Area Ratio $A_{eff} / A_g$</th>
<th>Extreme Fiber Ratio $y_c / c$</th>
<th>Inside Diameter $D_i$ (in.)</th>
<th>Outside Diameter $D_o$ (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.163</td>
<td>0.382</td>
<td>0.0313</td>
<td>0.699</td>
<td>0.494</td>
<td>12.02</td>
<td>14.60</td>
</tr>
<tr>
<td>15</td>
<td>0.202</td>
<td>0.413</td>
<td>0.0465</td>
<td>0.768</td>
<td>0.447</td>
<td>14.83</td>
<td>17.82</td>
</tr>
<tr>
<td>18</td>
<td>0.209</td>
<td>0.569</td>
<td>0.0653</td>
<td>0.749</td>
<td>0.554</td>
<td>17.83</td>
<td>21.42</td>
</tr>
<tr>
<td>24</td>
<td>0.233</td>
<td>0.669</td>
<td>0.1317</td>
<td>0.667</td>
<td>0.552</td>
<td>23.71</td>
<td>27.98</td>
</tr>
<tr>
<td>30</td>
<td>0.233</td>
<td>0.757</td>
<td>0.2415</td>
<td>0.816</td>
<td>0.448</td>
<td>29.46</td>
<td>34.98</td>
</tr>
<tr>
<td>36</td>
<td>0.294</td>
<td>1.058</td>
<td>0.3153</td>
<td>0.683</td>
<td>0.588</td>
<td>35.44</td>
<td>41.92</td>
</tr>
<tr>
<td>42</td>
<td>0.331</td>
<td>1.140</td>
<td>0.5395</td>
<td>0.693</td>
<td>0.564</td>
<td>40.98</td>
<td>48.18</td>
</tr>
<tr>
<td>48</td>
<td>0.323</td>
<td>1.095</td>
<td>0.4682</td>
<td>0.681</td>
<td>0.543</td>
<td>47.12</td>
<td>54.34</td>
</tr>
<tr>
<td>60</td>
<td>0.438</td>
<td>1.477</td>
<td>0.8150</td>
<td>0.751</td>
<td>0.766</td>
<td>58.90</td>
<td>66.97</td>
</tr>
</tbody>
</table>

$A_g$ equals gross area of pipe wall per unit length of pipe (in.²/in.).

$c$ equals the distance from the pipe wall centroid to the outermost fiber (in.).

<table>
<thead>
<tr>
<th>Nominal Size S (in.)</th>
<th>Wall Steel Area $A$ (in.²/ft)</th>
<th>Wall Steel Moment of Inertia $I_y$ (in.⁴/in.)</th>
<th>Rib Radius of Gyration $r$ (in.)</th>
<th>Rib Width/Thickness Ratio $b/t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>0.348</td>
<td>0.00063</td>
<td>0.144</td>
<td>8.97</td>
</tr>
<tr>
<td>30</td>
<td>0.344</td>
<td>0.00086</td>
<td>0.170</td>
<td>10.03</td>
</tr>
<tr>
<td>36</td>
<td>0.404</td>
<td>0.00122</td>
<td>0.187</td>
<td>10.36</td>
</tr>
<tr>
<td>42</td>
<td>0.461</td>
<td>0.00152</td>
<td>0.195</td>
<td>9.91</td>
</tr>
<tr>
<td>48</td>
<td>0.379</td>
<td>0.00218</td>
<td>0.257</td>
<td>11.90</td>
</tr>
<tr>
<td>60</td>
<td>0.482</td>
<td>0.00352</td>
<td>0.290</td>
<td>11.88</td>
</tr>
</tbody>
</table>
1047.3.2 The pipe shall be Type S and not be perforated unless specified otherwise.

1047.3.3 Field joints shall provide circumferential and longitudinal strength to maintain the pipe alignment, prevent separation of pipe and prevent infiltration of fill material. Coupling bands, if used, shall be of the same base material as the pipe. Corrugations in the bands shall have the same configuration as the corrugations in the pipe ends being connected. Prior to use, the design of coupling bands and fastening devices shall be submitted to and approved by MoDOT Construction and Materials or the County. Final acceptance of coupling bands and fastening devices will be based on field performance.

1047.3.4 The manufacturer shall provide to the Engineer an itemized statement of the sizes, section properties and lengths of pipe in each shipment.

1047.3.5 Pipe may be fabricated using English units of measurement. Pipe fabricated using English measurements shall meet the diameter dimensions shown on the plans. Pipe tolerances will be in accordance with AASHTO M 294 or AASHTO MP 20.

1047.4 Sampling, Testing and Acceptance Procedures. All manufacturers furnishing pipe meeting the requirements of AASHTO M 294, for St. Charles County projects shall be qualified as described herein. All manufacturers furnishing pipe meeting the requirements of AASHTO MP 20 for St. Charles County projects shall meet the quality control and assurance requirements of the appendix section in MP 20 and these specifications. All pipes will be subject to inspection by the Engineer at the source of manufacture, at an intermediate shipping terminal or at destination. The Engineer shall be allowed unlimited access to all facilities and records as required to conduct inspection and sampling in accordance with Sec 106.

1047.4.1 Application for Placement on Qualified List. To become qualified to furnish pipe meeting AASHTO M 294, a written request shall be sent by the manufacturer to the Engineer, and shall include the following information:

(a) A copy of the manufacturer’s current National Product Evaluation Program (NTPEP) certification.

(b) The pipe manufacturer’s certified analysis certificate setting forth the name or brand of pipe to be furnished, the specified type, category, grade and class of polyethylene compounds. The certificate shall be sworn for the manufacturer by a person having legal authority to bind the company. The certificate shall have attached a certified test report from an approved independent testing laboratory showing specific results of tests performed on each diameter pipe to be furnished, conforming to all requirements of these specifications. Pipes shall be randomly selected for test by the independent testing laboratory and shall be representative of that manufacturer’s pipe.

(c) A guarantee that all pipe furnished shall be in accordance with the specification requirements, shall bear a suitable identification brand or mark and shall be replaced without cost to the County when not in accordance with the specified requirements. The guarantee shall be worded such that the guarantee will remain in effect as long as the manufacturer continues to furnish material. The manufacturer shall conduct tests and measurements as necessary to ensure the material produced complies with all specification requirements. These tests and measurements shall be identified by the identification symbols or code used on the pipe in a manner that will permit the manufacturer to produce specific reports showing test results representative of specific lots of polyethylene pipe. Copies of reports of these tests shall be kept on file and shall be submitted to the Engineer upon request. The brand shall be removed or obliterated by the manufacturer on all material where control tests, as outlined herein, are not in accordance with this specification.

(d) Units of measurement, English or metric, used to fabricate the pipe.

1047.4.2 Maintaining Qualification. To maintain qualification to furnish pipe meeting AASHTO M 294, the manufacturer shall perform and maintain a quality control program in accordance with the NTPEP Certification
Program. The manufacturer’s NTPEP certification shall be maintained. The manufacturer shall maintain for three years a record of all test results, inspections and the bill of lading for each shipment of material used in the production of pipe and for each shipment of pipe. The manufacturer shall notify the Engineer at least 24 hours prior to each shipment of pipe to a St. Charles County project. Additional pipe may be considered part of the original shipment when the ordered quantity was underestimated or material was lost or damaged. A bill of lading in accordance with Sec 1047.5 shall be provided for each shipment of pipe.

1047.4.3 Disqualification of a Manufacturer. A manufacturer may be disqualified to provide pipe for use on St. Charles County projects based on the discretion of MoDOT Construction and Materials or the County, for reasons including, but not limited to, not maintaining NTPEP certification, failure of material to consistently meet specifications, falsification of documentation, misbranding of pipe, unsatisfactory performance in the field or for other reasons indicating lack of consistent material quality.

1047.4.3.1 In the case where a manufacturer loses NTPEP certification and was not disqualified for any other reason, reinstatement will be considered when the manufacturer is recertified by NTPEP.

1047.4.3.2 A manufacturer will not be considered for reinstatement until after one year from the date of removal for falsification of documents.

1047.4.3.3 Three notices of failure to meet specification requirements within a 12-month period will be cause for disqualification of the manufacturer for one year, effective from the date of the third notice.

1047.4.3.4 A manufacturer disqualified within one year of the end of a disqualification may be subject to permanent removal, with no application for reinstatement accepted for a period of three years.

1047.4.4 Reinstatement of a Manufacturer. Consideration of reinstatement of a manufacturer once disqualified will be no sooner than specified in Sec 1047.4.3, will require a written document from the manufacturer stating the reasons for disqualification and the action taken to correct those deficiencies, written concurrence from the Engineer that the problem has been suitably addressed, followed by a new application in accordance with Sec 1047.4.1.

1047.4.5 Sampling of Material. Random sampling of the pipe will be conducted by the Engineer to verify pipe and material is in accordance with this specification. Samples of polyethylene pipe will be obtained from fabricated culvert sections in accordance with AASHTO M 294 or AASHTO MP 20 at a frequency determined by the Engineer.

1047.4.6 Inspection. Inspection will include an examination of the pipe for markings, deficiency in specified diameter, net length of fabricated pipe and evidence of poor workmanship. The inspection may include taking samples.

1047.4.7 Testing. Specimen testing size and method of tests shall be in accordance with AASHTO M 294 or AASHTO MP 20. The Contractor or manufacturer shall provide the equipment and personnel to cut a sample from a section of pipe. The sample shall include the markings or a record of the markings for that section of pipe.

1047.4.8 Unacceptable Material.

1047.4.8.1 Any individual section of pipe failing to meet the marking, diameter, length or workmanship requirements of these specifications will be unacceptable. If 10 percent of the pipe in any lot fails to meet these requirements, the entire shipment of that pipe diameter may be rejected.

1047.4.8.2 If a test specimen taken in accordance with Sec 1047.4.7 fails to be in accordance with AASHTO M 294 or AASHTO MP 20, the pipe sampled will be rejected, and the lot will be resampled. A resample will be from the
same diameter of pipe as the original sample. The resample shall be in accordance to these specifications or the entire shipment will be rejected.

**1047.5 Bill of Lading.** A bill of lading or delivery receipt for each shipment of pipe shall be furnished to the Engineer at the shipping and destination points. The bill of lading shall contain an itemized statement of the sizes and lengths of pipe for that shipment. The bill of lading shall contain a certified statement. The certified statement shall be signed by an authorized representative of the manufacturer and shall state the following:

“This certifies that the pipe, bands and end sections in this shipment are in accordance with St. Charles County specifications, were fabricated at an approved plant and were fabricated from the following brand names:”
SECTION 1048
PAVEMENT MARKING MATERIAL

1048.1 Scope. This specification covers acrylic copolymer fast dry pavement marking paint, cold weather waterborne pavement marking paint, temporary raised pavement markers, preformed removable pavement marking tape, preformed short-term pavement marking tape, drop-on glass beads, extruded thermoplastic pavement marking, hot spray thermoplastic pavement marking, epoxy pavement marking materials, standard acrylic waterborne pavement marking paint, high build acrylic waterborne pavement marking paint, preformed thermoplastic material, and cold applied preformed pavement intersection marking material.

1048.1.1 Certification and Acceptance. All material contained in Sec 1048 shall be in accordance with the following requirements.

1048.1.1.1 To obtain approval of the material, the manufacturer shall submit material and application specifications, samples of the material, and a history of satisfactory use to MoDOT Construction and Materials or the County for testing and evaluation. The sample quantity submitted shall be at the discretion of the Saint Charles Highway Department. The approval process shall not be initiated prior to obtaining the concurrence of the Engineer. Following testing and evaluation, satisfactory material will be placed on a qualified list.

1048.1.1.2 For acceptance on a project, the Contractor shall furnish to the Engineer a manufacturer's certification stating the manufacturer and trade name, lot or batch number and that all material furnished is similar to the material originally qualified. For extruded or hot-spray thermoplastic, the certification shall state the specific gravity of the lot or batch. Acceptance of the material will be based on the manufacturer's certification, the results of such tests that may be performed by the Engineer and satisfactory performance in the field.

1048.1.1.3 The material may be inspected and sampled at the point of manufacture, at an intermediate shipping terminal or at destination. The Engineer shall be allowed access to all facilities and records as required to conduct inspection and sampling tasks as required. The Contractor shall adequately mix the contents of all shipping containers prior to obtaining samples or transferring partial containers of material to tanks on the striping equipment.

SECTION 1048.22 COLD WEATHER PAVEMENT MARKINGS.

1048.22.1 Acrylic Copolymer Fast Dry Pavement Marking Paint.

1048.22.1.1 Description. Acrylic copolymer fast dry pavement marking paint shall be capable of receiving and holding glass beads for producing retroreflective pavement marking.

1048.22.1.2 Material. The paint shall contain no more than 3,200 ppm lead or more than 800 ppm chromium based on dry weight, and shall have limited VOC content as noted herein.

1048.22.1.2.1 General. The finished paint shall be formulated and manufactured from first-grade material and shall be a fast drying, solvent-based, acrylic copolymer resin type paint capable of withstanding air and roadway temperatures without bleeding, staining, discoloring or deforming. The dried paint film shall be capable of maintaining original dimensions and placement without chipping, spalling or cracking. The dry paint film shall not deteriorate because of contact with normal roadway chemicals or materials.

1048.22.1.2.2 Durability Testing. Determination of conformance to this specification will include, but will not be limited to, the evaluation of test data from NTPEP or other MoDOT approved facilities. The maintained retroreflectivity and durability shall be in accordance with the following requirements after being installed on at least one NTPEP test deck in a northern, wet climate region for a minimum of six months, including December, January and February.
1048.22.1.2.3 Maintained Retroreflectivity. Photometric quantity to be measured will be the coefficient of retroreflective luminance (RL) in accordance with the requirements of ASTM E 1743 for 15-meter geometry or ASTM E 1710 for 30-meter geometry. The average RL for concrete and bituminous surfaces shall be expressed in millicandels per footcandle per square foot and shall be at least 100 for 15-meter geometry or 75 for 30-meter geometry, when measured in the wheel path area.

1048.22.1.2.4 Durability. Paint shall have a durability rating of at least 4 for both concrete and bituminous surfaces when tested in the wheel path area of the NTPEP test deck.

1048.22.1.3 Mixed Paint.

1048.22.1.3.1 The mixed paint shall be strained before filling, using a screen or a sieving device no coarser than 40 mesh.

1048.22.1.3.2 The VOC content of the finished paint shall be less than 1.25 pounds of volatile organic matter per gallon of total non-volatile paint material when tested in accordance with ASTM D 3960.

1048.22.1.3.3 The paint shall have the following physical properties.

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, KU</td>
<td>80 - 95</td>
</tr>
<tr>
<td>Laboratory Dry Time, ASTM D 711, minutes, max.</td>
<td>10</td>
</tr>
</tbody>
</table>

1048.22.1.4 Color. For white, the color shall closely match Color Chip 37925 of Federal Standard 595b. For yellow, the color shall closely match Color Chip 33538 of Federal Standard 595b. Color determination will be made for markings and the diffuse daytime color of the markings shall be in accordance with the below CIE Chromaticity coordinate limits. Color determination for liquid marking materials will be made over the black portion of a 2A or 5C Leneta Chart or equal, at least 24 hours after application of a 15-mil wet film. Color readings will be determined in accordance with the requirements of ASTM E 1349 using CIE 1931 2-degree standard observer and CIE standard illuminant D65.

<table>
<thead>
<tr>
<th>CIE Chromaticity Coordinate Limits (Initial)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Yellow</td>
</tr>
</tbody>
</table>

1048.22.1.4.1 Contrast Ratio. The contrast ratio shall be a minimum of 0.98 when drawn down as a 15-mil wet film on a 2A or 5C Leneta Chart or equal, and air-dried for 24 hours. The contrast ratio shall be calculated as follows: Contrast ratio = Black/White.

1048.22.1.4.2 Reflectance. The daylight directional reflectance of a 15-mil wet film applied to a 2A or 5C Leneta Chart or equal and dried for a minimum of 24 hours shall be 84% minimum for the white paint and 50% minimum for the yellow paint.

1048.22.1.5 Acceptance.

1048.22.1.5.1 Except as noted, each batch or lot of paint shall be sampled and approved by the Engineer prior to use.
1048.22.1.5.2 No paint shall be used that is more than 15 months old.

1048.22.1.5.3 In addition to the requirements of Sec 1048.1.1, the certification supplied by the manufacturer shall include reference to the specific NTPEP test deck to which the paint formulation was applied, including NTPEP identification numbers and report numbers.

1048.22 Cold Weather Waterborne Pavement Marking Paint.

1048.22.2 Description. These specifications cover waterborne traffic paint for application on bituminous or Portland cement concrete pavements by department owned spray equipment at application temperatures of 35 to 150°F (2 to 66°C). The paint shall be capable of receiving and holding glass beads for producing reflectorized traffic markings.

1048.22.2.1 Materials. The paint shall not contain more than 500 ppm lead and/or more than 780 ppm chromium based on dry weight and shall have limited Volatile Organic Content (VOC), as noted herein.

1048.22.2.2.1 Acrylic Emulsion Polymer. The acrylic emulsion polymer used in the manufacture of the paint shall be Dow Fastrack XSR or preapproved equivalent. Later generation acrylic emulsions may be substituted only after concurrence of the Chemical Laboratory Director.

1048.22.2.2.2 General. The finished paint shall be formulated and manufactured from first-grade materials and shall be a fast drying, water based, acrylic resin type paint capable of withstanding air and roadway temperatures without bleeding, staining, discoloring, or deforming. The dried paint film shall be capable of maintaining its original dimensions and placement without chipping, spalling, or cracking. In addition, it shall not deteriorate because of contact with sodium chloride, calcium chloride, mild alkalies and acids, or other ice control materials, or oil, gasoline or diesel fuel drippings from vehicles.

1048.22.2.2.3 Maintained retroreflectivity. Photometric quantity to be measured is coefficient of retroreflective luminance (RL) in accordance with the requirements of ASTM E1710 for 30-meter geometry. The average RL for concrete and asphalt surfaces shall be expressed in millicandelas per square meter per lux (milicandelas/m²/lux) and shall be at least 75 for 30 meter geometry, when measured in the wheel path area.

1048.22.2.4 Mixed Paint. The mixed paint shall conform to the following requirements.

1048.22.2.4.1 The paint shall be strained before filling, using a screen or strainer not coarser than 40 mesh or equivalent.

1048.22.2.4.2 The volatile content of the finished paint shall contain less than 150 grams of volatile organic matter per liter in accordance with ASTM D3960.

1048.22.2.4.3 The paint shall have the following properties:

1048.22.2.4.3.1 Physical Properties.

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight per Gallon @77°F, lbs</td>
<td>Report</td>
</tr>
<tr>
<td>Viscosity, KU</td>
<td>75-92</td>
</tr>
<tr>
<td>Grind (Hegman Gage), min.</td>
<td>3</td>
</tr>
<tr>
<td>Laboratory Dry Time, ASTM D 711, minutes, max.</td>
<td>10</td>
</tr>
<tr>
<td>Dry Through Time, minutes, max</td>
<td>150</td>
</tr>
</tbody>
</table>
1048.22.2.4.3.2 Color. For white the color shall closely match Color Chip 37925 of Federal Standard 595b. For yellow, the color shall closely match Color Chip 33538 of Federal Standard 595b. Color determination will be made for markings and the diffuse daytime color of the markings shall conform to the below CIE Chromaticity coordinate limits. Color determination for liquid marking materials will be made over the black portion of a 2A or 5C Leneta Chart (or equal) at least twenty-four (24) hours after application of a 15- mil wet film. Color readings will be determined in accordance with the requirements of ASTM E1349 using CIE 1931 2° standard observer and CIE standard illuminant D65.

<table>
<thead>
<tr>
<th>Color</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>0.334</td>
<td>0.357</td>
<td>0.334</td>
<td>0.297</td>
</tr>
<tr>
<td>Yellow</td>
<td>0.531</td>
<td>0.483</td>
<td>0.531</td>
<td>0.429</td>
</tr>
</tbody>
</table>

1048.22.2.4.3.3 Flexibility. The paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952B.

1048.22.2.4.3.4 Water Resistance. The paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952B.

1048.22.2.4.3.5 Freeze-Thaw Stability. The paint shall show no coagulation or change in consistency greater than 10 Kreb Units, when tested in accordance with Federal Specification TT-P-1952B.

1048.22.2.4.3.6 Heat Stability. The paint shall show no coagulation, discoloration or change in consistency greater than 10 Kreb Units, when tested in accordance with Federal Specification TT-P-1952B.

1048.22.2.4.3.7 Dilution Test. The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.

1048.22.2.4.3.8 Storage Stability. After 30 days storage in three-quarters filled, closed container, the paint shall show no caking that cannot be readily remixed to a smooth, homogeneous state, no skinning, livering, curdling, or hard settling. The viscosity shall not change more than 5(10) Kreb Units from the viscosity of the original sample.

1048.22.2.4.3.9 Contrast Ratio. The minimum contrast ratio (hiding power) shall be 0.99 for White and 0.98 for Yellow when drawn down with a 0.015 film applicator on a 2A or 5CLeneta Chart (or equal) and airdried for 24 hours. Contrast Ratio = Black/White.

1048.22.2.4.3.10 Reflectance. The daylight directional reflectance of the white paint shall not be less than 87 percent and not less than 50 percent for yellow paint of a 15 mil wet film applied to a 2A or 5C Leneta Chart (or equal). After drying for a minimum of 24 hours measure the reflectance of the paint over the black portion of the chart using colorimeter, ASTM E 1347.

1048.22.2.4.3.11 Bleeding. The paint shall have a minimum-bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952B. The asphalt saturated felt shall conform to ASTM D 226 for Type I.

1048.22.2.4.3.12 Dry Through Time. The paint shall be applied to a non-absorbent substrate at a wet film thickness of 15 ± 1 mils and placed in a humidity chamber controlled at 90 ± 5 percent R.H. and 72.5 ± 2.5°F. The dry through time shall be determined according to ASTM D 1640.
1048.22.2.5 Acceptance. The County reserves the right to make field tests of material after receipt of bids, but prior to award to determine the paint’s suitability for application in its equipment and for purposes of determining compliance with drying time requirements of this specification.

1048.22.2.5.1 Stability in Storage. After storage for periods up to twelve (12) months from the date of manufacture, the paint shall comply with the following requirements: a) The pigment shall not settle badly or cake in the container, nor shall the paint skin or thicken in storage sufficiently to cause an undesirable change in consistency, nor show spoilage. b) The paint shall comply with all other provisions of these specifications and be capable of being re-dispersed with a paddle or mixer to a smooth uniform condition of usable consistency.

SECTION 1048.23 TEMPORARY RAISED PAVEMENT MARKERS

1048.23.1 Temporary raised pavement markers shall consist of a flexible plastic body with prismatic retro reflective sheeting bonded to one or two vertical surfaces to reflect incident light from a single or opposite directions. An adhesive shall be laminated to the bottom surface of the marker body to provide for bonding the marker to the pavement. The marker shall be fitted with a flexible cover, which protects the marker during the application of the micro-surfacing or chip seal treatment. The cover shall be fastened to the body with two (2) staples.

1048.23.2 Color. The retro reflective material shall display either white or yellow as specified. The yellow markers shall have retro reflective material on both sides. The white markers shall have the retro reflective material on one (1) side.

1048.23.3 Reflectivity. The coefficient of luminous intensity and specific intensity shall not be less than the following table. The Contractor shall supply certified test reports, in triplicate to the Engineer that represents the submitted lot and meets or exceeds the requirements specified.

<table>
<thead>
<tr>
<th>Observation Angle (degrees)</th>
<th>Horizontal Entrance Angle (degrees)</th>
<th>Coefficient of Luminous Intensity (mcd)</th>
<th>Specific Intensity (cd/ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>+4 or -4</td>
<td>White 320</td>
<td>Yellow 230</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White 3.5</td>
<td>Yellow 2.5</td>
</tr>
</tbody>
</table>

1048.23.4 Adhesive. The adhesive shall be factory-applied to the base leg bottom, 0.125 inch thick, and shall have a minimum width by length of 0.75 inch by 4.0 inches on 1 inch wide release paper. The release paper shall remain on the marker until immediately before desired application. The adhesive shall be a solid compound with high initial bond strength and adhesion capable of retaining the marker in its installed position on the pavement.

1048.23.5 Dimensions.

1048.23.5.1 Body. The body shall be "L" shaped with a nominal wall thickness of 0.060 inch. The vertical wall shall be a minimum height by width of 2.0 inches by 4.0 inches. The base leg shall be a minimum width by length of 1.0 inch by 4.0 inches. The marker shall be formed of a high impact-resistant thermoplastic polyurethane or equivalent capable of presenting a strong white or yellow standard traffic daytime color.

1048.23.5.2 Sheeting. The sheeting shall be a prismatic retro reflective ultraviolet stabilized acrylic film with the micro prisms formed into the back surface of the film and is 0.10 inch thick. The sheeting shall be affixed along the top of the vertical section of the marker inside the I-beam on one or both sides. The back surface shall be metallized and coated with an adhesive, which will bond the sheeting securely to the marker body.

1048.23.5.3 Staples. The staples shall be 0.03 inch diameter galvanized high carbon steel wire with a 0.5 inch wide crown. The two (2) staples shall be attached to the cover in such a manner than the cover will remain in place and
protect the reflective sheeting. Stapling or clipping devices used to retain the protective cover shall not protrude through the reflective material.

1048.23.5.4 Cover. The cover shall be in the shape of an inverted "U" with a minimum wall thickness of 0.03 inch. The cover shall be transparent and colorless flexible polyvinyl chloride that shall be removed immediately after paving. The reflective material shall be protected with an easily removable cover of heat resistant material capable of withstanding and protecting the reflective material from the application of 400°F liquid asphalt.

1048.23.6 Durability.

1048.23.6.1 The body and cover shall have a Shore A hardness of not less than 80, as tested in accordance with ASTM D 2240.

1048.23.6.2 The body shall have a minimum tensile strength of 4,600 psi. The cover shall have a minimum tensile strength of 1,900 psi. Tensile strengths shall be determined in accordance with ASTM D 412.

1048.23.6.3 The adhesive pad shall be installed in accordance with manufacturer’s guidelines and the marker shall adhere to the road during its' intended use.

1048.23.6.4 Packaging. The brand name and manufacturer shall be stamped or indelibly printed on each container. The markers shall be packaged in a manner that ensures the vertical wall remains within 15 degrees of perpendicular to the base of the marker.

1048.23.6.5 Appearance. The markers, as applied, shall be in good condition, free of cracks or tears in the marker body or reflective material.

1048.23.7 Approval.

1048.23.7.1 Prior to approval and use of temporary raised pavement markers, the manufacturer shall submit material specifications, application specifications and samples of the markers for evaluation and possible testing. The quantity, color and reflective type submitted shall be at the discretion of the Engineer. Following the testing and evaluation of the marker, satisfactory marker will be placed on a prequalified list.

1048.23.7.2 Temporary Raised Pavement Markers appearing on the prequalified list may be accepted on the basis of manufacturer, product trade name, and color as shown in the prequalified list, so long as satisfactory performance is obtained in the field.

SECTION 1048.24 PREFORMED REMOVABLE PAVEMENT MARKING TAPE

1048.24.1 General. Preformed removable pavement marking tape shall be capable of being removed and shall leave no objectionable or misleading image or damage to the pavement after removal.

1048.24.2 Reflectance. Tape shall have a minimum specific luminance as shown in the table below, expressed as millicandelas per footcandle per square foot. The tape shall be applied to an 8 x 36 inch panel in a longitudinal orientation and measured in accordance with MoDOT Test Method TM 8 at an 86-degree entrance angle.

<table>
<thead>
<tr>
<th>Observation Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>1750</td>
<td>1300</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>1250</td>
<td>800</td>
</tr>
</tbody>
</table>
1048.24.3 Adhesive. Tape shall have a pre-coated pressure sensitive adhesive requiring no activation procedures. The adhesive shall be resistant to normal roadway chemicals or materials.

1048.24.4 Durability. The tape shall be weather-resistant and show no appreciable fading, lifting or shrinkage during the tape’s useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method No. 141, Method 6192, for 1000 cycles, using a CS-17 wheel and 1000-gram load shall not expose the backing material over more than five percent of the abraded area.

SECTION 1048.25 PREFORMED SHORT-TERM PAVEMENT MARKING TAPE

1048.25.1 Reflectance. The tape shall have a minimum specific luminance as shown in the table below, expressed as millicandels per footcandle per square foot. The tape shall be applied to an 8 x 36 inch panel in a longitudinal orientation and measured in accordance with MoDOT Test Method TM 8 at an 86-degree entrance angle.

<table>
<thead>
<tr>
<th>Observation Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>1350</td>
<td>800</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>750</td>
<td>500</td>
</tr>
</tbody>
</table>

1048.25.2 Adhesive. Tape shall have a pre-coated pressure sensitive adhesive requiring no activation procedures. Adhesive shall be resistant to normal roadway chemicals or materials.

1048.25.3 Durability. The tape shall be weather-resistant and show no appreciable fading, lifting or shrinkage during the tape’s useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method No. 141, Method 6192, for 1000 cycles, using a CS-17 wheel and 1000-gram load shall not expose the backing material over more than five percent of the abraded area.

SECTION 1048.30 DROP-ON GLASS BEADS

1048.30.1 General. When tested in accordance with MoDOT Test Method TM 70 for water resistance, the beads shall show no readily discernible dulling and the amount of 0.1 normal hydrochloric acid needed to titrate the filtrate shall not exceed 4.5 mL. When tested in accordance with MoDOT Test Method TM 70 for calcium chloride and sodium sulfide resistance, the beads shall show no readily discernible darkening or dulling.

1048.30.2 Type P Drop-On Glass Beads. Type P beads shall be manufactured from glass of a composition that is highly resistant to traffic wear and to the effects of weathering. If coating is required to meet the performance requirements for the specific marking material used, the beads shall be coated to ensure satisfactory embedment and adhesion.

1048.30.2.1 Refractive Index. Type P beads shall have a minimum refractive index of 1.51 when tested in accordance with AASHTO M 247.

1048.30.2.2 Roundness. All Type P beads passing the No. 30 sieve shall have a minimum of 75 percent true spheres when tested in accordance with ASTM D 1155 or AASHTO PP-74. All Type P beads retained on the No. 20 and No. 30 sieves shall have a minimum of 80 percent true spheres as determined by ASTM D 1155 or AASHTO PP-74.

1048.30.2.3 Gradation. Type P beads shall meet the following gradation requirements when tested in accordance with ASTM D 1214.
### Type P Bead Gradation Requirements

<table>
<thead>
<tr>
<th>U. S. Standard Sieve No.</th>
<th>Percent Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>3-10</td>
</tr>
<tr>
<td>30</td>
<td>15-35</td>
</tr>
<tr>
<td>50</td>
<td>45-75</td>
</tr>
<tr>
<td>70</td>
<td>0-10</td>
</tr>
<tr>
<td>Pan</td>
<td>0-5</td>
</tr>
</tbody>
</table>

#### 1048.30.3 Type L Drop-On Glass Beads

Type L beads shall be embedment coated and manufactured from glass of a composition that is highly resistant to traffic wear and to the effects of weathering. The beads shall be in accordance with AASHTO M 247, Type 1, except as follows.

**1048.30.3.1 Coating.** The beads shall be coated to ensure satisfactory embedment and adhesion when applied to uncured traffic marking material. The coating shall be tested in accordance with MoDOT Test Method TM 70.

**1048.30.3.2 Roundness.** Type L beads shall have a minimum of 80 percent rounds per screen for the two highest sieve quantities, and no more than 3 percent angular particles per screen, as determined by ASTM D 1155 or AASHTO PP-74. The remaining sieve fractions shall be determined by ASTM D 1155 or AASHTO PP-74 to be no less than 75 percent rounds.

**1048.30.3.3 Gradation.** Type L beads shall meet the following gradation requirements when tested in accordance with ASTM D 1214:

#### Type L Bead Gradation Requirements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 12</td>
<td>100</td>
</tr>
<tr>
<td>No. 14</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>80 - 95</td>
</tr>
<tr>
<td>No. 18</td>
<td>10 - 40</td>
</tr>
<tr>
<td>No. 20</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

#### 1048.30.4 Type 1 Drop-On Glass Beads

Type 1 beads shall be moisture-resistant and manufactured from glass of a composition that is highly resistant to traffic wear and to the effects of weathering. Glass beads shall be in accordance with AASHTO M 247, Type 1.

### SECTION 1048.41 EXTRUDED THERMOPLASTIC PAVEMENT MARKING

#### 1048.41.1 Thermoplastic Compound.

**1048.41.1.1** Thermoplastic material shall be in accordance with AASHTO M 249, shall be formulated with alkyd resin and shall have a maximum specific gravity of 2.35.

**1048.41.1.2** The thermoplastic material, when melted and ground to the finenesses listed below, shall not have leachable lead or chromium levels greater than 4.0 ppm when tested by the Toxicity Characteristic Leaching Procedure (TCLP, USEPA Method 1311/6010). TCLP leachability testing shall be performed at each of the following levels of fineness:

(a) Coarse Grind – 100 percent passing the 3/8 inch sieve and retained on the 1/4 inch sieve.

(b) Medium Grind – 100 percent passing the No. 8 sieve and retained on the No. 20 sieve.
(c) Fine Grind – 100 percent passing the No. 30 sieve.

1048.41.2 Primer. Primer, if required, shall be in accordance with the manufacturer’s recommendations.

1048.41.3 Testing. The thermoplastic material shall be tested in accordance with AASHTO M 249 and AASHTO T 250, as applicable.

1048.41.4 Packaging and Marking. Each package shall be labeled or marked with the color of the material, name of the manufacturer, date of manufacture, batch number, type of material (alkyd), net weight of contents and the temperature to which the material shall be heated for application. Granular thermoplastic material may be packaged in thermally degradable bags that are designed to melt with the material, provided the label states the bag does not adversely affect the application or performance of the thermoplastic material.

1048.41.5 Drop-On Glass Beads. Drop-on glass beads shall be in accordance with Sec 1048.30.2.

SECTION 1048.42 HOT SPRAY THERMOPLASTIC PAVEMENT MARKING

1048.42.1 Thermoplastic Compound.

1048.42.1.1 Except where otherwise specified, tests shall be performed in accordance with AASHTO T 250.

1048.42.1.2 The thermoplastic material shall be formulated with alkyd resin and intermix beads for application by the hot spray process at a 45-mil thickness. Intermix beads shall be in accordance with Sec 1048.30.4. Drop-on glass beads shall be in accordance with Sec 1048.30.2.

1048.42.1.3 The thermoplastic material shall be in accordance with Sec 1048.41.1.2.

1048.42.1.4 The binder shall consist of a mixture of synthetic alkyd resins. The total binder content of the thermoplastic compound shall be well distributed through the compound. The binder shall be free from all foreign material or ingredients that would cause bleeding, staining or discoloration. The binder shall be 25 percent minimum by weight of the thermoplastic compound as determined by ashing.

1048.42.2 Pigment.

1048.42.2.1 White. The pigment used for the white thermoplastic compound shall be a minimum of 93 percent pure titanium dioxide.

1048.42.2.2 Yellow. The pigments for the yellow thermoplastic compound shall be nontoxic, heat resistant and color-fast yellows, golds and oranges, which shall produce a compound meeting the requirements of Federal 595 Color No. 33538.

1048.42.2.3 Filler. Any filler that is insoluble in 6 N hydrochloric acid shall be of such a particle size as to pass a No. 100 sieve.

1048.42.3 Mixed Compound.

1048.42.3.1 Reflectance and Color. The mixed thermoplastic compound, after heating 2.2 pounds in an open, friction-top quart can with the rim removed for 4 hours ± 5 minutes at 375 ± 3°F and cooling at 77°F, shall meet the requirements below for daylight reflectance and color when tested using a color spectrophotometer with 45-degree circumferential/0-degree geometry, illuminant C and 2-degree observer angle. The color instrument shall measure the visible spectrum from 380 to 721 nm with a wavelength measurement interval and spectral bandpass of 10 nm.
### 1048.42.3.2 Specific Gravity. The specific gravity of the thermoplastic material shall not exceed 2.15 as determined by the kerosene displacement method.

### 1048.42.3.3 Softening Point. After heating the thermoplastic as described in Sec 1048.42.3.1 and testing in accordance with ASTM E 28, the material shall have a minimum softening point of 180°F, as measured by the ring and ball method.

### 1048.42.3.4 Tensile Bond Strength. After heating the thermoplastic as described in Sec 1048.42.3.1, the tensile bond strength to unprimed, sandblasted Portland cement concrete block, 0.0625 inch thick film drawdown at 375°F, test at 75 ± 2°F shall exceed 180 psi, when tested in accordance with ASTM D 4796.

### 1048.42.3.5 Impact Resistance. After heating the thermoplastic as described in Sec 1048.42.3.1, the impact resistance shall be a minimum of 50 inch-pounds with no cracks or bond loss when 0.0625 inch thick film drawdown is made at 375°F on an unprimed, sandblasted Portland cement concrete block, male indenter 5/8 inch, no female die, tested at 75 ± 2°F, when tested in accordance with ASTM D 2794.

### 1048.42.3.6 Yellowness Index. The unaged white thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with AASHTO T 250.

### 1048.42.4 Packaging. The thermoplastic material shall be packaged in suitable containers that will not adhere to the product during shipment and storage. Each container shall designate the color, type of binder, spray and user information. Each package shall be marked with the name of the manufacturer, type of material, month and year the material was packaged, lot number and the minimum/maximum temperature to which the material shall be heated for application.

### SECTION 1048.43 EPOXY PAVEMENT MARKING MATERIALS

#### 1048.43.1 General. Epoxy pavement marking material shall not contain toxic heavy metals. The material shall be two-component, 100 percent solids and formulated and tested to perform as a pavement marking material with glass beads applied to the surface. The two components shall be epoxy resin and an amine curing agent.

#### 1048.43.2 Epoxy Types. Type A epoxy marking material shall be a slow cure material and Type B epoxy marking material shall be a fast cure material.

#### 1048.43.3 Toxicity. Upon heating to application temperature, the material shall not release fumes that are toxic to persons or property. Upon curing, the material shall be completely inert, with all components fully reacted and environmentally benign.

#### 1048.43.4 No Track Time. The material shall have a no-track time between 10 and 45 minutes for Type A and 10 minutes or less for Type B, when mixed in the proper proportions and applied at a 25-mil wet film thickness at 75 ±
2°F with the proper application of glass beads and when tested in accordance with ASTM D 711. The material shall fully cure under a constant surface temperature of 32°F or above.

1048.43.5 Adhesion to Concrete. The pavement marking material shall have a high degree of adhesion to the concrete surface such that there is a 100 percent concrete failure when tested in accordance with ACI 503, Appendix A. 1. The prepared specimens shall have a film thickness of 15 ± 1 mil and shall be applied to concrete with a minimum compressive strength of 4000 psi. The concrete surface shall be 90 ± 2°F when the material is applied. The applied material shall be cured for 72 hours at 75 ± 2°F before performing the test.

1048.43.6 Hardness. The material shall have a minimum Shore D Hardness of 75 when tested in accordance with ASTM D 2240.

1048.43.7 Tensile Strength. The material shall have a minimum tensile strength of 5000 psi after 72 hours of cure at 75 ± 2°F when tested in accordance with ASTM D 638.

1048.43.8 Compressive Strength. The material shall have a minimum compressive strength of 10,000 psi after 72 hours of cure at 75 ± 2°F when tested in accordance with ASTM D 695.

1048.43.9 Abrasion Resistance. The material shall have a maximum abrasion resistance of 150 mg at 15 ± 1 mil thickness after 72 hours of cure and with a CS-17 wheel under a load of 1000 grams for 1000 cycles, when tested in accordance with ASTM C 501.

1048.43.10 Yellowness Index. The material shall have a maximum yellowness index of 6 before the QUV test and a maximum of yellowness index of 23 after the 72-hour QUV test, when tested in accordance with ASTM D 1925.

1048.43.11 Color. The finished white color shall be free from tint, furnishing good opacity and visibility under both daylight and artificial light. The finished yellow color shall closely match Federal Test Standard 595 - Color Chip Number 13538.

1048.43.12 Drop-on Glass Beads. Type P glass beads shall be in accordance with Sec 1048.30.2.

1048.43.13 Qualification. In addition to the requirements of Sec 1048.1.1, the material shall have been field tested at NTPEP test decks in a northern, wet climate region for a minimum of six months. The maintained retroreflectivity and durability shall be in accordance with the following requirements after being installed on at least one NTPEP test deck for a minimum of six months, including December, January and February.

1048.43.13.1 Maintained Retroreflectivity. Photometric quantity to be measured will be the coefficient of retroreflective luminance (R,) in accordance with ASTM E 1743 for 15-meter geometry or ASTM E 1710 for 30-meter geometry. The average R, for concrete and asphalt surfaces shall be expressed in millicandela per footcandle per square foot and shall be at least 125 for 15-meter geometry or 100 for 30-meter geometry, when measured in the wheel path area.

1048.43.13.2 Durability. Paint shall have a durability rating of at least 5 for both concrete and asphalt surfaces when tested in the wheel path area of the NTPEP test deck.

1048.43.14 Packaging. The manufacturer’s name and address, product name, color, manufacturing date, date of expiration and if the material is Part A or B shall be visible on the containers. In addition to the requirements of Sec 1048.1.1, the certification supplied by the manufacturer shall include reference to the specific NTPEP test deck to which the paint formulation was applied, including NTPEP identification numbers and report numbers.

SECTION 1048.44 ACRYLIC AND WATERBORNE PAVEMENT MARKING
1048.44.1 Acrylic Copolymer Fast Dry Pavement Marking Paint. Acrylic Copolymer Fast Dry Pavement Marking Paint shall be in accordance with Sec 1048.22.1.

1048.44.2 Standard Acrylic Waterborne Pavement Marking Paint.

1048.44.2.1 Description. Standard acrylic waterborne pavement marking paint shall be capable of receiving and holding glass beads for producing retroreflective pavement marking.

1048.44.2.2 Material. The paint shall contain no more than 3200 ppm lead or more than 800 ppm chromium, based on dry weight.

1048.44.2.2.1 General. The finished paint shall be formulated and manufactured from quality material and shall be a fast-drying, water-based, acrylic resin-type paint capable of withstanding air and roadway temperatures without bleeding, staining, discoloring or deforming. The dried paint film shall be capable of maintaining original dimensions and placement without chipping, spalling or cracking. The dry paint film shall not deteriorate from contact with normal roadway chemicals or materials.

1048.44.2.2.2 Acrylic Emulsion Polymer. The acrylic emulsion polymer used in the manufacture of the paint shall be Rohm & Haas E-2706, Dow DT211 or equal. Later generation acrylic emulsions may be substituted as approved by the Engineer.

1048.44.2.2.3 Durability Testing. The provisions of Sec 1048.44.3.2.3 will apply.

1048.44.2.2.3.1 Maintained Retroreflectivity. Photometric quantity to be measured will be the coefficient of retroreflective luminance (RL) in accordance with the requirements of ASTM E 1743 for 15-meter geometry or ASTM E 1710 for 30-meter geometry. The average RL for concrete and bituminous surfaces shall be expressed in milli candelas/lux/m2 and shall be at least 100 for 15-meter geometry or 75 for 30-meter geometry, when measured in the wheel path area.

1048.44.2.2.3.2 Durability. Paint shall have a durability rating of at least 4 on both concrete and bituminous surfaces when tested in the wheel path area of the NTPEP test deck.

1048.44.2.3 Mixed Paint. The provisions of Sec 1048.44.3.3 shall apply.

1048.44.2.4 Acceptance.

1048.44.2.4.1 Except as noted, each batch or lot of paint shall be sampled and approved by the Engineer prior to use.

1048.44.2.4.2 No paint shall be used that is more than 15 months old.

1048.44.2.4.3 In the addition to the requirements of Sec 1048.1.1, the certification supplied by the manufacture shall include reference to specific NTPEP test deck to which the paint formulation was applied, including NTPEP identification numbers and report numbers.

1048.44.3 High Build Acrylic Waterborne Pavement Marking Paint.

1048.44.3.1 Description. Acrylic waterborne pavement marking paint shall be capable of receiving and holding glass beads for producing retroreflective pavement marking.

1048.44.3.2 Material. The paint shall contain no more than 3,200 ppm lead or more than 800 ppm chromium, based on dry weight.
1048.44.3.2.1 General. The finished paint shall be formulated and manufactured from quality material and shall be a fast-drying, water-based, acrylic resin-type paint capable of withstanding air and roadway temperatures without bleeding, staining, discoloring or deforming. The dried paint film shall be capable of maintaining original dimensions and placement without chipping, spalling or cracking. The dry paint film shall not deteriorate from contact with normal roadway chemicals or materials.

1048.44.3.2.2 Acrylic Emulsion Polymer. The acrylic emulsion polymer used in the manufacture of the paint shall be Rohm & Haas HD-21, Dow DT400 or equal.

1048.44.3.2.3 Durability Testing. Determination of conformance to this specification will include, but will not be limited to, the evaluation of test data from NTPEP or other MoDOT approved facilities. The maintained retroreflectivity and durability shall be in accordance with the following requirements after being installed on at least one NTPEP test deck in a northern climate region for at minimum of six months, including December, January and February.

1048.44.3.2.3.1 Maintained Retroreflectivity. Photometric quantity to be measured will be the coefficient of retroreflective luminance (RL) in accordance with the requirements of ASTM E 1743 for 15-meter geometry or ASTM E 1710 for 30-meter geometry. The average RL for concrete and bituminous surfaces shall be expressed in millicandelas per footcandle per square foot and shall be at least 100 for 15-meter geometry or 75 for 30-meter geometry, when measured in the wheel path area.

1048.44.3.2.3.2 Durability. Paint shall have a durability rating of at least 4 for both concrete and bituminous surfaces when tested in the wheel path area of the NTPEP test deck.

1048.44.3.3 Mixed Paint.

1048.44.3.3.1 The paint shall be strained before filling using a screen or a sieving device no coarser than 40 mesh or equivalent.

1048.44.3.3.2 The volatile content of the finished paint shall contain less than 150 grams of volatile organic matter per liter in accordance with ASTM D 3960.

1048.44.3.3.3 The paint shall have the following physical properties:

<table>
<thead>
<tr>
<th>Acrylic Waterborne Pavement Marking Paint Physical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>Viscosity, 77°F, KU</td>
</tr>
<tr>
<td>Grind (Hegman Gage), minimum</td>
</tr>
<tr>
<td>Laboratory Dry Time, ASTM D 711, @ 15 mil, minutes, max.</td>
</tr>
<tr>
<td>Laboratory Dry Time, ASTM D 711, @ 25 mil, minutes, max.</td>
</tr>
<tr>
<td>Dry Through Time, minutes, max.</td>
</tr>
</tbody>
</table>

1048.44.3.3.3.1 Color. For white, the color shall closely match Color Chip 37925 of Federal Standard 595b. For yellow, the color shall closely match Color Chip 33538 of Federal Standard 595b. Color determination will be made for markings and the diffuse daytime color of the markings shall be in accordance with the below CIE Chromaticity coordinate limits. Color determination for liquid marking material will be made over the black portion of a 2A or 5C Leneta Chart or equal, at least 24 hours after application of a 15-mil wet film. Color readings will be determined in accordance with the requirements of ASTM E 1349 using CIE 1931 2-degree standard observer and CIE standard illuminant D65.
### CIE Chromaticity Coordinate Limits (Initial)

<table>
<thead>
<tr>
<th>Color</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>y</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>White</td>
<td>0.334</td>
<td>0.357</td>
<td>0.334</td>
<td>0.317</td>
</tr>
<tr>
<td>Yellow</td>
<td>0.53</td>
<td>0.483</td>
<td>0.53</td>
<td>0.429</td>
</tr>
</tbody>
</table>

**1048.44.3.3.2 Flexibility.** The paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952B.

**1048.44.3.3.3 Water Resistance.** The paint shall conform to Federal Specification TT-P-1952B. There shall be no blistering or appreciable loss of adhesion, softening or other deterioration after examination.

**1048.44.3.3.4 Freeze-Thaw Stability.** The paint shall show no coagulation or change in consistency greater than 10 Kreb Units when tested in accordance with Federal Specification TT-P-1952B.

**1048.44.3.3.5 Heat Stability.** The paint shall show no coagulation, discoloration or change in consistency greater than 10 Kreb Units when tested in accordance with Federal Specification TT-P-1952B.

**1048.44.3.3.6 Dilution Test.** The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.

**1048.44.3.3.7 Storage Stability.** After 30 days of storage in a 3/4 filled, closed container, the paint shall show no caking that cannot be readily remixed to a smooth, homogeneous state, and shall show no skinning, livering, curdling or hard settling. The viscosity shall change no more than 5 Kreb Units from the viscosity of the original sample.

**1048.44.3.3.8 Contrast Ratio.** The minimum contrast ratio (hiding power) shall be 0.96 when drawn down with a 0.005 bird film applicator on a 2A or 5C Leneta Chart or equal and air-dried for 24 hours. The contrast ratio shall be calculated as follows:

\[
\text{Contrast Ratio} = \frac{\text{Black}}{\text{White}}.
\]

**1048.44.3.3.9 Reflectance.** The daylight directional reflectance of a 15-mil wet film, applied to a 2A or 5C Leneta Chart or equal and dried for a minimum of 24 hours, shall be no less than 84 percent for the white paint and no less than 50 percent for the yellow paint.

**1048.44.3.3.10 Bleeding.** The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952B. The asphalt saturated felt shall be in accordance with ASTM D 226 for Type I.

**1048.44.3.3.11 Dry Through Time.** The paint shall be applied to a non-absorbent substrate at a wet film thickness of 15 ± 1 mil and placed in a humidity chamber controlled at 90 ± 5 percent relative humidity and 72.5 ± 2.5°F. The dry through time shall be determined in accordance with ASTM D 1640, except that the pressure exerted shall be the minimum needed to maintain contact with the thumb and film.

**1048.44.3.4 Acceptance.**

**1048.44.3.4.1** Except as noted, each batch or lot of paint shall be sampled and approved by the Engineer prior to use.

**1048.44.3.4.2** No paint shall be used that is more than 15 months old.
1048.45 DURABLE INTERSECTION PAVEMENT MARKINGS.

1048.45.1 Preformed Thermoplastic Material.

1048.45.1.1 General. Pavement marking material shall not contain toxic heavy metals. The material shall be solid, formulated and tested to perform as a pavement marking material with glass beads uniformly throughout the marking.

1048.45.1.2 Toxicity. Upon heating to application temperature, the material shall not release fumes that are toxic to persons or property. Upon curing, the material shall be completely inert, with all components fully reacted and environmentally benign.

1048.45.1.3 Adhesion to Pavement. The pavement marking material shall have a high degree of adhesion to the pavement surface. The product shall be applied per manufactures specification on a clean dry surface.

1048.45.1.4 Abrasion Resistance. The material shall have a maximum abrasion resistance of 150 mg with a CS-17 wheel under a load of 1,000 grams for 1,000 cycles, when tested in accordance with ASTM C 501.

1048.45.1.5 Yellowness Index. The material shall have a maximum yellowness index of 6 before the QUV test and a maximum of yellowness index of 23 after the 72-hour QUV test, when tested in accordance with ASTM D 1925.

1048.45.1.6 Color. The finished white color shall be free from tint, furnishing good opacity and visibility under both daylight and artificial light. The finished yellow color shall closely match Federal Test Standard 595 - Color Chip Number 33538.

1048.45.1.7 Qualification. In addition to the requirements of Sec 1048.1.1, the material shall have been field tested at NTPEP test decks in a northern, wet climate region for a minimum of six months. The maintained retroreflectivity and durability shall be in accordance with the following requirements after being installed on at least one NTPEP test deck for a minimum of six months, including December, January and February.

1048.45.1.8 Maintained Retroreflectivity. Photometric quantity to be measured will be the coefficient of retroreflective luminance (RL) in accordance with ASTM E 1743 for 15-meter geometry or ASTM E 1710 for 30-meter geometry. The average RL for concrete and asphalt surfaces shall be expressed in millicandelas per footcandle per square foot and shall be at least 125 for 15-meter geometry or 100 for 30-meter geometry, when measured in the wheel path area.

1048.45.1.9 Durability. Paint shall have a durability rating of at least 5 for both concrete and asphalt surfaces when tested in the wheel path area of the NTPEP test deck.

1048.45.1.10 Packaging. The manufacturer's name and address, product name, color, manufacturing date, date of expiration of the material. In addition to the requirements of Sec 1048.1.1, the certification supplied by the manufacturer shall include reference to the specific NTPEP test deck to which the product was applied, including NTPEP identification numbers and report numbers.
1048.45.3 Cold Applied Preformed Pavement Intersection Marking Material.

1048.45.3.1 Application. After application, the tape shall be immediately ready to receive traffic.

1048.45.3.2 Composition. Cold applied preformed pavement marking tape shall consist of a mixture of polymeric material and pigments with beads distributed throughout the cross-sectional area and with a reflective layer of glass beads embedded in the surface. The marking shall be capable of adhering to bituminous or concrete surfaces by a flexible conforming backing. A primer may be required to precondition the pavement surface.

1048.45.3.3 Dimensions. The marking tape as supplied shall be free of cracks, and have edges true, straight, and unbroken. The actual width of the rolls of preformed tape shall be no less than the nominal (stated) width and no more than 1/8 inch greater than the nominal width. The length shall be no less than the length stated.

1048.45.3.4 Adhesion. The tape shall be supplied with a precoated factory-applied pressure sensitive adhesive. The marking tape shall have minimum adhesion values as shown in table 2 of ASTM D1000.

1048.45.3.5 Color. The white and yellow marking tape shall conform to the requirements of ASTM D6628.

1048.45.3.6 Reflectance. The tape shall have a minimum specific luminance as shown for White and Yellow per ASTM D 4505, expressed as millicandelas /m2/lux. The tape shall be applied to an 8 x 36 inch panel per instrument recommendation for pavement marking tape and measured in accordance with MoDOT Test Method TM 8 at prescribed CEN geometry.

1048.45.3.7 Index of Refraction. The glass beads mixed into the pliant polymer shall have a minimum index of refraction of 1.50 when tested by the oil immersion method. If ceramic elements are used in the pavement marking, the ceramic elements shall have a minimum index of refraction of 1.70 when tested using the liquid oil immersion method. Ceramic beads with an index of refraction greater than 1.80 shall not be used.
SECTION 1049
PRECAST CONCRETE BOX CULVERTS

1049.1 Scope. These specifications cover precast concrete box culverts.

1049.2 Acceptance. Unless otherwise specified in the contract, acceptance of precast units will be on the basis of tests of material and inspection of the completed product. Acceptability of all types of sections covered by these specifications will be determined by the material tests required in Sec 1049.3, by crushing tests on concrete cores or cured concrete cylinders; by absorption tests on selected samples of concrete from the wall of the sections; and by inspections of the finished sections, including quantity and placement of reinforcement, to determine conformance with these specifications and freedom from defect.

1049.3 Material.

1049.3.1 Cement. Cement shall be in accordance with Sec 1019. Fly ash or GGBFS may be used to replace cement in accordance with Sec 501.

1049.3.2 Fly Ash. Fly ash shall be in accordance with Sec 1018.

1049.3.3 Ground Granulated Blast Furnace Slag. Ground granulated blast furnace slag shall be in accordance with the requirements of Sec 1017.

1049.3.4 Aggregate. Fine and coarse aggregate for the concrete mixture shall be in accordance with Sec 1005, except the requirements for gradation and percent passing the No. 200 sieve will not apply.

1049.3.5 Steel Reinforcement. Reinforcement shall be in accordance with Sec 1036.3.

1049.3.6 Concrete Mixture. The aggregate shall be sized, graded, proportioned and thoroughly mixed in such proportions of cement and water, as will produce a homogeneous concrete mixture of such quality that the units will conform to the test and design requirements. Admixtures or blends may be used with approval from the Engineer. The proportion of Portland cement in the mixtu re shall be no less than 470 pounds per cubic yard of concrete. Fly ash may be used to replace cement in accordance with Sec 501, except approved Class C or F fly ash may be substituted for a maximum of 25% of Type I or II cement on an equivalent weight basis.

1049.4 Design.

1049.4.1 Except as otherwise specified herein, the precast concrete box sections for the culvert shall be in accordance with AASHTO M 259 for culverts with 2 feet or more of cover, or AASHTO M 273 for culverts with less than 2 feet of cover with both subject to HS20 live loading, Table 1.

1049.4.2 Substituted precast concrete box culvert sections shall be designed for the earth cover shown on the plans for the cast-in-place box culvert and shall be equal in height and cross sectional area or as approved by the Engineer.

1049.4.3 The manufacturer may request approval of modified designs which differ from the designs in AASHTO M 259 or AASHTO M 273. The request for such modified or special designs shall fully describe any deviations from those standards, including a drawing showing wall thickness, concrete design strength, the type, size and placement of reinforcement, and inside or outside dimensions of both of the box sections.

1049.4.4 The minimum barrel length for box or end section shall be 2 feet.
1049.4.5 End sections may be precast or cast-in-place. If precast, the barrel, floor and wing walls shall be cast as an integral unit. In either case the end sections shall be constructed to the same dimensions, shapes, and with the same reinforcement as shown on the plans for cast-in-place culvert.

1049.4.6 Segmented end sections may be provided, but will be considered a modified design and will require approval as such.

1049.4.7 Toe walls shall be provided on both the upstream and downstream ends as shown on the plans and may be cast-in-place or precast. Precast toe walls shall be connected to the end section floor.

1049.5 Manufacture.

1049.5.1 Curing shall be in accordance with the applicable provisions of Sec 1026 until the concrete has developed the specified compressive strength.

1049.5.2 Hot or cold weather concreting and concrete testing equipment shall be in accordance with Sec 703.
SECTION 1050
LUMBER, TIMBER, PILING, POSTS AND POLES

1050.1 Scope. This specification covers wood products as defined in the AWPA Standards.

1050.2 Posts.

1050.2.1 Posts and Blocks for Guardrail. Posts and blocks for guardrail shall be rectangular, standard rough sawn and of the size and length shown on the plans. Posts and blocks shall be pressure treated in accordance with Sec 1050.6. All framing and boring shall be completed before treatment. Douglas Fir shall be "Dense No. 1 Structural Grade" in accordance with Paragraph 131- bb of the current Standard Grading Rules for West Coast Lumber. Southern Pine shall be "No. 1 Dense Grade" in accordance with Paragraph 406 of the current Standard Grading Rules for Southern Pine Lumber.

1050.2.2 Posts for Fence. Posts for fence shall be round and of the sizes and lengths shown on the plans. Posts shall be pressure-treated as shown in Table I for the noted species. Other preservatives and wood species shall be in accordance to applicable AWPA Standards. Allowable tolerances for size and length will be as follows:

<table>
<thead>
<tr>
<th>Fence Post Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
</tr>
<tr>
<td>≤ 4 inch diameter</td>
</tr>
<tr>
<td>&gt; 4 inch diameter</td>
</tr>
<tr>
<td>All Lengths (any diameter)</td>
</tr>
</tbody>
</table>

1050.2.2.1 Grade. Wood for posts shall be sound, free of decay, excessive knots and of end splits and seasoning checks that might affect serviceability. Posts shall be free of multiple crooks, except crooks in one plane only in accordance with Sec 1050.2.2.2 will be permitted.

1050.2.2.2 Straightness. A straight line drawn from the center of one end of the post to the center of the opposite end shall not deviate from the longitudinal axis of the post at any point more than one percent of the length of the post.

1050.2.2.3 Manufacture. Posts shall be clean peeled to remove all bark, except that strips of inner bark no more than 1/2 inch wide or more than 3 inches long will be permitted to remain on the peeled post. All protruding knots shall be trimmed flush, and all spurs and splinters shall be removed. The natural taper of round posts shall be followed in machine peeling operations. The ends of all posts shall be cut square, except posts to be driven shall be machine-pointed on the small end prior to treatment.

1050.2.3 Posts for One-Strand Access Restraint Cable. Posts for one-strand access restraint cable may be round or rectangular, as shown on the plans. Round posts shall be in accordance with Sec 1050.2.2. Rectangular posts shall be standard rough sawn and of the grade specified in Sec 1050.2.2.1. All posts shall be in accordance with Sec 1050.6.

1050.2.4 Posts for Signs. Posts for signs shall be rectangular, rough sawn or surfaced four sides (S4S), with square cut ends, and shall be of the grade, size and length shown on the plans. Posts shall be pressure-treated in accordance with Sec 1050.6. Other preservatives and wood species shall be in accordance with applicable AWPA Standards. If framing and boring is completed after pressure treatment, field treatment shall be in accordance with Sec 1050.7.

1050.2.4.1 Permanent. Project sign posts shall be treated to Use Category (UC) 4B.

1050.2.4.2 Temporary. Post for temporary use shall be treated to UC 4A.
1050.3 Lumber and Timber.

1050.3.1 Species and Grade Requirements. Unless otherwise specified, lumber and timber to be used as a permanent part of a structure shall be one of the species shown in Table I or other treatable species as specified in the AWPA Standards, and of the grade specified on the plans. Lumber and timber for temporary structures shall be of the species and grades shown on the plans.

1050.3.2 Dressing Requirements. Lumber and timber shall be standard rough sawn or shall be surfaced as specified in the contract. Lumber and timber shall be cut to exact lengths or to permissible variations in lengths shown in the contract documents.

1050.3.3 Treatment. If treatment is specified, lumber and timber shall be pressure-treated in accordance with Sec 1050.6.

1050.4 Electric Substation, Service and Span Wire Assembly Poles.

1050.4.1 Electric Substation and Service Poles. Electric substation and service poles shall be of the length and class specified in the contract documents, and shall be in accordance with ANSI O5.1. Poles shall be pressure treated in accordance with Sec 1050.6. Poles may be gained and drilled in the field after treatment. Areas exposed shall be treated in accordance with Sec 1050.7 before cross-arms or equipment are mounted.

1050.4.2 Span Wire Assembly Poles. Span wire assembly poles shall be of the length specified in the contract and shall be in accordance with ANSI O5.1, Class IV, unless otherwise specified. The poles shall be pressure treated in accordance with Sec 1050.6. All poles shall have a minimum diameter of 6 3/4 inches, measured at the top of the pole.

1050.4.3 Pole Crossarms. The species, grade and treatment of crossarms to be erected on substation and service poles will be shown on the plans.

1050.5 Round Timber Piles.

1050.5.1 Material. All round timber piles shall be in accordance with ASTM D 25, except for size, which shall be in accordance with Table I for the class specified in the contract.

1050.5.2 Chemical Treatment. Piles shall be pressure treated in accordance with Sec 1050.6. Framing and boring will not be required before treatment. Exposed untreated areas resulting from framing of treated piling shall be field treated in accordance with Sec 1050.7. Untreated piles for use in unexposed locations or in temporary bridges shall be of the species approved by the Engineer.

1050.6 Timber Preservatives. Pressure preservative treatment shall be in accordance with current AASHTO Standard M-133.

1050.6.1 Responsibility for Quality. The Contractor shall use preservatives that meet these specifications or the treated material will be subject to rejection, or to approved retreatment with an approved preservative.

1050.7 Care After Treatment. Care shall be taken in handling pressure-treated material to avoid damage. Cant hooks, peavies, pickaroons and end cant hooks shall not be used on the side surfaces of treated material. All handling of treated round stock with pointed tools shall be confined to the ends. If damaged material is permitted for use by the Engineer, or framing at site is required, remediation following current AWPA Standard M4 shall be followed.
1050.8 Inspection Requirements.

1050.8.1 Inspection. All material shall be inspected for compliance with these specifications in accordance with AWPA Standard M2.

1050.8.1.1 Timber products treated within the State of Missouri or within 100 air miles of the border may be inspected by Saint Charles County Highway Department personnel.

1050.8.1.2 The inspection of lumber, timber, piling, posts and poles shall be performed by the supplier or an approved inspection agency, and the cost for inspection shall be at the Contractor’s expense.

1050.8.2 Inspection Agency. An approved inspection agency will be a laboratory, accredited by the American Lumber Standards Committee, P.O. Box 210, Germantown, MD, or an experienced testing laboratory approved by the Engineer. Inspection agencies not accredited by the American Lumber Standards Committee shall submit for approval a resume to the County Engineer. The resume of the agency shall include the agency’s history of inspection of timber and treated products, a listing of state and county highway agencies which have approved the inspection agency and a listing of state and county agencies for which the inspection agency has performed inspection.

1050.9 Certification. The Contractor shall furnish to the Engineer certification from the supplier or inspection agency that the material furnished is in accordance with these specifications. Certification shall include or shall have attached a listing of the material being supplied. Except as noted, the certification shall have attached a certified test report, as detailed in Section 7.2 of AWPA Standard M2, from the supplier or inspection agency attesting to complete compliance with AWPA and these specifications. Electric substation, service and span wire assembly poles will not require certified test reports.

1050.10 Acceptance. Acceptance of material will be based on satisfactory supplier’s certification or inspection agency certifications, and upon results of any tests deemed necessary by the Engineer at destination to ascertain compliance with these specifications.

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>Circumferences and Diameters of Timber Piles, (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length Ft</td>
<td>Class A</td>
</tr>
<tr>
<td></td>
<td>3 ft from Butt</td>
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<tr>
<td></td>
<td>Cir Dia</td>
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<tr>
<td>Up to 50</td>
<td>47</td>
</tr>
<tr>
<td>Over 50</td>
<td>47</td>
</tr>
</tbody>
</table>

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Rev. 7/2020
SECTION 1051
SLOTTED DRAIN

1051.1 Scope. This specification covers slotted drain.

1051.2 Pipe. The pipe portion of the slotted drain shall be 16 gage. The material and fabrication of the pipe shall be in accordance with Sec 1020. The diameter of the pipe shall be as shown on the plans.

1051.3 Slotted Drain Grate Assembly. The grate assembly of Type A, B or C slotted drain shall be fabricated as shown on the plans. The grate assembly shall be 6 inches high unless otherwise specified on the plans.

1051.3.1 Type B and Type C slotted drain grate assemblies shall be fabricated from 3/16 inch thick ASTM A 36 structural steel. The entire grate assembly shall be hot dip galvanized, prior to attachment to the pipe, in accordance with AASHTO M 111.

1051.3.2 Type A slotted drain guide assemblies shall be fabricated from 14 gage galvanized steel meeting the same material requirements as the pipe. The drain guide slot shall be assembled with mechanical interlocks requiring no welding.

1051.4 All coupling devices and other necessary fittings shall be in accordance with Sec 1020.
1052.1 Scope. This specification covers material requirements for metallic soil reinforcement, non-metallic soil reinforcement, concrete facing panels for large block wall systems, and concrete blocks for small block wall systems that are supplied as part of mechanically stabilized earth wall systems.

SECTION 1052.2 METALLIC SOIL REINFORCEMENT

1052.2.1 Scope. This specification covers metallic soil reinforcement and the accompanying attachments utilized in mechanically stabilized earth wall systems.

1052.2.2 Reinforcement Strips. Metallic soil reinforcement strips shall be in accordance with the specifications of the manufacturer of the wall system and the contract documents. The minimum grade of steel for strips and connection devices shall be AASHTO M 270, Grade 36 (AASHTO M 270M, Grade 250).

1052.2.3 Reinforcement Mesh. Metallic soil reinforcement mesh shall be in accordance with the specifications of the manufacturer of the wall system and the contract documents. The mesh, connector bars and connection devices, as a minimum, shall be in accordance with AASHTO M 32. Welding shall be in accordance with AASHTO M 55.

1052.2.4 Fasteners. Fasteners shall consist of either AASHTO M 164 hexagon head bolts or AASHTO M 164 hexagonal cap screws with nuts and washers.

1052.2.5 Galvanizing. All soil reinforcement material, except for fasteners, shall be galvanized in accordance with AASHTO M 111. Fasteners, including bolts, nuts and washers, shall be galvanized in accordance with AASHTO M 232.

1052.2.6 Certification. The manufacturer of the wall system shall certify in writing that the soil reinforcement, connections and fasteners meet the minimum requirements directed by the design and this specification. The Contractor shall provide this certification and any other supporting documentation to the Engineer prior to the material being delivered to the construction site.

SECTION 1052.3 NON-METALLIC SOIL REINFORCEMENT

1052.3.1 Scope. This specification covers non-metallic or geosynthetic soil reinforcement utilized in mechanically stabilized earth wall systems.

1052.3.2 Geogrids. Non-Metallic or geosynthetic soil reinforcement shall be of a polymeric nature and shall consist of a geogrid determined by the wall manufacturer or supplier.

1052.3.2.1 The geogrid shall be dimensionally stable and shall be able to maintain geometry during transport, handling and installation.

1052.3.2.2 The geogrid manufacturer shall maintain a quality control program to ensure that the manufactured material meets the requirements of the index tests shown below. Sampling and conformance testing for the index tests shown in the table shall be done in accordance with ASTM D 4354.
### 1052.3.3 Certification
The manufacturer of geogrid shall certify in writing that the geogrid is in accordance with this specification. The certification shall include the roll numbers and identification, the sampling procedures, the results of the quality control tests along with the tests used, and the Minimum Average Roll Value (MARV) for each roll. This certification and any other supporting documentation shall be provided to the Engineer prior to the material being delivered to the construction site.

### SECTION 1052.4 LARGE BLOCK WALL SYSTEMS - CONCRETE-FACING PANELS

#### 1052.4.1 Scope
This specification covers the concrete facing panels used as part of large block mechanically stabilized earth wall systems.

#### 1052.4.2 Material

##### 1052.4.2.1 Concrete
Concrete material, proportioning, air entraining, mixing, slump and transporting of concrete shall be in accordance with Sec 501, except as noted in this section.

##### 1052.4.2.2 Aggregate
Fine and coarse aggregate for the concrete mixture shall be in accordance with Sec 1005, except that the requirements for gradation and percent passing the No. 200 sieve will not apply.

#### 1052.4.3 Design
The concrete shall be Class A-1, air-entrained, with a minimum compressive strength of 4000 psi at 28 days. No additional admixtures will be permitted unless approved by the Engineer.

#### 1052.4.4 Casting
The panels shall be cast in such a manner that the acceptance criteria of this specification are met. Soil reinforcement connection devices shall not be in contact with or attached to the reinforcing steel in the concrete facing panels.

#### 1052.4.5 Testing

##### 1052.4.5.1 Compression tests shall be performed on a standard 6 x 12 inch test specimen prepared in accordance with AASHTO T 23. Compressive strength testing shall be conducted in accordance with AASHTO T 22.

##### 1052.4.5.2 During the production of the panels, the manufacturer shall randomly sample the concrete in accordance with AASHTO T 141. A single compressive strength sample, consisting of a minimum of four cylinders, shall be randomly selected for every production lot. A production lot will be defined as a group of panels that will be represented by a single compressive strength sample, and shall consist of either 40 panels or a single day's production, whichever is less.

##### 1052.4.5.3 For every compressive strength sample, a minimum of two cylinders shall be cured in the same manner as the panels and tested at seven days or less. The average compressive strength of these cylinders, when tested in accordance with AASHTO T 22, shall represent the initial strength of the concrete. In addition, a minimum of two cylinders shall be cured in accordance with AASHTO T 23 and tested at 28 days. The average compressive strength...
of these cylinders, when tested in accordance with AASHTO T 22, shall represent the compressive strength of the production lot.

1052.4.5.4 Air content testing shall be performed in accordance with AASHTO T 152 or AASHTO T 196. Air content samples shall be taken at the beginning of each day’s production and at the same time as compressive samples are taken to ensure compliance with this specification.

1052.4.5.5 Slump testing shall be performed in accordance with AASHTO T 119. The slump shall be determined at the beginning of each day’s production and at the same time as the compressive strength samples are taken.

1052.4.6 Marking. The date of manufacture, production lot number and piece mark shall be clearly scribed on an unexposed face of each panel.

1052.4.7 Curing. Panels shall be cured in accordance with Sec 1029.6.11.

1052.4.8 Handling, Storage and Shipping. All panels shall be free of chips, discoloration, cracks, fractures, and any other defects determined to be detrimental to the cosmetic value or to the performance characteristics of the panels. The panels shall not be subjected to excessive bending stresses and the panel connection devices and exposed exterior finish shall be protected from damage.

1052.4.9 Tolerances.

1052.4.9.1 Panel Dimensions. Panel connection devices shall be within one inch of the specified dimension. The panel face and thickness dimensions shall be within 1/8 inch of the specified dimension. All other dimensions or items shall be within 1/4 inch of the specified dimensions.

1052.4.9.2 Panel Squareness. Squareness, as determined by the difference between the two diagonals, shall not exceed 1/2 inch.

1052.4.9.3 Panel Surface Finish. Surface defects on smooth formed surfaces measured over a length of 5 feet shall not exceed 1/8 inch. Surface defects on the textured-finish surfaces, measured over a length of 5 feet, shall not exceed 3/8 inch.

1052.4.10 Acceptance.

1052.4.10.1 Compressive Strength. Acceptance of the compressive strength of the concrete facing panels will be based on production lots. Acceptance of the compressive strength of a production lot will occur if the compressive strength test result is equal to or greater than 4000 psi at 28 days. If the compressive strength is less than 4000 psi, the concrete facing panels will be accepted if all of the following criteria are met:

(a) Ninety percent of the compressive strength test results for the overall production exceed 4100 psi at 28 days.

(b) The average of any six consecutive compressive strength test results exceeds 4250 psi at 28 days.

(c) No individual compressive strength test results are below 3600 psi at 28 days.

1052.4.10.2 Other Criteria. Concrete facing panels will not be accepted if any of the following defects are found:

(a) Defects indicating imperfect molding.

(b) Defects indicating honeycombing or open texture concrete.
(c) Cracked or severely chipped panels.

(d) Color variation on front face of panel due to excess form oil or other reasons.

**1052.4.10.3 Documentation.** The manufacturer of the concrete face panels shall certify that the concrete face panels are in accordance with this specification. This certification, copies of test results for all required tests, and any other supporting documentation shall be provided to the Engineer prior to the material being shipped to the construction site.

**SECTION 1052.5 SMALL BLOCK WALL SYSTEMS - CONCRETE BLOCKS**

**1052.5.1 Scope.** This specification covers the concrete blocks used as part of small block mechanically stabilized earth wall systems.

**1052.5.2 Material.**

**1052.5.2.1 Concrete.**

1052.5.2.1.1 Concrete material, proportioning, air entraining, mixing, slump and transporting of concrete shall be in accordance with Sec 501, except as noted in this section.

1052.5.2.1.2 Air-entraining agents, coloring pigments, integral water repellents, finely ground silica and other constituents shall be previously directed as suitable for use and shall be in accordance with applicable ASTM standards, or evidence shall be provided to prove the product is not detrimental to the durability of the concrete blocks or any material customarily used in masonry construction.

**1052.5.2.2 Aggregate.** Fine and coarse aggregate for the concrete mixture shall be in accordance with Sec 1005, except that the requirements for gradation and percent passing the No. 200 sieve will not apply.

**1052.5.3 Design.** The concrete mixture shall be air-entrained and shall have a minimum compressive strength of 4000 psi at 28 days. The design of the mixture shall be submitted to the Engineer and shall be approved before use. No additional admixtures will be permitted unless approved by the Engineer.

**1052.5.4 Finish Color.** Color and finish shall be as shown on the plans and shall be erected with a running bond configuration. If no color or finish is specified on the plans, the Contractor shall provide a color and finish to the Engineer for approval.

**1052.5.5 Testing.**

1052.5.5.1 The manufacturer shall perform compressive strength tests for the concrete blocks on a lot basis with the maximum number of blocks per lot being 2000. The lot shall be randomly sampled in accordance with ASTM C 140. Compressive strength test specimens shall be cored, or shall be in accordance with the saw-cut coupon provisions of Section 5.2.4 of ASTM C 140.

1052.5.5.2 The concrete blocks shall be tested for freeze-thaw durability in accordance with ASTM C 1262. Freeze-thaw durability shall be based on tests from five specimens made with the same material, concrete mix design, manufacturing process and curing process. Tests will be required for every project or for every 10,000 concrete blocks that are provided, whichever requires a greater testing frequency. The specimens shall be in accordance with both of the following provisions:

(a) The weight loss of four out of five specimens at the conclusion of 150 cycles shall not exceed one percent
of the initial weight when tested in water.

(b) The weight loss of each of four of the five test specimens at the conclusion of 50 cycles shall not exceed 1.5 percent of the initial weight when tested in a 3 percent saline solution.

1052.5.6 Curing. Concrete blocks shall be cured in accordance with Sec 1029.6.11.

1052.5.7 Tolerances. Concrete blocks shall be manufactured within the following tolerances:

(a) The length and width of each concrete block shall be within 1/8 inch of the specified dimension.

(b) The height of each concrete block shall be within 1/16 inch of the specified dimension.

(c) When a broken face finish is used, the dimension of the front face shall be within one inch of the theoretical dimension of the concrete block.

1052.5.8 Acceptance.

1052.5.8.1 Compressive strength acceptance of the concrete blocks will be determined on a lot basis. Concrete blocks represented by test coupons that do not reach an average compressive strength of 4000 psi will be rejected.

1052.5.8.2 At the time of delivery to the work site, the concrete blocks shall be in accordance with the following physical requirements:

(a) Minimum compressive strength shall be 4000 psi based on an average of three test coupons.

(b) Minimum compressive strength of an individual test coupon shall be 3500 psi.

(c) Maximum water absorption shall be 5 percent.

1052.5.8.3 All concrete blocks shall be sound and free of cracks or other defects that would interfere with the proper placement of the blocks or significantly impair the strength or permanence of the construction. Minor cracks will be defined as cracks that are no wider than 1/64 inch and no longer than 25 percent of the block height. Minor cracks incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery will not be grounds for rejection.

1052.5.8.4 Any exposed face of a concrete block shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting. Up to 5 percent of a shipment may contain slight cracks or small chips no larger than one inch.

1052.5.8.5 Concrete blocks will be rejected for failure to meet any of the requirements specified above. In addition, any or all of the following defects will be considered sufficient cause for rejection:

(a) Defects indicating imperfect molding.

(b) Defects indicating honeycomb or open texture concrete.

(c) Cracked or severely chipped blocks.

(d) Color variation on front face of blocks due to excess form oil or other reasons.
1052.5.8.6 The manufacturer of the concrete blocks shall certify that the concrete blocks are in accordance with this specification. This certification, copies of test results for all required tests, and any other supporting documentation shall be provided to the Engineer prior to the material being shipped to the construction site.

SECTION 1052.6 COPING AND TOP CAP UNITS.

1052.6.1 Precast or cast-in-place coping for MSE walls shall be constructed with epoxy coated Grade 60 (Grade 420) reinforcement and in accordance with the contract documents. Concrete shall be in accordance with the applicable requirements of Sec 501. The concrete for the coping shall be Class B-2 or B-1.
SECTION 1053
CONCRETE SEALER AND CONCRETE CRACK FILLER

SECTION 1053.1 PENETRATING CONCRETE SEALER

1053.1.1 Scope. This specification covers concrete sealers for the protection of concrete against damage from de-icing chemicals.

1053.1.2 Acceptance. All material under this specification shall be obtained from a source identified on MoDOT's Pre-Accepted List (PAL) designated for this specification. All material under this specification will be inspected and accepted in accordance with Sec 106. ASTM and AASHTO specifications, when referenced, control only the physical and chemical properties of the material.

1053.1.3 The sealer shall be an alkyltrialkoxysilane, with low oligomer and polymer compound content. The chemical composition shall meet the following requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purity</td>
<td>95% minimum monomer by weight</td>
</tr>
<tr>
<td>Solvent</td>
<td>Less than 5% by weight</td>
</tr>
<tr>
<td>Residue</td>
<td>Less than 2% by weight</td>
</tr>
<tr>
<td>Density</td>
<td>Per the manufacturer’s recommendation</td>
</tr>
<tr>
<td>Flash Point</td>
<td>ASTM D93: greater than 125°F</td>
</tr>
<tr>
<td>Dry Time</td>
<td>ASTM D1640 Sec 7.5.1: One hour or less</td>
</tr>
</tbody>
</table>

1053.1.3.1 The ASTM D1640 test shall be performed on a concrete surface. This concrete shall be a mix design called for in Sec 1053.1.3.2. The application rate shall be the same rate specified in Sec 703.

1053.1.3.2 The sealer shall meet the following performance criteria based on a single application at the application rate specified in Sec 703. St. Charles County reserves the right to verify any qualification tests at their expense on any field application. Test specimens shall be produced using either the St. Charles County Class B-2 concrete in accordance with Sec 501 or the concrete mix specified by the test being performed.

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Duration</th>
<th>Max Absorption / Cl-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Immersion</td>
<td>ASTM C642</td>
<td>48 hours</td>
<td>0.5 percent by weight (mass)</td>
</tr>
<tr>
<td>Water Immersion</td>
<td>ASTM C642</td>
<td>50 days</td>
<td>1.5 percent by weight (mass)</td>
</tr>
<tr>
<td>Salt Water Ponding (based on non-abraded specimen)</td>
<td>AASHTO T259</td>
<td>90 days</td>
<td>80% min reduction in Cl- absorption &amp; 0.50 lbs/cu yd Cl- at a depth of 1/2” - 1” max</td>
</tr>
</tbody>
</table>

1053.1.3.3 The sealer shall not permanently stain, discolor or darken the concrete. Application of the sealer shall not alter the surface texture or form a coating on the concrete surfaces.

1053.1.3.4 The sealer shall not leave residue on glass, painted metal or automobiles.

1053.1.3.5 The sealer shall not reduce the bond of pavement markings or reduce the skid resistance of the surface being sealed. Any sealer determined to have these adverse effects will be removed from the prequalified list.

1053.1.3.6 The sealer shall be delivered to the project in unopened containers with the manufacturer’s label identifying the product and with the seal(s) intact. Each container shall be clearly marked by the manufacturer with the following information:
(a) Manufacturer's name and address.

(b) Product name.

(c) Date of manufacture and expiration date.

(d) Lot identification.

(e) Storage requirements.

1053.1.4 Manufacturer and Brand Name Approval. Prior to approval and use of concrete sealers, the manufacturer shall submit to the Engineer a certified test report from an approved testing laboratory showing specific test results conforming to the requirements of these specifications. The certified test report shall also contain the manufacturer’s name, product brand name, lot number and date of manufacture. Upon approval of the certified test report by the Engineer the manufacturer and brand name will be added to MoDOT’s Pre-Accepted List (PAL) designated for this specification. New certified test results shall be submitted any time the manufacturing process or the sealer formulation is changed, and may be required by the Engineer when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified.

SECTION 1053.2 CONCRETE CRACK FILLER

1053.2.1 Scope. This specification covers concrete crack fillers for the protection of concrete against damage from de-icing chemicals.

1053.2.2 Acceptance. All material shall be obtained from a source identified on MoDOT’s Pre-Accepted List (PAL) designated for this specification, except as otherwise listed below. All materials under this specification will be inspected and accepted in accordance with Sec 106.

1053.2.3 The concrete crack filler shall be a low viscosity polymer. The chemical composition shall meet the following requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>AASHTO D-2393</td>
<td>Less than or equal to 25 cps</td>
</tr>
<tr>
<td>Gel Time</td>
<td>AASHTO T-237</td>
<td>Less than or equal to 20 minutes @ 70°F</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D638</td>
<td>Greater than or equal to 1500 psi</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D638</td>
<td>Greater than or equal to 5%</td>
</tr>
<tr>
<td>Solids Content</td>
<td></td>
<td>Greater than or equal to 95%</td>
</tr>
<tr>
<td>Flash Point</td>
<td>ASTM D1310</td>
<td>Greater than or equal to 50°F</td>
</tr>
<tr>
<td>Cure Rate</td>
<td>AASHTO T-237</td>
<td>Less than or equal to 3 hrs @ 70°F</td>
</tr>
</tbody>
</table>

1053.2.4 The concrete crack filler shall meet the procedures and the application rates as specified in Sec 704. St. Charles County reserves the right to verify any qualification tests at their expense on any field application.

1053.2.5 Manufacturer and Brand Name Approval. Prior to approval and use of concrete crack fillers, the manufacturer shall submit to the Engineer a certified test report from an approved testing laboratory showing specific test results conforming to the requirements of these specifications. The certified test report shall also contain the manufacturer’s name, product brand name, lot number and date of manufacture. Upon approval of the certified test report by the Engineer the manufacturer and brand name will be added to MoDOT’s Pre-Accepted List (PAL) designated for this specification. New certified test results shall be submitted any time the manufacturing process or the crack filler formulation is changed, and may be required by the Engineer when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified.
SECTION 1054
CONCRETE ADMIXTURES

1054.1 Scope. This specification covers air-entraining admixtures, water-reducing admixtures, retarding admixtures, accelerating admixtures and latex emulsion admixtures for concrete.

1054.2 Acceptance. All material under this specification shall be obtained from a source identified on MoDOT’s Pre-Accepted List (PAL) designated for this specification. All material under this specification will be inspected and accepted in accordance with Sec 106.

1054.3 Air-Entraining Admixtures. Air-entraining admixtures shall be in accordance with AASHTO M 154, except as modified herein.

1054.3.1 Certification. The manufacturer shall submit a certification to MoDOT Construction and Materials prior to approval. The certification shall provide the following:

(a) The brand name and designation.
(b) The composition or description of the admixture.
(c) The manufacturing ranges for percent total solids and pH by AASHTO T 200.
(d) The infrared spectrum.
(e) The manner in which the material will be identified on containers.
(f) The material is in accordance with these specifications.

1054.3.1.1 Certifications shall include or have attached specific test results as required in Sec 1054.3.1.2 or Sec 1054.3.1.3.

1054.3.1.2 For an air-entraining admixture other than that specified in Sec 1054.3.1.3, the certification shall include results of tests conforming to the requirements of AASHTO M 154. Tests for bleeding, bond strength and volume change will not be required.

1054.3.1.3 For an air-entraining admixture that is an aqueous solution of vinsol resin manufactured by neutralizing the resin with sodium hydroxide, the certification shall include results of tests showing the ratio of sodium hydroxide to vinsol resin. The certification or test report shall also state that no other additive or chemical agent is present in the solution.

1054.3.2 Packaging and Marking. The containers in which air-entraining admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number and net quantity. A delivery ticket showing this information shall accompany bulk shipments. If the manufacturer supplies air-entraining admixtures in more than one concentration, the concentration shall be designated on the container, or for bulk shipments, in a prominent manner on the delivery ticket.

1054.4 Water-Reducing Admixtures. Water-reducing admixtures shall be in accordance with AASHTO M 194, Type A, except as modified herein. High range water-reducing admixtures, when permitted for use, shall be in accordance with AASHTO M 194, Type F or Type G.

1054.4.1 Certification. The manufacturer shall submit certification to the Engineer prior to approval.
1054.4.1.1 The certification shall provide the following:

(a) The brand name and designation.

(b) The composition or description of the admixture.

(c) The manufacturing ranges for specific gravity at 77°F and percent total solids.

(d) The infrared spectrum.

(e) The manner in which the material will be identified on containers.

(f) The material is in accordance with these specifications.

1054.4.1.2 The certification shall include or have attached specific test results in accordance with AASHTO M 194, Type A, F or G, as applicable, and the recommendation for use, including amounts to be added.

1054.4.2 Packaging and Marking. The containers in which water-reducing admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number and net quantity. A delivery ticket showing this information shall accompany bulk shipments.

1054.5 Retarding Admixtures. Retarding admixtures shall be in accordance with AASHTO M 194, Type B or D, except as modified herein.

1054.5.1 Certification. The manufacturer shall submit certification to the County prior to approval.

1054.5.1.1 The certification shall provide the following:

(a) The brand name and designation.

(b) The composition or description of the admixture.

(c) The manufacturing ranges for specific gravity at 77°F and percent total solids.

(d) The infrared spectrum.

(e) The manner in which the material will be identified on containers.

(f) The material is in accordance with these specifications.

1054.5.1.2 The certification shall include or have attached specific test results in accordance with AASHTO M 194, Type B or D, and the recommendation for use, including amounts to be added.

1054.5.2 Packaging and Marking. The containers in which retarding admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number and net quantity. A delivery ticket showing this information shall accompany bulk shipments.

1054.6 Accelerating Admixtures. Accelerating admixtures shall be in accordance with AASHTO M 194, Type C or E, except as modified herein.

1054.6.1 Certification. The manufacturer shall submit certification to the County prior to approval.
1054.6.1.1 The certification shall provide the following:

(a) The brand name and designation.

(b) The composition or description of the admixture.

(c) The manufacturing ranges for specific gravity at 77°F and percent total solids.

(d) The infrared spectrum.

(e) The manner in which the material will be identified on containers.

(f) The material is in accordance with these specifications.

1054.6.1.2 The certification shall include or have attached specific test results in accordance with AASHTO M 194, Type C or E, and the recommendation for use, including amounts to be added.

1054.6.2 Packaging and Marking. The containers in which accelerating admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number and net quantity. A delivery ticket showing this information shall accompany bulk shipments.

1054.7 Latex Emulsion Admixtures. Latex emulsion admixtures shall be non-toxic, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture. The admixture shall be a styrene-butadiene latex emulsion in which at least 90 percent of the non-volatiles are styrene-butadiene polymers.

1054.7.1 Properties The admixture shall be homogeneous, uniform in composition and shall be in accordance with the following requirements when tested with the procedures shown in Report No. FHWA RD 78 35, April 1978, *Styrene-Butadiene Latex Modifiers for Bridge Deck Overlay Concrete*:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>White</td>
</tr>
<tr>
<td>Polymer Type</td>
<td>Styrene-Butadiene</td>
</tr>
<tr>
<td>Percent Solids</td>
<td>46 - 53</td>
</tr>
<tr>
<td>pH</td>
<td>5.0 - 12.0, the pH may not vary more than ± 1 from the pH of matl. submitted for prequalification.</td>
</tr>
<tr>
<td>Particle Size</td>
<td>1400 to 2500 Angstroms, the mean particle size shall not vary more than ± 300 Angstroms from the mean diameter of material submitted for prequalification.</td>
</tr>
<tr>
<td>Viscosity</td>
<td>± 20 centipoises of the viscosity of material submitted for prequalification.</td>
</tr>
<tr>
<td>Percent Coagulum</td>
<td>0.10 percent by weight, max.</td>
</tr>
<tr>
<td>Freeze-Thaw Stability</td>
<td>0.10 percent by weight max. coagulum after 2 freeze-thaw cycles.</td>
</tr>
<tr>
<td>Surface Tension</td>
<td>50.0 dynes/cm, max.</td>
</tr>
<tr>
<td>Percent Butadiene</td>
<td>30 to 40 by weight</td>
</tr>
</tbody>
</table>

1054.7.2 Certification. The manufacturer shall submit certification to the County prior to approval.

1054.7.2.1 The certification shall provide the following:

(a) The brand name and designation.
(b) The composition or description of the admixture.

(c) The manufacturing ranges for specific gravity at 77°F by AASHTO T 157, percent total solids by ASTM D 1644, Method A and pH by AASHTO T 200.

(d) The infrared spectrum.

(e) The manner in which the material will be identified on containers.

(f) The material is in accordance with these specifications.

1054.7.2.2 The certification shall include or have attached specific test results in accordance with this specification.

1054.7.3 Packaging and Marking. The containers in which latex emulsion admixtures are delivered shall be plainly marked with the manufacturer's name, the brand name and designation of the material, lot number and net quantity. A delivery ticket showing this information shall accompany bulk shipments.
1055.1 Scope. This specification covers material to be used for the purpose of curing Portland cement concrete. Curing is a procedure for insuring the hydration of the cementitious materials in newly-placed concrete. It generally implies control of moisture loss and sometimes of temperature. These curing materials are divided into intermediate and final curing.

1055.1.1 Acceptance. Material under this specification may be obtained from a source identified on MoDOT's Pre-Accepted List (PAL) designated for this specification. If the manufacturer is different from the source supplying the material, the manufacturer shall also be listed. All material under this specification will be inspected and accepted in accordance with Sec 106.

1055.2 Intermediate Curing Materials (Moisture Retention) Scope. Intermediate curing materials are liquid or atomized materials placed between when the surface has been finished and before the final set of the concrete begins. The purpose of initial curing of concrete is to reduce the loss of moisture from the concrete surface.

1) VOC Content. The applied VOC Content shall be less than 350 g/l as determined by ASTM D 5095.

1055.2.1 Evaporation Reducers Scope. This specification covers material to be used for the purpose of reducing the rapid evaporation (when the rate of evaporation exceeds 0.1 lb./ft.2/hour as determined by ACI 305 chart of evaporation rates) of concrete pavement and superstructure immediately after the surface texture is applied.

1055.2.1.1 Material Requirements. Evaporation reducers shall produce a continuous mono-molecular film on fresh concrete surfaces and shall be:

1) Water-based.

2) Colored / tinted to assist in the uniform application of the product and that dissipates once the concrete surface is dry.

3) Shall have no effect on the concrete hydration process.

4) Reduce surface moisture evaporation by:

   a) 35 percent in sunlight.

   b) 75 percent in wind.

5) Applied at a rate not less than 1 gallon per no more than 200 sq. ft.

1055.2.2 Water Fogging Scope. This specification covers water fogging to be used for the purpose of reducing the rapid evaporation (when the rate of evaporation exceeds 0.1 lb./ft.2/hour as determined by ACI 305 chart of evaporation rates) of concrete pavement and superstructure immediately after the surface texture is applied. This process is used during hot weather conditions to increase the relative humidity in the air above the concrete surface, reducing the rate of evaporation.

1055.2.2.1 Material Requirements. Water fogging uses specially designed multi-port nozzles that atomizes the potable water (see Sec 1070) into a fog-like mist. The fog spray is directed above, not at, the concrete surface, which means continuous fogging is necessary. Water from fogging shall not be worked into the surface in subsequent finishing operations. The applied water fogging temperature shall not be less than 20°F of the concrete at the time.
of placement. Water from fogging shall be either removed or allowed to evaporate before finishing. The concrete surface shall be kept moist at all times by fogging with approved atomizing nozzles until the surface has been covered by the final cure.

1055.2.2.2 Fogging Equipment. To supply additional moisture above the concrete surface to increase the relative humidity of the air just above the plastic concrete surface without accumulating any water on the concrete, use fogging equipment with the following characteristics:

1) Water to be used is defined in accordance with Sec 1070;

2) A heavy-duty pump capable of delivering a minimum fog application not less than 10.6 gallons of water per hour per square yard to at least two solid brass multiport fogging nozzles that produce atomized water with a maximum droplet diameter of 0.003 inch at an air pressure of 100 psi;

3) The ability to consume approximately 22 ft³/minute of compressed air;

4) The rate of fogging shall be such that evaporation of water from the concrete surface is prevented and that standing water does no accumulate on the concrete surface;

5) A minimum ¼ inch inside diameter hose long enough to reach all areas of the paved surface; and

6) An adjustable spray gun and tip to provide various patterns of atomized spray or fog for changing finishing conditions.

1055.2.2.3 Basis of Acceptance. The water fogging equipment and application method of reducing evaporation shall be submitted to the Engineer for review, modification and approval 14 calendar days before the date of use. The submittals shall include manufacturer guide installation instructions and any deviation(s) required. The method will be accepted on the basis of the Engineer’s visual inspection during the fogging operation.

1055.3 Final Curing Materials (Moisture Application) Scope. Final curing materials are liquid or wet burlap materials placed immediately after the final set of the concrete has taken place. Burlap materials are used in conjunction with potable curing water. Curing water shall not be less than 20°F of the concrete at the time of placement. Absorbent material shall be nonstaining and free of sugars or fertilizers.

1055.3.1 Ponding or Immersion.

1055.3.1.1 Scope. This specification covers the use of water ponding or immersion used in curing superstructure, precast, retaining wall or slip form concrete. After the concrete has achieve its final set, a pond of potable water can be created by a ridge, dike or other dam at the edge of the slab, culvert floor or footing.

1055.3.1.2 Material Requirements. The water shall not be more the 20°F cooler than the concrete at the time of placement and the dike around the pound shall be secured from leaking during the curing period. After curing the material shall dissipate naturally or be removed in manner approved by the Engineer that does not contaminate storm water structures or open water channels.

1055.3.2.3 Basis of Acceptance. The use of water ponding for curing, including method for disposal of water, shall be approved in advance by the Engineer. Ponding shall not be used during winter concreting conditions, but may be used at other times with the approval of the Engineer.

1055.3.2 Burlap and Mats of Jute or Cotton.
1055.3.2.1 Scope. This specification covers requirements for burlap used in curing superstructure, precast, retaining wall or slip form concrete. Blanket material shall be maintained in a wet condition during the curing period using soaker hoses or sprinklers.

1055.3.2.2 Material Requirements. For curing, burlap cloth made from Jute or Kenaf and Cotton Mats shall be in accordance with AASHTO M 182, Class 4. The Burlap shall be of one type and be manufactured to weigh 10 to 12 ounces per linear yard on a 40 inch basis. Jute mats shall consist of two plies of burlap stitched together to maintain the shape and stability of the unit. Cotton mats shall consist of filler or cotton batts covered with unsized cloth or burlap, and tufted or stitched to maintain the shape and stability of the unit. Burlap and mats shall, in the judgment of the Engineer, be of such construction and in such condition as required to adequately maintain free moisture on the surface of the concrete with the type of system being used to provide the water. Material shall be free from deleterious matter harmful to concrete. Burlap shall be free from cuts, tears, uneven weaving and contaminants. The length of the mats shall be 2 feet 6 inches greater than the width of pavement to be cured.

1055.3.2.3 Basis of Acceptance. Burlap shall be cleaned and free from cuts, tears, uneven weaving and contaminants. The burlap will be accepted on the basis of a visual inspection by the Engineer, weighing of a sample at the point of use and by a certification that specifies this product conforms to this specification.

1055.3.3 White Burlap-Polyethylene Sheeting.

1055.3.3.1 Scope. This specification covers requirements for white burlap-polyethylene sheeting used in curing concrete. Blanket material shall be maintained in a wet condition during the curing period using soaker hoses or sprinklers.

1055.3.3.2 Material Requirements. White burlap-polyethylene sheeting shall be in accordance with ASTM C 171. White burlap-polyethylene sheeting shall consist of burlap weighing not less than 9 oz./yd2, extrusion coated on one side with white opaque polyethylene at least 4 mil (0.004 inch) thick and the white side shall have a minimum daylight reflectance of 70 percent as determined by ASTM E 1347. The water vapor transmission rate (WVTR) of the sheet material shall be no more than 10 g/m2 in 24 hours when tested in accordance with ASTM E 96. Each roll of white burlap-polyethylene sheeting shall be identified with the length, width, and name and address of the manufacturer.

1055.3.3.3 Basis of Acceptance. White burlap-polyethylene sheeting shall be clean and free from cuts, tears, uneven burlap weaving and contaminants. The white burlap-polyethylene sheeting will be accepted on the basis of a visual inspection by the Engineer, weighing of a sample at the point of use and by a certification that specifies this product conforms to this specification.

1055.4 Final Curing Material (Moisture Retention) Scope. Final curing materials are liquid or wet burlap materials placed immediately after the final set of the concrete has taken place. The following final curing sheet or liquid membrane curing materials are based on moisture retention.

1055.4.1 Sheet Curing Materials.

1055.4.1.1 Scope. This specification covers requirements for sheet curing materials used on concrete pavement.

1055.4.1.2 Waterproof Curing Paper.

1055.4.1.2.1 Material Requirements. Waterproof curing paper, in accordance with ASTM C 171, shall consist of two sheets of kraft paper cemented together with a bituminous material in which are embedded cords or strands of fiber running in both directions and not more than 1¼ inches apart. The paper shall be light in color, free of visible defects and shall have a uniform appearance. White paper shall have a white surface on at least one side. The white side shall have a minimum daylight reflectance of 50 percent as determined by ASTM E 1347. The water vapor
transmission rate (WVTR) of the sheet material shall be no more than 10g/m2 in 24 hours when tested in accordance with ASTM E 96.

1055.4.1.2.2 Basis of Acceptance. Each shipment shall be accompanied by the manufacturer’s certificate attesting to the fact that the shipment meets the specified standards. Upon request, the manufacturer shall supply a record of the results of the prescribed tests as made on the samples to the Engineer.

1055.4.1.3 Polyethylene Sheeting.

1055.4.1.3.1 Material Requirements. Polyethylene sheeting shall be in accordance with Sec 1058 for curing Portland cement concrete. The water vapor transmission rate (WVTR) of the sheet material shall be no more than 10g/m2 in 24 hours when tested in accordance with ASTM E 96.

1055.4.1.3.2 Basis of Acceptance. Each shipment shall be accompanied by the manufacturer’s certificate attesting to the fact that the shipment meets the specified standards. Upon request, the manufacturer shall supply a record of the results of the prescribed tests as made on the samples.

1055.4.1.4 Closed-Cell Curing Blankets (Multi-Use).

1055.4.1.4.1 Scope. This specification covers closed-cell curing blankets (multiuse) that shall be manufactured for hot and cold weather concrete curing use.

1055.4.1.4.2 Material Requirements. Closed-cell curing blankets shall be strong, durable construction made of closed-cell polypropylene foam adhesive bonded between strong, abrasive-resistant, U.V. stabilized polyethylene coating vinylcovered fabric, each layer at least 6 mil (0.006 inch) in thickness. One side will have a reflective silver-color and the other will have a non-reflective black color. Closed-cell curing blankets material will be judged on its ease and practicability of installation, durability and imperviousness to moisture penetration and absorption. The minimum thickness for any blanket insulation considered shall be 1 inch. The thermal conductivity (k) of any proposed insulating material shall not exceed 0.32 BTU per square foot per F per inch of thickness (R-value ≥ 3). If the material does not meet ASTM C 171 water vapor transmission rate requirements specified below, then polyethylene sheeting in accordance with Sec 1055.4.1.3 is required to supplement the closed-cell curing blankets:

1) Performance requirements for water vapor transmission rate (WVTR) of the sheet material be no more than 10g/m2 in 24 hours when tested in accordance with ASTM E 96.

2) Physical requirements in accordance with Sec 1055.4.1.3, Polyethylene Sheeting.

1055.4.1.4.3 Basis of Acceptance. Closed-cell curing blankets for all-weather concreting shall be accepted on the basis of the manufacturer’s certificate attesting to the fact that the shipment meets the specified standards. Upon request, the manufacturer shall supply a record of the results of the prescribed tests as made on the samples.

1055.4.2 Liquid Membrane Curing Materials.

1055.4.2.1 Scope. This specification covers white-pigmented and clear membrane curing compound material and quality requirements for spray application on surfaces of newly placed Portland cement concrete.

1055.4.2.2 General. Water retention properties for all curing compounds shall be determined by ASTM C 156 Test Method for Water Retention by Concrete Curing Materials. The vehicle class of all curing compounds shall be Class A except as modified herein. Sampling from containers prior to application may be made upon request. A sample of curing compound shall consist of one quart of material in a screw top can. Approved material shall be delivered to the work site in clean containers. The curing compound shall be agitated mechanically to a uniform consistency throughout the container immediately before use or sampling. Material supplied shall be of a sprayable consistency...
and have a maximum permissible volatile organic compound (VOC) content of 350 g/L as determined by ASTM D 3960 Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings. Curing compounds shall be applied by power-driven pressure sprayers with a pressure range of 25 to 100 psi. For small irregular areas pressurized hand-operated spraying equipment may be used with approval of the Engineer. Spray nozzles shall be of the proper type for the material being sprayed. The curing membrane shall display properties described as follows:

1) **Water Retention.** At the specified minimum application rate and tested in accordance with ASTM C 156, the material shall restrict the loss of water to not more than 0.55 kg/m² in 72 hours.

2) **Drying Time.** At the specified minimum application rate and tested in accordance with ASTM C 156, the material shall dry to the touch in not more than 4 hours.

3) **Consistency Requirement.** Produce a uniform coating by spraying at temperatures above 40°F.

### 1055.4.2.3 Material Requirements.

**1055.4.2.3.1 Type 1-D Curing Compounds.** For curing concrete driveway, paved approach, steps and medians. Type 1-D liquid membrane-forming curing compounds shall be in accordance with ASTM C 309 for Type 1-D, Class A translucent with red fugitive dye that will fade uniformly. Type 1-D curing compounds are applied to concrete median, median strip, sidewalk (exposed aggregate concrete shall use dissipating curing compounds), steps, and paved approaches. When applied immediately after the final set (disappearance of the surface water sheen) of the concrete has taken place, material shall be applied at a minimum rate of one gallon per no more than 150 square feet of surface. The curing membrane shall display properties described in Sec 1055.4.2.2 and as follows:

1) **Fugitive Dye.** The membrane-forming compounds with red fugitive dye shall be readily distinguishable upon the concrete surface for at least 4 hours after application, but shall become inconspicuous within 7 days after application if exposed to direct sunlight.

**1055.4.2.3.2 Type 2 Curing Compounds.** For curing concrete pavement, the compound shall consist of finely ground white pigment and wax or resin-based vehicle, ready mixed for immediate use without alteration. Type 2, liquid membrane forming curing compounds shall be in accordance with ASTM C 309 for Type 2, Class A white pigmented. The product shall not be frozen during storage. Type 2 curing compounds are applied to Portland cement concrete pavements. When applied immediately after the final set of the concrete has taken place the material shall be applied at a minimum rate of one gallon per no more than 150 square feet of surface. The curing membrane shall display properties described in Sec 1055.4.2.2 and as follows:

1) **Reflectance Property.** When tested in accordance with ASTM E 1347 shall exhibit a daylight reflectance of not less than 60 percent.

**1055.4.2.3.3 Dissipating Curing Compounds.** For concrete superstructures and pavements or bases to receive an asphaltic overlay after being open to traffic, curing compounds shall be liquid membrane-curing compounds in accordance with ASTM C 1315 Class B, which is a clear all resin (no wax) cure, for Type 1-D or Type 2 and shall be designated to be dissipating over time with exposure to direct sunlight (ultraviolet light). All superstructure curing compounds shall be manufactured such that the curing compounds may be removed prior to dissipation. When applied immediately after the final set of the concrete has taken place the material shall be applied at a minimum rate of not less than one gallon per no more than 150 square feet of surface.

**1055.4.2.3.3.1 Additional Certification.** Certification for bridge curing compounds shall include a statement that the product is manufactured to dissipate. The certification shall specify the method by which removal of the compound prior to dissipation or removal of residual material from the surface can be accomplished.
1055.4.2.3.4 High Performance Curing Compound. High performance curing compounds are for concrete pavement opened to traffic in three days or less. High performance white liquid membrane-forming compounds shall conform to the requirements of ASTM C 1315 for Type 2, Class A or B as follows:

1) Percent Solids. The curing compound shall have a minimum of 42 percent solids (total solids minus pigment) by total weight and the vehicle shall be 100 percent poly-alpha Methyl Styrene (PAMS).

2) Water Retention. As per ASTM C 156 the loss of water shall not be more than 0.15 kg/m² at 24 hours and no more than 0.40 kg/m² at 72 hours.

3) Reflectance. As per ASTM E 1347, the three-day reflectance readings shall be greater than 65.

4) Drying Time. As per ASTM C 1315 Part 8.3, shall set to touch in no longer than one hour after application and will be tack-free in no longer than four hours after application.

5) Application Rate. Not less than 1 gallon per no less than 200 sq. ft. of surface.

6) Flash Point. Shall have a flash point greater than 100°F.

1055.4.2.4 Basis of Acceptance. Material or systems under this specification may be obtained from a source identified on MoDOT's Pre-Accepted List (PAL) designated for this specification and meeting the requirements specified herein. All material under this specification will be inspected and accepted in accordance with Sec 106.

1055.4.2.5 General. Each shipment shall be accompanied by the manufacturer's certificate attesting to the fact that the shipment meets the specified standards. Upon request, the manufacturer shall supply a record of the results of the prescribed tests as made on the samples.

1055.4.2.6 Shipment Documentation. After approval, the manufacturer shall furnish, with each shipment, a certificate of analysis and performance test results for each batch number furnished, verifying that it meets ASTM C 309 for the type and class of liquid membrane-forming curing compound furnished, a Materials Safety Data Sheet and application instructions. Each container of liquid membrane curing compound shall be delivered in the manufacturer's original clean, sealed container plainly marked with the manufacturer's name and trademark, the batch number, the type and class of cure, and a date of manufacture. In addition, each container shall be legibly marked with the nominal percentage of nonvolatile material and place of manufacture. For material shipped in bulk tankers, a label shall be furnished with each load to be placed on the project storage tank for identification purposes. Compounds shall be used in the same year as manufactured. The manufacturer's certification and test results shall be made available upon request.

1055.4.2.7 Sampling. Each lot or batch of liquid membrane-forming compound shall be subject to sampling, testing and approval prior and during use.

1055.4.2.8 Packaging. Material shall be supplied in either 5 gallon pails or 55 gallon drums.

1055.4.3 Cold Weather Protection and Curing.

1055.4.3.1 Scope. This specification covers the material details, quality requirements, and method of application for approval of form insulating materials or equipment used for above-grade winter concreting operations.

1055.4.3.2 Heated Curing Blankets Scope. Electrically heated curing blankets shall be manufactured to maintain the pavement or structural concrete element's specified maintained temperature range, throughout the minimum specified curing period or until the minimum compressive strength specified is achieved.
1055.4.3.2.1 **Material Requirements.** Heated curing blankets shall be rated at a minimum power density of 15 watts per square foot and work on a thermostatically controlled, grounded 110 volt system. Heated curing blankets shall maintain the concrete’s minimum temperature within the operating tolerance specified for the curing period specified. Heated curing blankets shall be properly weighted and secured at laps and edges. Heated curing blankets shall be lapped at least 8 inches and be free from holes, cuts, tears and contaminants. If the material does not meet ASTM C 171 water vapor transmission rate requirements specified below, then polyethylene sheeting in accordance with Sec 1055.4.1.3 is required to supplement the heated curing blankets:

1) Performance requirements for water vapor transmission rate (WVTR) of the sheet material be no more than 10g/m2 in 24 hours when tested in accordance with ASTM E 96.

2) Physical requirements in accordance with Sec 1055.4.1.3 Polyethylene Sheeting.

1055.4.3.2.2 **Testing.** Maturity sensor(s) shall be embedded in the concrete by the Engineer to monitor temperature during the curing cycle. The Engineer shall inspect the system at any time for line breaks, excessive temperature or direct contact with the concrete element.

1055.4.3.2.3 **Basis of Acceptance.** Heated curing blankets for winter concreting shall be accepted on the basis of the manufacturer's certificate attesting to the fact that the shipment meets the specified standards. Upon request, the manufacturer shall supply the Engineer a record of the results of the prescribed tests as made on the samples. The heated curing blanket system shall be submitted to the Engineer for review and approval at least 14 calendar days before the date of use.

1055.4.3.3 **Hydronic Heat Transfer System Scope.** A system shall be manufactured to maintain the pavement or structural concrete element’s specified maintained temperature range, throughout the minimum specified curing period, or until the minimum compressive strength specified is achieved.

1055.4.3.3.1 **Supplemental Material Requirements.** If the material does not meet ASTM C 171 water vapor transmission rate requirements specified below, then polyethylene sheeting in accordance with Sec 1055.4.1.3 is required to supplement the Hydronic heat transfer system. Materials used shall meet the following performance and physical requirements:

1) Performance requirements for water vapor transmission rate (WVTR) of the sheet material be no more than 10g/m2 in 24 hours when tested in accordance with ASTM E 96.

2) Physical requirements in accordance with Sec 1055.4.1.3, Polyethylene Sheeting.

1055.4.3.3.2 **Equipment Requirements.** A Hydronic heat transfer system shall consist of a circulating glycol / water solution in a closed system of pipes or hoses, uniformly spaced no more than two feet apart, which can maintain a concrete slab or structural element’s specified maintained temperature range for the specified curing time.

1055.4.3.3.3 **Testing.** Maturity sensor(s) shall be embedded in the concrete by the Engineer to monitor temperature during the curing cycle. The Engineer shall inspect the system at any time for leaks, line breaks, excessive temperature or direct contact with the concrete element.

1055.4.3.3.4 **Basis of Acceptance.** The hydronic system and method of curing shall be submitted to the Engineer for review, modification and approval at least 14 calendar days before the date of use. The submittals shall include manufacturer guide installation instructions and any deviation(s) requested. Approved insulating blankets and vapor barrier shall be included in the system submittal for approval.

1055.4.3.4 **Form Insulating Materials for Winter Concreting.**
**1055.4.3.4.1 Scope.** This specification covers the material details, quality requirements, and method of application for approval of form insulating pavement or structural elements during winter concreting operations. Stay-in-place insulating concrete forms or insulated composite forms may be used with the approval of the Engineer. Insulated forms for cold weather protection may be used at approved locations in lieu of enclosures, if the method will keep the temperature of the concrete within the specified as-maintained limits. The Contractor shall secure prior approval by the Engineer of the type of insulation, method of insulation, and the locations at which it is proposed for use.

**1055.4.3.4.2 Material Requirements.** Each insulating material will be judged on its ease and practicability of installation, durability and imperviousness to moisture penetration and absorption. The minimum thickness for any foam board and blanket insulation considered shall be 1 inch. The thermal conductivity (k) of any proposed insulating material shall not exceed 0.32 BTU per square foot per F per inch of thickness (R-value ≥ 3).

**1055.4.3.4.3 Sampling and Testing.** Application of approval of an insulating material shall be made to the Materials Testing Lab. Certified laboratory test results for thermal conductivity (k) and thermal resistance (R), F per BTU per hour per square foot, measured at the nominal product thickness shall be required for evaluation. A 3 foot square (minimum) sample shall accompany each request for approval. The sample shall exhibit all major features of the insulating product such as covers, seams, fasteners, grommets, etc. All necessary and normal product information shall accompany the sample. If there is a specific process required to apply the insulating material, complete details of the process shall accompany the sample.

**1055.4.3.4.4 Sprayed Foam Supplemental Sampling and Testing.** If sprayed foam is the material in question, the Contractor shall also be required to send the applicator's name plus a list of jobs done by the applicator during the last 12 months. If investigation of these jobs demonstrates quality workmanship, the applicator shall be issued a temporary approval good for one contract. Based upon its subsequent performance, a decision will be made as to whether or not to approve the applicator on future work.

**1055.4.3.4.5 Basis of Acceptance.** The approval of the form insulating material shall be based upon the submitted information and tests performed by a materials testing lab. Such products shall then be accepted on the basis of the brand name labeled plainly on the material. The insulating materials for winter concrete shall be submitted to the Engineer for review, modification and approval at least 14 calendar days before the date of use.

**1055.4.3.5 Heated Enclosures.**

**1055.4.3.5.1 Scope.** This specification covers the material requirements for heated enclosures, which are used to cure cast-in-place structural concrete during winter concreting operations.

**1055.4.3.5.2 General.** Concrete placed in cold weather shall be protected from freezing during the curing period by the use of a heated weatherproof enclosure when the ambient temperature is below 40°F for superstructure, substructure units, and box culverts of an opening size 15 square feet or greater.

**1055.4.3.5.3 Material and Equipment Requirements.** Enclosures shall be designed to keep the concrete between the specified ranges of maintained concrete temperatures. When dry heat is used, at least 40 percent relative humidity shall be maintained at the concrete surface. The exposed surfaces of the concrete shall be kept moist either by the application of steam or wet burlap mats. When heaters are required, they shall be vented to carry combustion gasses to the outside. The concentration of carbon dioxide in the enclosure air shall not be greater than 1.5 percent by volume when workers are present. The Contractor shall provide adequate fire protection at all times and shall maintain proper temperature and humidity conditions within the housing during the specified curing period. Operations of the heater(s) are to be supervised continuously by the Contractor. The Contractor shall secure prior approval by the Engineer of the type of insulation, method of insulation, and the locations at which it is proposed for use.
1055.4.3.5.4 Testing. Maturity sensor(s) shall be embedded in the concrete by the Contractor to monitor temperature during the curing cycle. The Engineer shall inspect the system at any time for leaks, line breaks, excessive temperature or direct contact with the concrete element.

1055.4.3.5.5 Basis of Acceptance. The heated enclosure method of curing shall be submitted to the Engineer for review, modification and approval at least 14 calendar days before the date of use. The submittals shall include manufacturer guide installation instructions and any deviation(s) requested. Approved liquid curing materials, insulating blankets and vapor barrier shall be included in the system submittal for approval.

1055.4.4 Curing System for Precast Concrete. This specification covers the material and equipment requirements for curing of precast concrete box culverts and reinforced concrete pipe.

1055.4.4.1 Water Curing. Concrete products are water cured by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hose, or by any other Engineer approved method that will keep the products moist during the curing period.

1055.4.4.2 Sealing Membrane. A sealing membrane in accordance with ASTM C 309 is applied and shall be left intact until the required strength requirements are met. The concrete at the time of application of the membrane shall be within 10°F of the atmospheric temperature. All concrete surfaces shall be kept moist prior to the application of the membrane and shall be damp when the membrane is applied.

1055.4.4.3 Accelerated Curing with Low Pressure Steam or Radiant Heat. The manufacturer may use accelerated curing with low pressure steam or radiant heating in accordance with Sec 1055.4.5 when approved by the Engineer.

1055.4.4.4 The manufacturer is not prohibited from combining the above methods provided the required concrete compressive strength is attained.

1055.4.5 Basis of Acceptance. The curing system for precast concrete shall be submitted to the Engineer for review, modification and approval at least 14 calendar days before the date of use.

1055.4.5 Accelerated Curing with Low Pressure Steam or Radiant Heat Scope. This specification covers the material and equipment requirements for curing of precast prestressed concrete members with low pressure steam or radiant heat. All water applied for curing shall be in accordance with Sec 1070. Burlap materials shall be in accordance with Sec 1055.3.2.2.

1055.4.5.1 Radiant Heating. Radiant heat may be applied by means of pipes circulating steam, hot oil or hot water, or by electric heating elements. Perform radiant heat curing under a suitable waterproof enclosure to contain both heat and moisture. Minimize moisture loss by covering all exposed concrete surfaces with 2 layers of wet burlap. Temperature maintained in the enclosure and the concrete shall meet the requirements in accordance with Sec 1055.4.5.2.

1055.4.5.2 Steam Curing. Concrete products are placed in a low pressure curing chamber, free of outside drafts, and cured in a moist atmosphere maintained by the injection of steam for such time and temperature as needed to enable the products to meet the specified strength requirements. When steam curing is applied, the jets shall not impinge directly on the concrete or on the forms; free circulation around the units shall be maintained; the steam shall be thoroughly saturated at all times; the temperature around the concrete shall not be raised more than 40°F per hour and shall not exceed 160°F at any time, while the maximum internal concrete temperature shall be limited to 180°F. Hold the maximum temperature until the concrete has reached the desired strength. After the expiration of the steam curing period, the temperature inside the chamber shall be reduced at a rate of not more than 40°F per hour until a temperature has been reached about 20°F above the temperature of the air to which the concrete will be exposed. Do not allow the temperature of the concrete to drop below 50°F at any time.
1055.4.5.3 Application of Heat or Steam Time Limitations. Allow the initial set of the concrete to take place by delaying the initial application of steam or heat from 2 to 4 hours after the final placement of concrete. If retarders are used, increase the waiting period before application of the steam or radiant heat to 4 to 6 hours. If the time of initial set is determined by the standard method of test for "Time of Setting of Concrete Mixtures by Penetration Resistance", ASTM C 403, the time limits described above may be waived.

1055.4.5.3.1 Instrumentation. When accelerated curing is used, install instruments during the curing period for measuring and recording temperature and humidity inside curing enclosures and for measuring and recording temperature in the concrete for each 200 feet of casting bed. Provide a minimum of 2 calibrated instrument installations of each type for each enclosure. The location of each instrument must be approved by the Engineer. Humidity level indicators may be waived by the Engineer.

1055.4.5.3.2 Recording Thermometers. Provide calibrated recording thermometers showing the time-temperature relationship throughout the curing period from placing concrete to transfer of prestress. All temperature records will be retained by the Engineer as part of the curing records. Missing or incomplete time temperature records shall be cause for rejection of the corresponding prestressed units. Temperature limits and use of recording thermometers are the same when curing with steam or radiant heat. Due to the slow rise of ambient temperatures with radiant heat, application of heat cycles may be accelerated to meet climatic conditions, however, do not increase the ambient air temperature within the curing enclosure by more than 40°F per hour.

1055.4.6 Basis of Acceptance. The Accelerated Curing with Low Pressure Steam or Radiant Heat system, shall be submitted to the Engineer for review, modification and approval at least 14 calendar days before the date of use.

1055.5 Documentation. The distributor shall maintain certification that the material and equipment supplied is in accordance with these specifications. The certification shall be made available upon request.
SECTION 1056
CONCRETE TINTING AND STAINING MATERIAL

SECTION 1056.1 CONCRETE TINTING MATERIAL

1056.1.1 Description. This work item shall consist of providing a concrete tinting material to aesthetically color concrete as shown on the plans.

1056.1.2 Material Requirements. This material shall consist of a homogeneous mixture mineral oxide pigment of an approved tint with such other additives as deemed necessary by the manufacturer. The tinting material shall conform to the specification outlined on ASTM C979. The material shall be free from oil, grease, dirt and nonferrous particles. The tinting material shall not contain any material that might promote oxidation of the iron particles if exposed to air and moisture, or that might have any detrimental effect on concrete. The Contractor shall supply the Engineer with a manufacturer’s certification indicating that the material supplied is in accordance with this specification.

1056.1.3 Construction Requirements. The Contractor shall incorporate the tinting material into the concrete through mixing with the aggregate, cementitious material and water in accordance with the manufacturer’s recommendation. The dry shake method; whereby the tinting material powder, combined with dry cement and sand, is sprinkled onto the concrete and worked into the surface through finishing; shall not be allowed.

SECTION 1056.2 CONCRETE STAINING MATERIAL

1056.2.1 Description. This work item shall consist of providing a field concrete stain to aesthetically color concrete exteriors as shown on the plans.

1056.2.2 Material Requirements. The material shall be two-coat, pigmented acrylic resin system which penetrates into the concrete surface to provide water repellency, semi opaque aesthetic color and salt resistance and shall form a breathable film allowing trapped moisture vapor to safely migrate through the coating without blistering or peeling. The Contractor shall supply the Engineer with a manufacturer's certification indicating that the material supplied is in accordance with this specification.

1056.2.3 Construction Requirements. The concrete surface shall be fully cured a minimum of 28 days prior to application of the aesthetic concrete stain. The absence of moisture in the concrete surface shall be verified with standard test ASTM D4263. Pressure washing with a minimum of 3,000 psi shall be used to remove all foreign matter, form oils, waxes, curing compounds, laitance, efflorescence and dirt. Sand blasting will not be permitted for cleaning. The cleaned surface shall be free of blemishes, discolorations, surface voids and conspicuous form marks to the satisfaction of the Engineer. The concrete stain shall be adequately mixed within its container until homogenous in color. Application of the stain shall be in accordance with the manufacturer's recommendations including allowable ambient conditions. Application of the stain will not be allowed during rain. All manufacturers’ safety precautions shall be submitted to the Engineer prior to work and followed during staining.
1057.1 Scope. This specification covers joint material to be used as specified or as shown on the plans.

1057.2 Acceptance. All material under this specification shall be obtained from a source identified on MoDOT's Pre-Accepted List (PAL) designated for this specification.

1057.3 Dowel Bars. Dowels for transverse joints shall be in accordance with the requirements for plain rounds of AASHTO M 31. The dowels shall be epoxy coated in accordance with Sec 1036, except the coating thickness shall be a 5-mil minimum, the flexibility of coating requirement will not apply and the cut ends will not be required to be coated. The dowels shall be free of cutting burrs and other projections. Dowel supporting units shall be in accordance with one of the types shown on the plans. Dowel bar diameters and length for various pavement thicknesses are summarized in the following table:

<table>
<thead>
<tr>
<th>Pavement Thickness (T), inches</th>
<th>Bar Size</th>
<th>Length, inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>T &lt; 7</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>7 ≤ T &lt; 9</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>9 ≤ T &lt; 11</td>
<td>1 1/4</td>
<td>18</td>
</tr>
<tr>
<td>T ≥ 11</td>
<td>1 1/2</td>
<td>18</td>
</tr>
</tbody>
</table>

1057.3.1 Alternative Dowel bars manufactured with steel in accordance with ASTM A 1035 may be used in lieu of AASHTO M 31. Alloy Types CM and CS shall be used. The dowel bars manufactured with this type steel will not be required to be epoxy coated. Grades 100 and 120 may be used.

1057.3.2 Graphite Grease. The free end of the dowel bar shall be coated with an approved graphite grease for a length of 11 inches. Graphite grease shall contain a minimum of 25 percent graphite, and the graphite content shall be certified by the manufacturer or shown on the container label. Graphite grease shall be applied with a thin, uniform coating that will result in a thorough covering of the free end of the bar.

1057.3.3 Pre-Dipped Bondbreaker. In lieu of the graphite grease application, the dowel bar basket supplier may supply completed basket units pre-dipped in an approved bondbreaker solution. The bondbreaker solution shall not be applied in a spray or field application. The resulting dry dowel bar coating shall be visually evident. The coating shall be uniformly applied without excessive drips or thickness. Dirty or excessively scraped dowel bar units will be rejected. Rejected units may be used if the units are fully cleaned of all dirt and bondbreaker coating and graphite grease is applied according to these specifications. The dowel bar supplier shall provide a certification for the coating with each shipment, certifying the bondbreaker product name, manufacturer and date of coating application.

1057.4 Tie Bars. Tie bars for longitudinal joints and construction joints shall be round, deformed and in accordance with AASHTO M 31, except for tie bars that are to be bent and straightened shall be in accordance with AASHTO M 31, Grade 40. Tie bars shall not be bent and straightened more than one time. Tie bars shall be epoxy coated in accordance with Sec 1036, except the coating thickness shall be a 5-mil minimum, the flexibility of coating requirement will not apply and the cut ends will not be required to be coated. Tie bar diameters and length for various pavement thicknesses are summarized in the following table:
### Tie Bars – Epoxy Coated

<table>
<thead>
<tr>
<th>Pavement Thickness (T), inches</th>
<th>Bar Size</th>
<th>Bar Diameter</th>
<th>Length, inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>T &lt; 11</td>
<td>No. 5</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>T ≥ 11</td>
<td>No. 6</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

1057.4.1 Alternative. Tie bars manufactured with steel in accordance with ASTM A 1035 may be used in lieu of AASHTO M 31. Alloy Types CM and CS shall be used. The tie bars manufactured with this type of steel will not be required to be epoxy coated. Grades 100 and 120 may be used for straight bars. For tie bars that are to be bent and straightened, ASTM A 1035 steel shall not be used.

1057.5 Concrete and Asphalt Joint Sealer, Hot-Poured Elastic Type. “The sealer material shall be in accordance with ASTM D 6690, Type II. The joint sealer material shall be packed and shipped in suitable commercial containers clearly marked with the name of the material, the name of the manufacturer, brand name, weight, batch number, pouring temperature recommended by the manufacturer and maximum safe heating temperature.

1057.6 Pavement Joint Forming Material.

1057.6.1 Preformed Fiber Expansion Joint Filler. Preformed fiber expansion joint filler material shall be in accordance with AASHTO M 213. Percent asphalt content shall be tested in accordance with AASHTO T 42 or 164 with the following modifications: Oven dry test strips at 104 ± 3°C for one hour. Cool and weigh approximately 50 g into an extraction bowl. Cover test portion in the bowl with a chlorinated solvent, such as trichloroethylene, and allow sufficient time for solvent to soak the test portion. Follow test procedure outlined in AASHTO T 164 section 12.3 and 12.4, except discard extract and washings. Carefully transfer extracted test strips and scrap residue from the filter ring into a tared weighing pan. Oven dry at 104 ± 3°C for one (1) hour and cool in a desiccators. Calculate the percent asphalt content by weight on an oven dry basis per ASTM D 545 subsection 7.5.4. In cases of dispute, AASHTO T 42 test results will control.

1057.6.2 Semi-rigid, Closed-cell Polypropylene Foam, Preformed Expansion Joint Filler. This material shall be semi-rigid, closed-cell polypropylene foam, preformed expansion joint filler in accordance with ASTM D8139.

1057.7 Joints for Concrete Structures

1057.7.1 Plastic Waterstop. The plastic waterstop shall consist of a basic resin of polyvinyl chloride (PVC) with additional resins, plasticizers and stabilizers as necessary to produce a durable material with a high fatigue point, resistant to acid and alkali solutions, showing little deterioration under accelerated aging tests and shall meet the approval of the Engineer. The plastic waterstop shall have a tensile strength of no less than 1800 psi and an ultimate elongation of no less than 200 percent. The waterstop shall be a continuous strip, ribbed on both sides, and with a hollow bulb center, a “U” shaped reinforced center-pleat section, or other approved type of center section.

1057.7.2 Rubber Waterstop. The rubber water stop shall consist of a durable, elastic, cured rubber compound capable of effectively sealing joints in concrete against the infiltration of moisture.

1057.7.2.1 Physical Properties. The rubber waterstop shall be in accordance with the following requirements:

(a) Hardness - The Shore A durometer hardness shall be 60 - 70.

(b) Elongation - The elongation shall be no less than 450 percent.

(c) Tensile Strength - The tensile strength shall be no less than 3000 psi.
(d) **Water Absorption** - The water absorption shall be a maximum of five percent by weight (mass) after immersion in water for two days at 158°F.

(e) **Tensile Strength After Aging** - The tensile strength of the test specimen, after accelerated aging test of seven days at 158°F, shall be no less than 80 percent of the tensile strength prior to the aging test. The tensile strength of the test specimen, after accelerated aging test of 48 hours in oxygen at 158°F and 300 psi, shall be no less than 80 percent of the tensile strength prior to the test.

(f) **Compression Set** - The compression set after 22 hours at 158°F shall be no more than 30 percent.

1057.7.2.2 **Visual Inspection.** The waterstop shall be manufactured in such a manner that the finished product will have an integral cross section that will be dense, homogeneous, and free from porosity and other imperfections. Minor surface defects, such as surface peel covering less than one square inch, and surface cavities or bumps less than 1/4 inch in the longest lateral dimension and less than 1/16 inch deep, will be permitted.

1057.7.3 **Copper Sheeting for Flashing.** Copper sheeting shall be of soft grade containing no less than 99.7 percent copper and shall be capable of being bent cold through an angle of 180 degrees flat upon itself without evidence of cracking. Test specimens shall have an elongation in 2 inches of at least 20 percent. The weight per square foot of the sheeting to be used will be shown on the plans. Tolerances in thickness shall be in accordance with ASTM B 248.

1057.7.4 **Preformed Sponge Rubber Expansion and Partition Joint Filler.** This material shall be in accordance with AASHTO M 153, Type I, Sponge Rubber.

1057.8 **Plastic Joint Compound for Vitrified Clay and Concrete Pipe.** Plastic joint compound shall be a homogeneous blend of bituminous or butyl rubber material, inert filler and suitable solvents or plasticizing compounds thoroughly mixed at the factory to a uniform consistency suitable for sealing joints of vitrified clay and concrete pipe. The physical requirements of the compound shall be in accordance with ASTM C 990. Trowel grade material shall conform to the following requirement:

| Bitumen, soluble in soluble chlorinated solvent, such as Trichloroethylene, percent by weight, min | 45 |
| Ash, percent by weight | 15-50 |
| Penetration, standard cone, 150 g, 5 sec, 25°C - uses 12 ounce can, d mm | 110-275 |

1057.9 **Tubular Joint Seal.** Tubular joint seal shall be manufactured from extruded closed-cellular rubber, the base polymer being a blend of nitrile and vinyl meeting the physical requirements of ASTM D 1056, Type 2, Class C, Grade 1, and the chemical resistance requirements of ASTM C990. The seal shall be a single continuous part conforming to the joint shape. The outer surface shall be completely covered with a natural skin. The cross-sectional diameter and installation shall be in accordance with the manufacturer’s recommendations for the size of pipe being placed.

1057.10 **Silicone Expansion Joint Sealant.** The sealant for expansion joints shall be in accordance with Sec 717.30. The silicone joint sealant shall be a rapid cure, self-leveling, cold applied, two-component silicone sealant. The sealant shall demonstrate resilience, flexibility and resistance to moisture and puncture upon curing. The sealant shall demonstrate excellent adhesion to Portland cement concrete, polymer concrete and steel over a range of temperatures from –30 to 130°F, while maintaining a watertight seal. The sealant shall not contain any solvents or diluents that cause shrinkage or expansion during curing. Acid-cure sealants shall not be used. The date of manufacture or “use by” date shall be provided with each lot of sealant or primer. Material 12 months old or older from the date of manufacture or past the “use by” date shall not be used. The Engineer reserves the right to test
The manufacturer shall certify that the sealant meets or exceeds the following test requirements before installation begins:

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each component as supplied</td>
<td></td>
</tr>
<tr>
<td>Specific Gravity (ASTM D 1475)</td>
<td>1.2 - 1.4</td>
</tr>
<tr>
<td>Extrusion Rate (ASTM C 1183)</td>
<td>200 - 550 g/minute</td>
</tr>
<tr>
<td>Durometer Hardness, Shore (ASTM D 2240)</td>
<td>30 – 60</td>
</tr>
<tr>
<td>&quot;00&quot; (0°C and 25°C ± 1°C [77 ± 3°F])</td>
<td></td>
</tr>
<tr>
<td>Ozone and U.V. Resistance (ASTM C 793)</td>
<td>No chalking, cracking or bond loss after 5000 hrs.</td>
</tr>
<tr>
<td>After Mixing</td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>Self-Leveling</td>
</tr>
<tr>
<td>Tack-Free Time (ASTM C 679)</td>
<td>60 minutes maximum</td>
</tr>
<tr>
<td>Upon Complete Cure: (ASTM D 5329(^a))</td>
<td></td>
</tr>
<tr>
<td>Joint Elongation (Adhesion to concrete/steel/polymer concrete)</td>
<td>600% minimum</td>
</tr>
<tr>
<td>Joint Modulus (at 100% elongation)</td>
<td>3-12 psi</td>
</tr>
</tbody>
</table>

\(^a\) Modified; Sample cured two days at 77 ± 2°F and 50 ± 5 percent relative humidity.

1057.11 Silicone Joint Sealant for Saw Cut and Formed Joints. The sealant for sawed and formed joint shall be in accordance with Sec 717.40. The silicone joint sealant shall be a cold applied, single component, chemically curing gray sealant with 100 percent elongation and 50 percent compressive joint movement capability. The sealant shall be type NS (Non-Sag) and the physical properties shall be in accordance with ASTM D 5893 and the following:

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Gray</td>
</tr>
<tr>
<td>Tack free time</td>
<td>35 – 75 minutes</td>
</tr>
<tr>
<td>Cure time</td>
<td>7 days @ 75°F –90°F and 45 – 55 % relative humidity</td>
</tr>
<tr>
<td>Elongation</td>
<td>1200 % minimum</td>
</tr>
</tbody>
</table>

1057.12 Documentation. All material specified in this section shall include certification showing representative test results of the material and certify that the material supplied is in accordance with these specifications.
SECTION 1058
POLYETHYLENE SHEETING

1058.1 Scope. This specification covers polyethylene sheeting for use in highway construction.

1058.2 Polyethylene Sheet for Curing. Polyethylene sheeting for curing Portland cement concrete shall be white and shall be in accordance with ASTM C 171.

1058.3 Polyethylene Sheet as a Bond Breaker. Polyethylene sheeting for use as a bond breaker between a bridge approach slab and a granular base shall be in accordance with ASTM E 1745 Performance Class A.

1058.4 Certification and Acceptance. The Contractor shall furnish a manufacturer’s certification that the material supplied is in accordance with these requirements.
SECTION 1059
PROTECTIVE COATING MATERIAL

SECTION 1059.10 PROTECTIVE COATING—CONCRETE BENTS AND PIERS (URETHANE)

1059.10.1 Scope. This material will typically be applied under expansion devices for protection from deleterious agents in areas where aesthetics is not a high priority.

1059.10.2 General Requirements. The material shall be suitable for outdoor exposure and shall be resistant to deterioration by ultraviolet light. Additives for ultraviolet stabilization shall not be added after the original manufacturing process. The material shall be suitable for application to concrete surfaces. Surface preparation shall be in accordance with the manufacturer’s recommendations. The material shall be suitable for application to obtain a thickness of 40 mils, dry film without runs or sags when applied to a vertical concrete surface. The material shall have a minimum shelf life, in unopened containers, of at least six months from the date of delivery.

1059.10.3 Cured Material. The cured material shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore A Hardness, ASTM D 2240 (Material shall be cured in 40 mil thick film for 7 days at 75 ± 2°F at 50% relative humidity. Test specimen shall be composed of plied pieces, to a minimum 1/4 inch thickness).</td>
<td>15, minimum</td>
</tr>
<tr>
<td>Tensile Strength, ASTM D 412 (Method and time of cure may be modified as recommended by the manufacturer).</td>
<td>45 psi, minimum</td>
</tr>
<tr>
<td>Elongation, ASTM D 412 (Method and time of cure may be modified as recommended by the manufacturer).</td>
<td>200 percent, minimum</td>
</tr>
<tr>
<td>Water Vapor Permeability, ASTM D 1653 or ASTM E 96, Method BW 40 mil film thickness.</td>
<td>0.8 perms, maximum</td>
</tr>
</tbody>
</table>

1059.10.4 Packaging. All two-component materials shall be prepackaged to exact mixing quantities.

1059.10.5 Manufacturer and Brand Name Qualification. Prior to approval and use, the manufacturer shall submit a representative one-gallon sample to the Engineer. Upon approval of the material, the brand name and manufacturer will be placed on a list of qualified Urethane Protective Coating Agents for Concrete Bents and Piers. The sample shall be identified by brand name, manufacturer’s name and address, and shall be accompanied by the following:

   (a) Manufacturer’s complete material data showing typical test results for the properties specified, generic name of the major components of the material, mixing instructions, surface preparation and application instructions and intended use.

   (b) Test results after 1000 hours of exposure in an accelerated weathering device, in accordance with ASTM D 822, Procedure B. The film thickness of test specimens shall be 40 mils and shall show no cracking, flaking or blistering after exposure. Slight discoloration will be permitted.

   (c) In lieu of the accelerated weathering test results required in Sec 1059.10.5(b), the manufacturer may submit a use history showing satisfactory performance for three years in at least two exposed applications. Name, address and telephone number of the users shall be included in the use history.
1059.10.6 Acceptance. The Contractor shall furnish a manufacturer's certification stating that the material supplied is in accordance with all requirements specified and that the material furnished is of the same composition as originally qualified. The Engineer reserves the right to sample the material at destination if deemed necessary.

SECTION 1059.20 PROTECTIVE COATING – CONCRETE BENTS AND PIERS (EPOXY)

1059.20.1 Scope. This specification covers two-component modified polyamide converted epoxy to be used as shown on the plans. This material will typically be applied under expansion devices where aesthetics is a high priority.

1059.20.2 Material. The material shall be suitable for application to obtain a minimum coating thickness of 6 mils, dry film without runs or sags when applied to a vertical concrete surface. Pot life and method and time of cure shall be in accordance with the manufacturer’s recommendation. The material shall be suitable for outdoor exposure and shall be resistant to deterioration by ultraviolet light. Additives for ultraviolet stabilization shall not be added after the original manufacturing process. The material shall have a minimum shelf life, in unopened containers, of at least six months from the date of delivery.

1059.20.2.1 Color. The color shall be clear or concrete gray.

1059.20.2.2 Finish. The finish shall be high gloss.

1059.20.3 Packaging. Two-component material shall be prepackaged to exact mixing quantities.

1059.20.4 Manufacturer and Brand Name Qualification. Prior to approval and use, the manufacturer shall submit a representative one-gallon sample to the Engineer. Upon approval of the material, the brand name and manufacturer will be placed on a list of qualified Epoxy Protective Coating Agents for Concrete Bents and Piers. The sample shall be identified by brand name, manufacturer's name and address, and accompanied by the following information:

(a) Manufacturer's complete material data showing typical test results for the properties specified, generic name of the major components of the material, mixing instructions, surface preparation and application instructions and intended use.

(b) Test results after 1000 hours of exposure in an accelerated weathering device shall be provided. The tests shall be conducted in accordance with ASTM D 822 or ASTM G 154 using test cycle No. 2 defined in ASTM D 822, except that during the six hour period of darkness, the relative humidity of the air shall be 95 ± 4%. If ASTM G 154 QUV exposure testing is used, Type A lamps shall be used.

1059.20.4.1 For either test, specific operating conditions shall be summarized and provided with the test results. The film thickness on test specimens shall be 6 mils and shall show no cracking, flaking or blistering after exposure. Only slight discoloration will be permitted.

1059.20.4.2 In lieu of the accelerated weathering test results required in Sec 1059.20.4(b), the manufacturer may submit a use history showing satisfactory performance for three years in at least two exposed applications. Name, address and telephone number of the users shall be included in the use history.

1059.20.5 Acceptance. The Contractor shall furnish a manufacturer's certification stating that the material supplied is in accordance with all requirements specified and that the material furnished is of the same composition as originally qualified. The Engineer reserves the right to sample the material at destination if deemed necessary.

SECTION 1059.30 CONCRETE AND MASONRY PROTECTION SYSTEM
1059.30.1 **Scope.** This specification covers clear penetrating siloxane or silane based sealer for use as shown on the plans.

1059.30.2 **Physical Properties.** The sealer shall be breathable and non-yellowing and shall be in accordance with the following requirements:

<table>
<thead>
<tr>
<th>Concrete and Masonry Protection System</th>
<th>Sealer Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specification Item</strong></td>
<td><strong>Vertical Application</strong></td>
</tr>
<tr>
<td>Solids Content, percent by weight, min.</td>
<td>6.7</td>
</tr>
<tr>
<td>Reduction in Water Absorption, percent, min.</td>
<td>80</td>
</tr>
<tr>
<td>Reduction in Chloride Intrusion, percent, min.</td>
<td>82</td>
</tr>
<tr>
<td>Water Vapor Transmission, percent, min.</td>
<td>110</td>
</tr>
</tbody>
</table>

\[a\] Tested in accordance with NCHRP 244 Series tests.

1059.30.3 **Manufacturer and Brand Name Qualification.** Prior to approval and use, the manufacturer shall submit a representative one-quart sample to the Engineer. The sample shall be identified as to brand name, designation as to horizontal or vertical application, manufacturer’s name and address, and shall be accompanied by the manufacturer’s data and application sheets, and test results in accordance with Sec 1059.30.2. The manufacturer shall submit certification that the material complies with all requirements of this specification. Upon approval of the material, the brand name and manufacturer will be placed on a list of qualified Concrete and Masonry Protection Systems.

1059.30.4 **Field Approval.** Prior to application of the sealer, including bulk purchase and delivery of products, the Contractor shall prepare a minimum 12 x 12 inch application sample on each of the specified concrete or masonry products for the purpose of demonstrating the final effect, visual and physical/chemical, of the planned installation. The Contractor shall proceed with work only after the Engineer’s acceptance of the test application for color and compatibility with the substrate.

1059.30.5 **Acceptance.** The Contractor shall furnish a manufacturer’s certification stating that the material supplied is in accordance with all requirements specified and that the material furnished is of the same composition as originally approved. The Engineer reserves the right to sample the material at destination if deemed necessary.

**SECTION 1059.40 SACRIFICAL GRAFFITI PROTECTION SYSTEM**

1059.40.1 **Scope.** This specification covers a sacrificial graffiti protection system for application to all surfaces as shown on the plans.

1059.40.2 **Physical Properties.** The sacrificial graffiti protection system shall be in accordance with the following physical properties and shall be chemically compatible with any other coatings to be used. The material shall be suitable for application to obtain a wet-film thickness of 4 to 6 mils without runs or sags when applied to a vertical surface.

<table>
<thead>
<tr>
<th>Sacrificial Graffiti Protection System</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting Point, F, ASTM F 766</td>
<td>165 ± 5</td>
</tr>
<tr>
<td>Solids Content, min., percent by weight, ASTM D 2834</td>
<td>26</td>
</tr>
<tr>
<td>Volatile Organic Content (VOC), lb/gal, max, ASTM D 3960</td>
<td>0.58</td>
</tr>
</tbody>
</table>
1059.40.3 Manufacturer and Brand Name Qualification. Prior to approval and use, the manufacturer shall submit a representative one-gallon sample to the Engineer. The manufacturer shall submit documentation to the Engineer stating brand name, manufacturer’s name and address and accompanied by the manufacturer’s data and application sheets. The manufacturer shall submit certification, including specific test results, that the material complies with all requirements of this specification. Upon approval of the material, the brand name and manufacturer will be placed on a list of qualified Sacrificial Graffiti Protection Systems.

1059.40.4 Field Approval. Prior to application of the sacrificial graffiti protection system, including bulk purchase and delivery of products, the Contractor shall prepare a minimum 12 x 12 inch application sample on each of the specified concrete or masonry products for the purpose of demonstrating the compatibility of the planned installation. If the sacrificial graffiti protection system is to be applied over previous coatings, the test specimen shall have already received these previous coatings. The Contractor shall proceed with work only after the Engineer’s acceptance of the test application for appearance and compatibility.

1059.40.5 Acceptance. The Contractor shall furnish a manufacturer’s certification stating that the material supplied is in accordance with all requirements specified and that the material furnished is of the same composition as originally approved. The Engineer reserves the right to sample the material at destination if deemed necessary.

SECTION 1059.50 TEMPORARY COATING – CONCRETE BENTS AND PIERs (WEATHERING STEEL)

1059.50.1 Scope. This specification covers a system for protection against absorptive staining from unpainted, corrosion-resistant steel during initial weathering as shown on plans.

1059.50.2 Physical Properties. The temporary coating shall be in accordance with the following physical properties and shall be compatible with any other coatings to be used. The material shall be suitable for application to obtain a wet-film thickness of 4 to 6 mils without runs or sags when applied to a vertical surface.

| Temporary Coating – Concrete Bents and Piers (Weathering Steel) |
|---|---|
| Item | Requirement |
| Melting Point, F, ASTM F 766 | 165 ± 5 |
| Solids Content, min., percent by weight, ASTM D 2834 | 26 |
| Volatile Organic Content (VOC), lb/gal, max, ASTM D 3960 | 0.58 |

1059.50.3 Manufacturer and Brand Name Qualification. Prior to approval and use, the manufacturer shall submit a representative one-gallon sample to the Engineer. The manufacturer shall submit documentation to the Engineer stating brand name, manufacturer’s name and address, and accompanied by the manufacturer’s data and application sheets. The manufacturer shall submit certification, including specific test results, that the material complies with all requirements of this specification. Upon approval of the material, the brand name and manufacturer will be placed on a list of qualified Rust Staining Protection Systems.

1059.50.4 Acceptance. The Contractor shall furnish a manufacturer’s certification stating that the material supplied is in accordance with all requirements specified and that the material furnished is of the same composition as originally approved. The Engineer reserves the right to sample the material at destination if deemed necessary.
SECTION 1060
ELECTRICAL CONDUIT

1060.1 Scope. This specification covers electrical conduit to be used as specified or as shown on the plans.

1060.2 Acceptance. All material in this section will be accepted based on certification indicating the material is in accordance with this specification and any testing as required by the Engineer.

1060.3 Material.

1060.3.1 Rigid Metallic Conduit and Tubing. Except for rigid aluminum conduit, rigid metallic conduit shall be galvanized on both the inside and the outside surfaces. The weight of zinc coating shall be no less than 0.5 ounce per square foot of coated surface, as determined in accordance with AASHTO T 65. The interior or exterior surface, or both, may be given a coating of suitable material to facilitate installation of wires and cables and to permit the conduit to be readily distinguished from pipe used for purposes other than electrical.

1060.3.1.1 Rigid Steel Conduit, Zinc Coated. Rigid steel conduit, zinc coated, (GRC) shall be in accordance with ANSI C80.1, except as noted herein.

1060.3.1.2 Intermediate Metal Conduit. Intermediate metal conduit (IMC) shall be in accordance with ANSI C80.6, except as noted herein.

1060.3.1.3 Rigid Aluminum Conduit. Rigid aluminum conduit (RAC) shall be in accordance with ANSI C80.5.

1060.3.1.4 Electrical Metallic Tubing, Zinc Coated. Electrical metallic tubing (EMT), zinc coated, shall be in accordance with ANSI C80.3 except as noted herein.

1060.3.1.5 Fittings for Rigid Metal Conduit and Electrical Metallic Tubing. Fittings shall be in accordance with ANSI C80.4.

1060.3.1.6 Fittings for Intermediate Metal Conduit. Fittings shall be in accordance with UL 1242, except the coating shall meet the same requirements as the conduit with which the fittings are used.

1060.3.1.7 Inspection. Conduit, tubing and fittings will be inspected for compliance with specifications. Test specimens for determination of weight of coating will be at least 2 inches long, cut no less than 6 inches from the end of the length of conduit or tubing selected for testing. If the prescribed two additional samples for retests are taken, and either sample does not comply, the lot represented will be rejected.

1060.3.2 Rigid Non-Metallic Conduit. Rigid non-metallic conduit shall be either polyvinyl chloride (PVC) or high-density polyethylene (HDPE).

1060.3.2.1 Polyvinyl Chloride Conduit. PVC conduit, bends, couplings and fittings shall be in accordance with UL 651.

1060.3.2.2 High Density Polyethylene Conduit. HDPE conduit shall be in accordance with ASTM D 3035 SDR11.

1060.3.2.3 Fittings for Polyvinyl Conduit. Fittings for PVC conduit shall be in accordance with UL 514. Cement used for the fittings shall be in accordance with the conduit manufacturer’s recommendations.

1060.3.2.4 Fittings for High Density Polyethylene Conduit. Fittings for HDPE conduit shall be in accordance with ASTM D 2683. Epoxy used for the fittings shall be in accordance with the conduit manufacturer’s recommendations.
1060.3.2.5 Inspection and Testing. Material will be inspected for compliance with the specifications, and samples for testing will be taken at either the project location or warehouse, as determined by the Engineer.

1060.4 Certification. The Contractor shall furnish a manufacturer's certification that the material supplied is in accordance with all requirements. If requested by the Engineer, the Contractor shall also furnish typical test results representative of the material.
1061.1 General. This specification covers electrical conductors and associated material for use on highway construction projects. Contractor furnished equipment that will become the property of the County shall be of new stock unless stated otherwise in the contract documents. Electrical conductors and associated equipment shall be in accordance with applicable requirements of ICEA, IMSA, NEMA, EIA, NEC, NFPA and regulations of the National Board of Fire Underwriters and shall meet the approval of the Engineer.

1061.2 Conductors. Except as noted, all conductors shall be soft drawn, Class B or C stranded copper wire in accordance with NEMA WC70/ICEA A-95-658. Solid conductors may be used only for grounding where connected to a ground rod.

1061.3 High Voltage Power Cable. The voltage rating for high voltage power cable supplying primary electrical power shall be 5 KV for primary voltages less than 5,000 volts, and 15 KV for voltages of 5,000 volts and greater. The specific type of cable shall be as recommended and approved by the utility company or municipality supplying power.

1061.4 Low Voltage Power Cable. Low voltage power cable shall be 600-volt, single conductor cable and thermoplastic or thermosetting cross-linked polyethylene insulated. All cable shall be plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice. Insulation type shall be THHN/THWN-2 or XHHW-2. Average thickness of insulation shall be no less than specified in the following table, with a minimum thickness of 90 percent thereof.

<table>
<thead>
<tr>
<th>Size (AWG or kcmil)</th>
<th>Thickness, Mils THHN/THWN-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-12</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>8-6</td>
<td>30</td>
</tr>
<tr>
<td>4-2</td>
<td>40</td>
</tr>
<tr>
<td>1-4/0</td>
<td>50</td>
</tr>
<tr>
<td>250-500</td>
<td>60</td>
</tr>
<tr>
<td>501-1000</td>
<td>70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (AWG or kcmil)</th>
<th>Thickness, Mils THHN/XHHW-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-12</td>
<td>30</td>
</tr>
<tr>
<td>8-2</td>
<td>45</td>
</tr>
<tr>
<td>1-4/0</td>
<td>55</td>
</tr>
<tr>
<td>213-500</td>
<td>65</td>
</tr>
<tr>
<td>501-1000</td>
<td>80</td>
</tr>
</tbody>
</table>

1061.5 Cable-Conduit. Cable-conduit shall consist of one to four low voltage power cables with an insulated sized electrical neutral and a bare safety ground, factory installed in black polyethylene conduit intended for direct burial. The conduit shall be plainly marked on the outside with manufacturer's name and identification in accordance with industry practice and shall be in accordance with ASTM D 3485. Cable conduit shall be accompanied by the manufacturer's certification stating the conduit is in accordance with the requirements of this specification.

1061.6 Pole and Bracket Cable. Pole and bracket cable located in the lighting or signal pole that supplies electrical power to highway lighting shall consist of two single conductors. Wire size shall be No. 10 AWG in accordance with the requirements of low voltage power cable. Insulation type shall be THHN/THWN-2 or XHHW-2. Average insulation shall be in accordance with Sec 1061.4.
1061.7 Multi-Conductor Cable. Multi-conductor cable for traffic signals shall be No. 14 AWG, rated at 600 volts. The cable shall be in accordance with IMSA Specification No. 19-1 or No. 20-1.

1061.8 Induction Loop Detector Cable. Induction loop detector cable shall be single-conductor No. 14 AWG wire, with Type XHHW insulation, marked as such, rated at 600 volts. The cable shall be in accordance with IMSA Specification No. 51-7.

1061.9 Loop Detector Lead-In Cable. Lead-in cable used between the loop detector and the controller shall be two-conductor, twisted, shielded No. 14 AWG wire rated at 600 volts. The cable shall be in accordance with IMSA Specification No. 50-2.

1061.10 Certification. All cables and conductors shall be accompanied by certification from the supplier indicating:

   (1) the supplier is familiar with the requirements of these specifications and,

   (2) cable furnished was from a lot manufactured by (manufacturer’s name) whose test results are in accordance with these specifications.
SECTION 1062
PULL AND JUNCTION BOXES

1062.1 Scope. This specification covers pull and junction boxes intended for use on highway lighting and traffic signal projects.

1062.2 Pull Boxes. Pull boxes may be cast-in-place concrete, precast concrete, preformed polymer concrete or preformed fiberglass reinforced polymer concrete. Pull box dimensions shall be as shown on the plans. Each pull box shall be equipped with cable hooks as shown on the plans. Cable hooks shall be galvanized steel or brass with a minimum diameter of 3/8 inch and a minimum length of 5 inches.

1062.2.1 Cast-in-place concrete pull boxes shall be constructed of Class B or B-1 concrete, or a commercial mixture in accordance with Sec 501. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Sec 501. Placing, finishing and curing shall be in accordance with Sec 703. Pull boxes shall be cast in a neat and workmanlike manner. Forms will be required for the inside and outside surfaces of the pull box walls. An outside form shall be installed across all trenches leading into the pull box excavation. The ends of all conduits through the walls shall fit tightly against the form.

1062.2.2 Precast concrete pull boxes shall be constructed of Class B or B-1 concrete, or a commercial mixture in accordance with Sec 501. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Sec 501. Concrete for precast pull boxes shall be placed, finished and cured in accordance with Sec 703.

1062.2.3 Preformed pull boxes shall withstand a wheel load of 20,000 pounds. Pull box walls may be either flared or vertical. Pull boxes shall have a collar or ring at the top that will allow for securing the concrete apron. Metal conduit, if used in preformed pull boxes, shall be electrically bonded to one another inside each pull box.

1062.3 Pull Box Covers. Each pull box shall be equipped with a bolt down cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow the cleanout of sand, dirt and other debris. Lock-down bolts shall be stainless steel with a penta-head. Frames and covers for cast-in-place and precast concrete pull boxes shall be cast iron in accordance with AASHTO M 105, Class 30, and shall be of the dimensions and weights shown on the plans. Preformed pull box covers shall be polymer concrete and shall have a minimum wheel load rating of 20,000 pounds. A lift opening shall be provided on all covers. Covers for pull boxes to be used for highway lighting or sign lighting shall be embossed with "LIGHTING". Covers for pull boxes to be used for traffic signals, or a combination of traffic signals and 120 volt intersection lighting, shall be embossed with "TRAFFIC SIGNALS". Covers for pull boxes to be used for fiber optics shall be embossed with "FIBER OPTICS".

1062.4 Junction Boxes. Junction boxes shall be flanged and designed for flush mounting if encased in concrete, or designed for surface mounting if external mounting is specified. Junction boxes shall be drilled or tapped for all conduit connections. Junction boxes shall be installed such that covers are removable. Junction boxes shall be stainless steel, fiberglass or PVC watertight NEMA 4 enclosures. PVC junction boxes shall have a minimum wall thickness of 1/4 inch. Junction boxes shall be in accordance with the following minimum sizes unless otherwise specified:

<table>
<thead>
<tr>
<th>Maximum Entering Conduit Size, Inches</th>
<th>Minimum Box Size, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>12 x 12 x 4</td>
</tr>
<tr>
<td>4</td>
<td>16 x 12 x 6</td>
</tr>
</tbody>
</table>
1062.4.1 PVC and metal conduit shall be joined to junction boxes to make a rigid and waterproof connection. If metal conduit is used, an insulated bushing shall be provided at the end of the metal conduit on the inside of the junction box to prevent scuffing of the cable insulation.

1062.4.2 The junction box cover shall be made watertight with a suitable gasket and secured with stainless steel or cadmium plated screws or bolts.

1062.5 Certification and Acceptance. The Contractor shall furnish a manufacturer's certification that the material supplied, excepting material made from cast-in-place concrete, is in accordance with these specifications.
SECTION 1063
TEMPORARY TRAFFIC CONTROL DEVICES

1063.1 Scope. This specification covers material to be used for temporary traffic control devices.

1063.2 General Requirements. All temporary traffic control devices shall be manufactured as shown on the plans and as specified, in accordance with MUTCD requirements and shall be NCHRP 350 compliant. Nominal dimensions will be permitted for dimensional lumber where applicable. All temporary traffic control devices shall exhibit good workmanship and shall be free of objectionable marks or defects that affect appearance or serviceability. The brand name or model number shall be permanently identified on each traffic control device.

1063.3 Channelizers. All trim-lines and drum-like channelizers shall be manufactured from a non-metallic material, pigmented and molded of a Highway Orange color throughout and stabilized against fading by ultraviolet or other light rays by the incorporation of adequate inhibitors. All reflective sheeting for channelizers shall be in accordance with Sec 1042.2.7.3.

1063.3.1 Temporary Tubular Delineators. Temporary tubular delineators shall be a nominal height of 28 inches and manufactured from a non-metallic material, pigmented and molded of a Highway Orange color throughout and stabilized against fading by ultraviolet or other light rays by incorporation of adequate inhibitors. All reflective sheeting for temporary tubular delineators shall be in accordance with Sec 1042.2.7.5.

1063.4 Type III Movable Barricades. Type III movable barricades shall be entirely free standing and portable. Marking shall only be applied to one side of the barricade, except when used for roadway closures.

1063.5 Signs.

1063.5.1 Rigid Signs.

1063.5.1.1 Sign Substrate. All signs shall be fabricated of substrate designed to provide satisfactory structural rigidity.

1063.5.1.2 Sign Sheeting. All signs shall have a retroreflectORIZED background. Retroreflective sheeting shall be in accordance with Sec 1042.2.7.2. Sheeting shall be applied to the sign substrate in accordance with the manufacturer’s recommendations and the surface shall be free of air bubbles, wrinkles or other blemishes as determined by the Engineer.

1063.5.2 Roll-up Signs.

1063.5.2.1 Sign Substrate. Sign and overlay blanks shall consist of fluorescent orange microprismatic retroreflective sheeting sealed to a heavy-duty coated fabric or vinyl material. The sheeting shall have a minimum coefficient of retroreflection, expressed as candelas per footcandle per square foot (candelas/lux/m²), as shown below, when measured in accordance with ASTM E 810. The color specifications shall be in accordance with ASTM D 4956. Material shall be submitted by the manufacturer to NTPEP for a minimum exposure time of one year. Results shall be published by NTPEP and available for review by the County Highway Department. For all NTPEP test decks, weathered material shall be within the color specification limits. Heat and impact resistance of the sheeting shall be in accordance with the latest version of ASTM D 4956.
Minimum Coefficient of Retroreflection for Fluorescent Orange Sheeting

<table>
<thead>
<tr>
<th>Observation Angle, Degrees</th>
<th>Entrance Angle, Degrees</th>
<th>Candelas/footcandle/ft² (Candelas/lux/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>-4</td>
<td>115</td>
</tr>
<tr>
<td>0.2</td>
<td>+30</td>
<td>65</td>
</tr>
<tr>
<td>0.5</td>
<td>-4</td>
<td>72</td>
</tr>
<tr>
<td>0.5</td>
<td>+30</td>
<td>41</td>
</tr>
</tbody>
</table>

1063.5.2.2 Overlays. Overlays, when used, shall be mechanically fastened to the face of the sign in a manner that will ensure the overlay remains securely attached. Fasteners shall not detract from the appearance of the sign when the overlay is not in use. Velcro fasteners will not be permitted.

1063.5.2.3 Bracing. Each sign shall have a horizontal and vertical cross brace and at least one anti-kiting device located near the center of the sign. Cross braces of sufficient cross-section shall be fastened to each other at the midpoints and the ends securely held to the back of the sign by mechanical means. The design shall ensure that the sign remains taut and retains the sign’s intended shape when exposed to normal field conditions.

1063.5.3 Legend and Borders. Legends and borders of all signs shall be vinyl or silk-screened. Vinyl shall be cut by die or a computer-driven cutter. Stencil ink used shall be in accordance with the sheeting manufacturer’s recommendations. Free-hand legend and borders will not be permitted.

1063.5.4 Sign Layout and Design. Sign layout and design shall be as shown on the plans or as directed by the Engineer.

1063.5.5 Flag Assembly. Flag assemblies, when specified, shall consist of a flag bracket and two flags. Flags shall be 18 in x 18 in fluorescent orange, vinyl and be securely attached on one side to a blank suitable for displaying the flag as shown on the plans. The flag shall not be of mesh material. The blank shall be securely attached to the flag bracket, be of sufficient cross-section to display the flag in wind speeds up to 50 mph and be of sufficient length to hold the flags approximately six inches from the sign.

1063.5.6 Advance Warning Rails. Advanced warning rails shall be supplied as a system of three rails as shown on the plans. The rail system may be post mounted or mounted on portable structures. When used on post mounted signs, the advance warning rails shall consist of substrate of high-density polyethylene plastic. The rail wall thickness shall be 1/4 inch with white and orange reflective sheeting in accordance with Sec 1042.2.7.4, and shall be applied as shown on the plans.

1063.6 Warning Lights.

<table>
<thead>
<tr>
<th>Item</th>
<th>Type A Low Intensity</th>
<th>Type B High Intensity</th>
<th>Type C Steady Burn</th>
<th>Sequential Flashing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens Directional Faces</td>
<td>1 or 2</td>
<td>1</td>
<td>1 or 2</td>
<td>1</td>
</tr>
<tr>
<td>Flashing Rate per Minute</td>
<td>55 to 75</td>
<td>55 to 75</td>
<td>Constant</td>
<td>55 to 75</td>
</tr>
<tr>
<td>Minimum (1)</td>
<td>10%</td>
<td>8%</td>
<td>Constant</td>
<td>Constant</td>
</tr>
<tr>
<td>Hours of Operation</td>
<td>Dusk to Dawn</td>
<td>24 hrs/day</td>
<td>Dusk to Dawn</td>
<td>24 hrs/day</td>
</tr>
</tbody>
</table>

1063.7 Flashing Arrow Panels. All lamps shall have a nominal 5 inch, 360-degree tunnel visor. A lamp on the back side of the flashing arrow panel shall be continuously energized during operation of the flashing arrow panel. Lamps shall be visible at an angle of 15 degrees to the left and right of center and 4 degrees above and below center during “on” time. The flashing arrow panel shall contain a device to align the arrow panel to oncoming traffic. Arrow panels
shall be capable of displaying the flashing arrow, flashing double arrow and four corner flashing caution modes. Solar-powered flashing arrow panels shall be capable of operating in the flashing arrow mode for 20 consecutive days and shall be provided with a device to indicate the remaining charge in batteries.

1063.7.1 Trailer-Mounted Flashing Arrow Panels. Trailer-mounted flashing arrow panels shall be MUTCD, Type C. Trailer-mounted flashing arrow panels shall be solar powered.

1063.7.2 Truck-Mounted Flashing Arrow Panels. Truck-mounted flashing arrow panels shall be MUTCD, Type B.

1063.8 Changeable Message Sign. Each Changeable Message Sign (CMS) shall consist of a message board, solar power supply, control systems and mounting and transporting equipment.

1063.8.1 Message Board. The CMS shall be equipped with a power source and battery back-up to provide continuous operation when failure of the primary power source occurs. Either message board shall be capable to provide three lines of eight individual changeable characters per line. Each character shall be yellow in display on a black background and be a minimum of 18 inches. The CMS shall be legible up to a distance of 650 feet for both day and night operation.

1063.8.2 Solar Power Supply. The CMS shall be equipped with a power source and battery back-up to provide continuous operation when failure of the primary power source occurs.

1063.9 Portable Traffic Signals. Each portable traffic signal (PTS) system shall consist of two trailer-mounted PTS units, a controller assembly and communication link. Each PTS unit shall consist of signal heads and indications, a solar power supply, vehicle detection and mounting and transporting equipment. All components shall be capable of operating in a temperature range of -20 to 120°F.

1063.9.1 Controller Assembly. The controller assembly shall be a minimum two-phase, solid-state traffic signal controller with a conflict monitor capable of operating the signals in accordance with MUTCD requirements and NEMA Standard TS1. The controller shall operate as a fully-actuated unit and shall have the capability of being manually operated to display simultaneous red on both phases. The controller shall be capable of red rest during non-actuated periods. Upon detection of a conflict, the system shall change to a solid red clearance interval followed by flashing red.

1063.9.2 Communication Link. A continuous communications link between the PTS units shall be provided. If a break in communications between the PTS units occurs, the system shall change to a solid red clearance interval followed by flashing red. Upon restoration of communications, the system shall change to a solid red clearance interval followed by normal operations.

1063.9.3 Signal Heads and Indications. Each unit shall consist of two polycarbonate signal heads, including backplates and visors. One signal head shall be mounted on the mast arm assembly and the other on the vertical upright. The signal head mounted on the mast arm shall provide a minimum lateral clearance of 9.5 feet from the center of the outer signal head to the edge of the trailer and a minimum vertical clearance of 16 feet from the bottom of the backplate to the roadway surface. The signal head mounted on the vertical upright shall provide a minimum clearance of 8 feet from the bottom of the backplate to the roadway surface. All signal indications shall be 12 inches in diameter. Traffic signal heads and indications shall be in accordance with the vehicle traffic control signal head requirements of ITE and NEMA Standard TS1 and TS2.

1063.9.4 Solar Power Supply. The power supply shall use a battery bank with sufficient capacity to operate the PTS for 20 consecutive days with no sun. All terminals and connections shall be clearly labeled.

1063.9.5 Vehicle Detection. Detection shall be provided by one of the non-intrusive vehicular detection methods specified in Sec 902 or temporary loop detectors with the capability of providing coverage for a 6 foot x 30 foot
Temporary loops shall be performed at the factory. The temporary loops shall have self-adhesive rubberized asphalt backing, which shall bond to the pavement.

1063.9.6 Support. A factory trained service representative shall be available at the delivery location to provide technical assistance and training, including the installation and operation of software. No additional payment will be made for travel expenses.

1063.10 Portable Signal Flagging Device. Each portable signal flagging device (PSFD) system shall consist of four portable cart-mounted units. Each PSFD unit shall provide a vertical upright with one signal head, vehicle detection, radio controller, and self-contained power supply capable of operating the unit for 16 continuous hours. All components shall be capable of operating in a temperature range of –20 to 120°F.

1063.10.1 Signal Heads and Indications. The signal head shall consist of three (red ball, amber ball, green ball) 12 inch LED signal indications. All signal heads shall be mounted on the vertical uprights with a minimum clearance of 7 feet when the upright is fully extended.

1063.10.2 Vehicle Detection. Detection shall be provided by one of the non-intrusive vehicular detection methods specified in Sec 902 with the capability of providing coverage for a 6 foot x 3 foot area.

1063.10.3 System Operation. The system shall be able to operate in a fixed-time, traffic-actuated, and manual control mode. The system shall be MUTCD compliant with a controller and conflict monitor and include a wireless radio communication package and wireless remote.

1063.11 Radar Speed Advisory System. Each radar speed advisory system shall consist of a radar unit, speed display, speed limit display, solar power supply and mounting and transporting equipment.

1063.11.1 Radar Unit. The radar unit shall include necessary cables for connection to the digital display and power supply, shall be capable of instantaneously displaying and locking readings and shall meet the following minimum requirements:

<table>
<thead>
<tr>
<th>Radar Unit Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed range</td>
<td>15 to 99 mph</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±1 mph</td>
</tr>
<tr>
<td>Internal test</td>
<td>32 mph check</td>
</tr>
</tbody>
</table>

1063.11.2 Speed Display. The speed display shall be a minimum of 12 inches high and shall be capable of displaying the radar unit output from 0 to 99 mph.

1063.11.3 Speed Limit Display. The speed limit display shall indicate the work zone speed limit by means of a 24” x 30” or a 36” x 48” speed limit sign, depending on the roadway classification as indicated by the MUTCD. The speed limit sign may be comprised of a rigid or roll-up sign or a rigid sign with a variable speed display. The variable speed display shall be a minimum of 12 inches high and shall be capable of displaying two digits.

1063.11.4 Solar Power Supply. The power supply shall be capable of operating the radar unit, speed display and speed limit display, if applicable, for a minimum of eight hours per day.

1063.12 Truck or Trailer Mounted Attenuators. Each Truck or Trailer Mounted Attenuator (TMA) shall be in accordance with Test Level 3 criteria as set forth in NCHRP 350 or MASH. Each TMA shall have a standard trailer lighting system, including brake lights, taillights, turn signal lights and Federal Motor Carrier Safety Administration identification bar lights. In the operating position, the rear facing of the TMA shall be marked with alternating 8 inch yellow and 8 inch black retroreflective sheeting forming an inverted “V” at the center and slope downward at an...
angle of 45 degrees toward each side of the unit or a checkered board pattern consisting of 12 inch square red and 12 inch square white retroreflective sheeting. The TMA may be marked with the same operating pattern or red and white DOT conspicuity tape to simulate the looks of a standard van body trailer when traveling. The TMA shall have the same standard trailer lighting system noted above when the unit is in the transport position.

1063.13 Certification. The Contractor shall furnish a manufacturer's certification for all material governed by this specification. The certification shall indicate full compliance with each applicable specification.
1064.1 Scope. This specification covers temporary concrete traffic barrier for use in highway construction.

1064.2 Type F Temporary Concrete Barrier.

1064.2.1 Acceptance.

1064.2.1.1 Three-Loop Concrete Barrier. The manufacturer shall provide certification to the Contractor that the barrier is in accordance with the contract documents.

1064.2.1.2 Two-Loop Concrete Barrier. District material personnel when notified to re-stamp previously accepted barrier will be responsible for re-stamping the barrier if the previous acceptance stamp is legible and if the barrier is not damaged to the extent that it is felt that the barrier cannot perform properly. Reasons for rejection will be, but not limited to:

(a) Exposed steel reinforcement.
(b) Damage or cracks in the connecting loops.
(c) Missing chunks of concrete.
(d) Excessive marring or scarring.
(e) Extensive scaling of the concrete
(f) Misalignment of the connecting loops that would hinder insertion of the keeper pin.

1064.2.2 Material.

1064.2.2.1 All material, in the manufacturing of three-loop type F temporary concrete barrier, shall be in accordance with the following specifications:

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>AASHTO M 31, Grade 60</td>
</tr>
<tr>
<td>Connection Rod</td>
<td>A36 Steel</td>
</tr>
<tr>
<td>Anchor Bolts</td>
<td>ASTM A 307</td>
</tr>
<tr>
<td>Connection Rod Assembly</td>
<td>AASHTO M 183</td>
</tr>
<tr>
<td>Retainer Bolt and Nut</td>
<td>SAE Grade 8</td>
</tr>
<tr>
<td>Asphalt Pin</td>
<td>A36 Steel</td>
</tr>
<tr>
<td>Thrie Beam</td>
<td>Nested 12 Gage or 10 Gage</td>
</tr>
<tr>
<td>Thrie Beam Bolts</td>
<td>ASTM A 307</td>
</tr>
</tbody>
</table>

1064.2.2.1.1 All reinforcing steel shall be deformed bar. Loop steel shall be 0.75 inch smooth steel bars with a minimum yield of 60 ksi, shall have a tensile strength of no less than 1.25 times the yield strength, but a minimum of 80 ksi, a minimum 14 percent elongation in 8 inches, and passing a 180-degree bend test using a 3.5 times diameter pin bend diameter. The loops shall be installed within 0.125 inch of the plan dimensions.

1064.2.2.1.2 The manufacturer shall retain, at a minimum, all compressive strength test results, entrained air content records, and reinforcing steel certification for at least five years.
1064.2.3 Manufacture.

1064.2.3.1 Welding of loop steel shall be limited to the minimum surface welding necessary to maintain the position required for placement.

1064.2.3.2 Visual cracks in the loop steel will be cause for rejection.

1064.2.3.3 Concrete shall be air-entrained with 28-day compressive strength of 5,000 psi. Concrete shall be continuously cured until 5,000 psi is attained. Fine and coarse aggregate shall be in accordance with Sec 1005, except that gradation requirements and percent passing the No. 200 sieve will not apply. Temporary concrete traffic barrier shall be manufactured in accordance with industry standard practices for pre-cast construction.

1064.2.3.4 All temporary concrete traffic barrier units shall be permanently marked with the name and location of the manufacturer, and the month and year of manufacture in a location visible after installation. Paint or other liquid marking will not be permitted.

1064.2.3.5 The surface of temporary concrete traffic barrier shall be smooth and non-deformed and substantially free of honeycomb, surface spalls and surface defects. Barrier units shall be straight and square on the ends and shall meet the following tolerances:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>+ 3/4 inch</td>
</tr>
<tr>
<td>Width</td>
<td>+ 1/4 inch</td>
</tr>
<tr>
<td>Height</td>
<td>+ 1/4 inch</td>
</tr>
</tbody>
</table>

1064.3 Alternative Temporary Traffic Barrier.

1064.3.1 Approval. Prior to approval and use, the manufacturer shall submit to the Engineer, the manufacturer’s name, the product brand name or model number, a copy of the MASH or NCHRP 350 test results, a copy of the FHWA acceptance letter, shop drawings and any other information requested by the Engineer.

1064.3.2 Acceptance. Acceptance of the material will be based on the manufacturer’s certification and upon satisfactory field performance.

1064.4 Certification. The manufacturer shall provide certification to the Contractor that the barrier is in accordance with the contract documents.
1065.1 **Scope.** This specification covers delineators for use in highway construction.

1065.2 **Delineator Body.** The delineator body shall be flat sheet aluminum in accordance with Sec 1042.2.1 and meet dimensions as shown on the plans.

1065.3 **Permanent Tubular Delineators.** Permanent tubular delineators shall be a nominal height of 36 inches and manufactured from a non-metallic material, pigmented and molded to match the color of the closest pavement or curb marking, and stabilized against fading by ultraviolet or other light rays by incorporation of adequate inhibitors.

1065.4 **Temporary Traffic Barrier Delineators.** Temporary tabs shall be manufactured from a thermoplastic material and meet dimensions as shown on the plans.

1065.5 **Retroreflective Sheeting.** Retroreflective sheeting shall be permanently affixed to the body of the delineator and follow guidelines in accordance with Sec 1042.2.7.5 for application of sheeting. Manufacturer’s certification shall be provided for delineator sheeting.
1066.1 **Scope.** This specification covers mortars and grout for use in pipe joints, rubble and brick masonry.

1066.2 **Mortars and Grout.** Mortars and grout shall be mixed in small quantities as needed and shall not be retempered or used after setting has begun. Type I Portland cement shall be accordance with Sec 1019. Sand shall be clean and shall be in accordance with Sec 1005, except the minus No. 200 sieve requirement will not apply. Water shall be in accordance with Sec 1070.

1066.2.1 **Mortar For Pipe Joints.** Mortar shall consist of one part Type I Portland cement and two parts sand, by volume, mixed with sufficient water to form a plastic mortar.

1066.2.2 **Mortar for Grout.** Mortar used for grout shall consist of one part Type I Portland cement and three parts sand, by volume, mixed with sufficient water to form a grout of proper consistency.

1066.2.3 **Mortar For Rubble and Brick Masonry.** The mortar shall be composed of one part Portland cement plus 10 percent, by volume, of hydrated lime and of two parts sand by volume. Hydrated lime shall be in accordance with ASTM C 207, Type N. After the dry material has been thoroughly mixed, water shall be added, and the mixture shall be turned and chopped by hand or mechanical methods until a stiff mortar results. Mortar shall be mixed no more than 30 minutes prior to use. Mortar for pointing shall be mixed in the proportions of one part Portland cement to one part sand by volume.

1066.2.4 **Expansive Mortar.**

1066.2.4.1 **Aluminum Powder Expansive Mortar.** The mortar shall consist of one part Type I Portland cement and three parts sand, by volume, mixed with sufficient water to form a stiff plastic mortar. Unpolished aluminum powder at the rate of 4 grams per sack of cement shall be thoroughly dry mixed with the cement before incorporation with other ingredients.

1066.2.4.2 **Other Expansive Mortars.** Upon approval from the Engineer, other expansive mortars may be used. The expansive mortars shall contain no more than 0.02 percent chlorides by weight and, when subjected to a pull-out test, shall equal or exceed the results of tests conducted using the material specified in Sec 1066.2.4.1.
1067.1 Scope. This specification covers truncated domes used for sidewalk curb cuts and pedestrian island cut throughs.

1067.2 Domes. Domes shall have a base diameter of 0.9 to 1.4 inches. The top diameter shall be 50 to 65 percent of the base diameter. The dome height shall be 0.2 inches. Dome center-to-center spacing shall be 1.6 to 2.4 inches with a minimum base-to-base spacing of 0.65 inches. Stamped concrete will not be accepted.

1067.3 Panels. Truncated dome surfaces shall extend a minimum of 24 inches in the direction of sidewalk travel and the full width of the curb ramp (exclusive of flares), the landing, or blended transition. The panels shall be made of a durable material. The panels shall carry a manufacturer warranty covering all defects for a five-year period from the time of installation.

1067.4 Acceptance. All material shall be obtained from a source identified on the MoDOT's Qualified List (QL) designated for this specification.
1070.1 Scope. This specification covers water for use in mixing and curing concrete, and for use in mortar and grout.

1070.2 Requirements. Water for use in mixing and curing concrete, and in mortar and grout, shall be reasonably clean and shall be free from injurious quantities of deleterious substances such as oil, acid, alkali, salt or organic matter. Potable water may be accepted without being tested. Requirements for testing water for mixing or curing purposes may be waived if in the judgment of the Engineer, the water is considered satisfactory for the purpose.

1070.3 Testing. As required by the Engineer, and if laboratory testing shows that the pH of the water is less than 4.5 or more than 9.5, or that the water contains deleterious substances, the following requirements shall also be met. Autoclaved bars, made with the water and a cement that shows satisfactory soundness when mixed with distilled water, shall show an expansion not to exceed 0.5 percent. The compressive strength at seven days of a mortar consisting of one part cement and 2.75 parts of natural silica sand and the water being tested shall show a reduction of no more than 10 percent of the compressive strength developed by 1:2.75 mortar containing the same cement and sand and mixed with distilled water.
1071.1 Scope. This specification covers asphalt release agents for use in coating truck beds and bituminous mixture additives.

1071.2 Acceptance. All material under this specification shall be obtained from a source identified on MoDOT’s Pre-Acceptance List (PAL) designated for this specification. All material will be inspected and accepted in accordance with Sec 106.

1071.3 Asphalt Release Agent. The asphalt release agent shall not be detrimental to bituminous mixtures and shall not dissolve asphalt binder when applied to the truck bed.

1071.3.1 Physical Properties. The following physical properties shall be determined.

1071.3.1.1 Unit Weight. The weight per gallon shall be determined in accordance with AASHTO T 59, Weight per Gallon of Emulsified Asphalt.

1071.3.1.2 Solids. The percent solids shall be determined in accordance with ASTM D 1644, Method A.

1071.3.1.3 Acidity or Alkalinity Level (pH). The pH of the undiluted agent shall be determined by appropriate methods.

1071.3.1.4 Asphalt Miscibility. When tested in accordance with MoDOT Test Method TM 63, the asphalt release agent shall show no evidence of dissolving the asphalt binder.

1071.3.2 Dilution. Dilution by diesel or other petroleum products will not be permitted.

1071.3.3 Documentation. The manufacturer shall submit a certification and guarantee to the County prior to initial approval showing the brand name and designation, the composition or description of the release agent, and the manner in which the material will be identified on the containers. The manufacturer shall certify that the material is in accordance with this specification and shall list typical values of current tests for the properties listed in Sec 1071.3.1. The certified test report shall show the manufacturer's name, brand name of material, lot and date tested. The manufacturer shall also submit a one-quart sample accompanied by an MSDS for the material. In addition, the manufacturer shall furnish information for any dilution requirements, including the minimum dilution rate and special application requirements.

1071.3.4 Packaging and Marking. The containers in which release agents are delivered shall be plainly marked with the manufacturer's name, the brand name and designation of the material, lot number and net quantity. Special applicators and dilution rates shall be designated on the container. Bulk shipments shall be accompanied by a delivery ticket showing this information.

1071.4 Bituminous Mixture Fiber Additives. Fibers for stone matrix asphalt mixture may be either cellulose or mineral fiber, and shall be in accordance with AASHTO MP8, Table 3 for cellulose fibers, or Table 4 for mineral fibers when tested in accordance with MoDOT Test Method TM 60.

1071.4.1 Documentation. The manufacturer shall submit a certification and guarantee to County or MoDOT Construction and Materials prior to initial approval, showing the brand name and designation, the composition or description of the fibers, and the manner in which the material will be identified on the containers. The manufacturer shall certify that the material is in accordance with this specification and shall list typical values of current tests for the properties listed in AASHTO MP8. The certified test report shall show the manufacturer's name,
brand name of material, lot and date tested. The manufacturer shall submit at least a 5-pound sample accompanied by an MSDS for the material.

1071.4.2 Packaging and Marking. The containers in which fibers are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number and net quantity. Bulk shipments shall be accompanied by a delivery ticket showing this information.

1071.5 Liquid Anti-Strip Additives. Liquid anti-strip additives shall not be detrimental to the bituminous mixture.

1071.5.1 Physical Properties. Amine-type liquid anti-strip additives that are physically mixed with the asphalt binder will be classified as Type I. Latex-type liquid anti-strip additives that are applied to the aggregate will be classified as Type II. The following physical properties shall be determined for each type.

1071.5.1.1 Type I Liquid Anti-Strip Additives.

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity @ 77°F</td>
<td>AASHTO T 228</td>
</tr>
<tr>
<td>Brookfield Viscosity 77°F using an RVT viscometer. The report shall include the corresponding test temperature, speed, spindle and model of instrument.</td>
<td>ASTM D2196</td>
</tr>
<tr>
<td>Pensky-Martens Closed Cup Flash Point or Cleveland Open Cup Flash Point</td>
<td>ASTM D93 AASHTO T 48</td>
</tr>
<tr>
<td>Infrared Spectrum (neat material)</td>
<td>Appropriate Method</td>
</tr>
</tbody>
</table>

1071.5.1.2 Type II Liquid Anti-Strip Additives.

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight Per Gallon @ 77°F</td>
<td>ASTM D1475</td>
</tr>
<tr>
<td>Brookfield Viscosity 77°F using an RVT viscometer. The report shall include the corresponding test temperature, speed, spindle and model of instrument.</td>
<td>ASTM D2196</td>
</tr>
<tr>
<td>pH</td>
<td>Appropriate Method</td>
</tr>
<tr>
<td>Percent Solids</td>
<td>ASTM D1644 Method A</td>
</tr>
<tr>
<td>Infrared Spectrum (latex portion)</td>
<td>Appropriate Method</td>
</tr>
</tbody>
</table>

1071.5.2 Heat Stability. The additive shall be stable and shall not separate under all manufacturer listed storage and use temperatures. When Type I or Type II additives are blended with the proposed bituminous material to be used at the anticipated application rate, the blended material shall still meet all bituminous material specifications and shall be heat stable. Heat stability shall be established by comparing AASHTO T 283 specimens made by preparing three conditioned specimens using aged, blended material that has been held at 325°F for 96 hours and three conditioned specimens using fresh blended material. The average tensile strength of conditioned specimens using aged material shall be compared with conditioned specimens made with fresh blended material. If the average conditioned strength of the mixture with aged material is less than 90 percent of the mixture with fresh blended material, the anti-strip additive will not be permitted for use. This requirement will also apply if tested on any specific mix design using the approved anti-strip additive.

1071.5.3 Unconditioned Strength. The anti-strip additive shall not significantly lower the unconditioned strength of AASHTO T 283 specimens. This shall be determined by preparing an additional six unconditioned specimens, three with and three without the liquid anti-strip additive. The average tensile strengths of unconditioned specimens shall be compared with specimens with and without the liquid anti-strip additive. If the average
unconditioned strength of the mixture with the additive is less than 90 percent of the mixture without the additive, the anti-strip additive will not be permitted for use in that bituminous mixture.

**1071.5.4 Documentation.** The manufacturer shall submit a certification and guarantee to County or MoDOT Construction and Materials prior to initial approval showing the brand name and designation, the composition or description of the anti-strip liquid, and the manner in which the material will be identified on the containers. The manufacturer shall certify that the material is in accordance with this specification and shall list typical values of current tests for the properties listed in Sec 1071.5.1. A copy of the bituminous mix design used to test for heat stability and unconditioned strength shall be included with the test results. The certified test report shall show the manufacturer's name, brand name of material, lot and date tested. The manufacturer shall submit at least a one-gallon sample accompanied by an MSDS for the material.

**1071.5.5 Packaging and Marking.** The containers in which anti-strip liquids are delivered shall be plainly marked with the manufacturer's name, the brand name and designation of the material, lot number and net quantity. Bulk shipments shall be accompanied by a delivery ticket showing this information.
SECTION 1073
JOINT MATERIAL FOR STRUCTURES

1073.1 Scope. This specification covers material for preformed compression seals and strip seals with lubricant-adhesive for sealing joints, and expanded or extruded polystyrene material for use as bedding material under prestressed panels and in the corrugation areas of stay-in-place forms used on bridge decks.

1073.2 Preformed Compression Seal. Preformed compression seals shall be in accordance with ASTM D 3542 and with the following additional requirements.

1073.2.1 The movement range of the seal as defined in ASTM D 3542 shall be as shown in the contract documents, and the height of seal shall be no less than the nominal width. The seal shall be delivered in containers marked with the manufacturer’s name, size of the seal, lot number and date of manufacture.

1073.2.2 The lubricant adhesive applied for installation shall be in accordance with the seal manufacturer and in accordance with Sec 717. The lubricant adhesive shall be delivered in containers marked with the manufacturer’s name, lot number, date of manufacture and instructions for storage and use.

1073.3 Strip Seal. Strip seals shall be in accordance with ASTM D 2628 and the following additional requirements.

1073.3.1 The gland lugs of the seal that fasten into the steel extrusion shall be of a type that exerts pressure to the contact surfaces. Glands with snap or arrowhead-type lugs will not be permitted. The seal shall be delivered in containers marked with the manufacturer’s name, size of the seal, lot number and date of manufacture.

1073.3.2 The lubricant adhesive applied for bonding the gland to the steel extrusion shall be as recommended by the seal manufacturer and in accordance with Sec 717. The lubricant-adhesive shall be delivered in containers marked with the manufacturer’s name, lot number, date of manufacture and instructions for storage and use.

1073.4 Expanded or Extruded Polystyrene Material for Use as Bedding Material for Prestressed Panels.

1073.4.1 Expanded or Extruded Polystyrene Materials. The expanded or extruded polystyrene material shall be in accordance with the following requirements.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Strength</td>
<td>ASTM D 1621</td>
<td>60 psi, min.</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D 2842</td>
<td>2% by volume, max.</td>
</tr>
<tr>
<td>Oxygen Index</td>
<td>ASTM D 2863</td>
<td>24 minimum</td>
</tr>
</tbody>
</table>

1073.4.2 Material for Corrugation Areas of Stay-In-Place Forms. Expanded polystyrene material shall be in accordance with the following:

1073.5 Expanded Polystyrene Material for Use in Corrugation Areas of Stay-In Place Forms. The expanded polystyrene materials shall be in accordance with the following requirements.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Strength</td>
<td>ASTM D 1621</td>
<td>10 psi, min.</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D 2842</td>
<td>2% by volume, max.</td>
</tr>
</tbody>
</table>

1073.6 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to Engineer a certified test report showing specific test results in accordance with all requirements of these specifications. The certified test report shall contain the manufacturer's name, brand name of material, lot tested.
and date of manufacture. In addition, the manufacturer shall submit a sample of the seal or polystyrene material and one-pint (half liter) sample of the adhesive for laboratory testing accompanied by a technical data sheet and a material safety data sheet. With approval by the Engineer of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on the appropriate qualified list. The qualified lists are available through Engineer or MoDOT’s web site. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed, and may be required when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

1073.7 Acceptance. To obtain final acceptance of this material, the manufacturer shall furnish a certification to the Engineer at destination certifying that the material supplied is in accordance with all requirements specified and stating that the material is the same and is formulated the same as the material tested for manufacturer and brand name approval.
SECTION 1075
CENTRIFUGALLY-CAST FIBERGLASS-REINFORCED POLYMER MORTAR PIPE

1075.1 Scope. This specification covers centrifugally-cast fiberglass-reinforced polymer mortar pipe to be used in pipejacking and microtunneling for horizontal boring applications under roadways.

1075.2 Acceptance. Acceptance of the material will be based on the manufacturer’s certification and upon the results of any tests required by the Engineer.

1075.3 Manufacture.

1075.3.1 Pipe shall be manufactured from polyester resin systems with a proven history of acceptable performance for the particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.

1075.3.2 Pipe shall be manufactured from reinforcing glass fibers of commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

1075.3.3 Pipe shall be manufactured from silica sand, with a minimum of 98 percent silica, and a maximum moisture content of 0.2 percent.

1075.3.4 When used, resin additives, such as curing agents, pigments, dyes fillers, thixotropic agents, etc., shall not detrimentally affect the performance of the product.

1075.4 Documentation. The manufacturer shall provide certification to the Contractor that the material provided is in accordance with ASTM D 3262 and that pipe joints meet the performance requirements of ASTM D 4161. The certification shall state the manufacturer’s name and shall have attached typical results of tests on the material and pipe joints.

1075.5 Construction Inspection. Pipe will be inspected for defects prior to installation. Damaged pipe will be rejected. Any pipe that appears cracked near the joint will be rejected.
SECTION 1080
STRUCTURAL STEEL FABRICATION

1080.1 Scope. This specification covers the fabrication and inspection of bridges and structures made of structural steel and miscellaneous metals.

1080.2 Material. Except as amended by Sec 1080.2.4, all material shall be in accordance with Division 1000, Material Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section / Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Connectors</td>
<td>1037</td>
</tr>
<tr>
<td>Paint for Structural Steel</td>
<td>1045</td>
</tr>
<tr>
<td>Coating of Structural Steel</td>
<td>1081</td>
</tr>
<tr>
<td>Structural Carbon Steel</td>
<td>AASHTO M 270, Grade 36 ASTM A 709, Grade 36</td>
</tr>
<tr>
<td>Structural Low Alloy Steel</td>
<td>AASHTO M 270, Grade 50 ASTM A 709, Grade 50</td>
</tr>
<tr>
<td>Quenched and Tempered Alloy Steel</td>
<td>AASHTO M 270, Grade HPS 50W ASTM A 709, Grade HPS 70W</td>
</tr>
<tr>
<td>Low Carbon Steel Bolts and Nuts</td>
<td>ASTM A 307</td>
</tr>
<tr>
<td>High Strength Bolts, Nuts and Washers</td>
<td>ASTM A 325, ASTM A 490, ASTM F 436, ASTM A 563, AASHTO M 292</td>
</tr>
<tr>
<td>Cold Finished Carbon Steel Shafting</td>
<td>AASHTO M 169</td>
</tr>
<tr>
<td>Carbon Steel Forgings</td>
<td>AASHTO M 102 Class F</td>
</tr>
<tr>
<td>Alloy Steel Forgings</td>
<td>AASHTO M 102 Class G</td>
</tr>
<tr>
<td>Gray Iron Castings</td>
<td>AASHTO M 105 Class 50</td>
</tr>
<tr>
<td>Malleable Iron Castings</td>
<td>ASTM A 47</td>
</tr>
<tr>
<td>Carbon Steel Castings</td>
<td>AASHTO M 103 Grade 485-275</td>
</tr>
<tr>
<td>Galvanized Coatings</td>
<td>AASHTO M 111, AASHTO M 232 Class C, ASTM B 695 Class 55</td>
</tr>
<tr>
<td>Lead for Bearing Pads</td>
<td>ASTM B 29</td>
</tr>
<tr>
<td>Identification of Metals</td>
<td>ASTM A 6</td>
</tr>
</tbody>
</table>

1080.2.1 Galvanized Bolts. Bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with the requirements of AASHTO M 232, Class C or shall be mechanically galvanized in accordance with ASTM B 695, Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. Fasteners installed prior to the completion of shop blast cleaning will not require galvanizing. The thickness of the zinc coating for galvanized bolts shall be measured on the wrench flats and top of the bolt head. For mechanically galvanized bolts, the significant surfaces as referenced in ASTM B 695 shall be the entire bolt surface, excluding the underside of the surface of the head and the shank surface between the threaded portion and the underside of the head. The thickness of the zinc coating on the galvanized nuts shall be measured on the wrench flats. For mechanically galvanized nuts, the
significant surfaces shall be all surfaces of the nut excluding the threads. The thickness of the zinc coating on galvanized washers shall be measured on both sides. The significant surfaces on mechanically galvanized washers shall be all surfaces of the washer.

1080.2.2 Fit Up Bolts. Fit up and shipping bolts shall be coated to prevent corrosion where a finish coat will not be applied. Shipping bolts for uncoated weathering steel will not require coating.

1080.2.3 Falsework. Falsework material will be subject to the Engineer's approval. All falsework material shall be in good condition such that the material performs as designed. Falsework piling shall be capable of withstanding driving to a depth sufficient to develop adequate bearing.

1080.2.4 Certified Mill Test Reports. For structural steel, the Contractor shall submit a copy of the certified mill test report giving the chemical analysis and results of physical tests on the material furnished. The mill test report shall state the location of the mill where the molten metal was produced. Two copies of the mill test report will be required for material used in railroad structures. If steel is produced outside the United States, the Contractor shall submit a certified test report from a MoDOT approved U. S. laboratory showing specific results of chemical analysis and physical tests for each heat furnished and stating that the material meets the specification requirements. Mill tests and laboratory reports shall be submitted for approval before any request is made for shop or field inspection. In addition, the Engineer may take samples for chemical analysis and physical tests from the fabricated steel delivered to the project site. Any time or cost effects caused by obtaining and analyzing samples from delivered steel shall be anticipated by the Contractor as part of the quality assurance process and no compensation or additional time will be allowed for costs or delays associated with this activity. Unless otherwise specified, the supplementary requirements of AASHTO M 270 for Charpy V notch impact tests in temperature zone 2 shall be mandatory where the contract documents indicate notch toughness is required for fracture critical or non-fracture critical components. Mill test reports shall include the results of Charpy V-notch testing and impact serial numbers for fracture critical components.

1080.2.5 High Strength Fastener Assemblies. In addition to the requirements of Sec 712.2, high strength bolts, nuts and washers shall meet the following requirements. The Contractor shall furnish a manufacturer's certification showing results of tests performed. Identification in accordance with the appropriate AASHTO/ASTM specifications shall be maintained by container markings which shall match identifying numbers on the certifications and be traceable to the certified mill test reports. High strength fastener assemblies shall be galvanized unless used with unpainted weathering steel or specifically indicated otherwise by the contract documents. When high strength bolts are used with weathering steel, the fasteners shall be Type 3. ASTM A 490 bolts shall be installed black, tensioned and then cleaned and coated with the coating system as specified on the plans. The cleaning and the zinc coating shall not be applied by any process, which can cause hydrogen embrittlement. All certification testing requirements and mill test reports referenced in the following sections shall be in accordance with Sec 106.

1080.2.5.1 Bolts. All bolts shall be in accordance with ASTM A 325 except when ASTM A 490 bolts are specified on the plans. If the Contractor elects to use load indicator bolts, only a hex head will be permitted. The type of head used shall be consistent throughout the entire structure, unless otherwise approved by the Engineer.

1080.2.5.1.1 Proof Load Tests. Proof load tests in accordance with ASTM F 606 Method 1 shall be performed. Minimum test frequency shall be in accordance with ASTM A 325.

1080.2.5.1.2 Wedge Tests. Wedge tests on full size bolts, in accordance with ASTM F 606, paragraph 3.5 shall be performed. If bolts are to be galvanized, tests shall be performed after galvanizing. Minimum test frequency shall be in accordance with ASTM A 325.

1080.2.5.2 Nuts. All nuts shall be in accordance with AASHTO M 292 as applicable or ASTM A 563, except as follows.
1080.2.5.2.1 Nut Grades. Ungalvanized nuts shall be grades 2, C, D or C3 with a minimum Rockwell hardness of 89 HRB or Brinell hardness 180 HB or heat treated grades 2H, DH or DH3. Nuts that are to be galvanized shall be heat treated grade 2H, DH or DH3.

1080.2.5.2.2 Overtapping. Nuts to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overtap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition and shall be in accordance with the mechanical requirements and the rotational-capacity test requirements of ASTM A 563. The overtapping requirements of ASTM A 563 will apply, except these limits shall be considered maximum values instead of the minimum, as currently shown.

1080.2.5.2.3 Nut Lubrication. All galvanized nuts, including ASTM A 194 nuts, shall meet the supplementary requirements of ASTM A 563. Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

1080.2.5.2.4 Proof Load Tests. Proof load tests in accordance with ASTM F 606 shall be performed. Minimum test frequency shall be in accordance with ASTM A 563 or AASHTO M 292. If nuts are to be galvanized, tests shall be performed after lubricating.

1080.2.5.2.5 Weathering Steel. When Type 3 fasteners are specified for use with weathering steel, nuts shall be in accordance with ASTM A 563 and shall be grades C3 or DH3.

1080.2.5.3 Washers. All washers shall be in accordance with ASTM F 436. Hardness testing shall be performed on galvanized washers. The coating shall be removed prior to taking hardness measurements.

1080.2.5.4 Rotational-Capacity Tests. Rotational-capacity tests shall be performed on all bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Washers shall be part of the test, regardless if they are required as part of the installation procedure or not. Tests shall be conducted after galvanizing when galvanizing is required.

1080.2.5.4.1 Test Methods. Except as modified herein, the rotational-capacity test shall be performed in accordance with ASTM A 325.

1080.2.5.4.2 Test Lots. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required as part of the installation procedures, washers need not be included in the lot identification. A rotational-capacity lot number shall be assigned to each combination of lots tested. The minimum frequency of testing shall be two assemblies per rotational-capacity lot.

1080.2.5.4.3 Testing Device. The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device.

1080.2.5.4.4 Minimum Rotation. The minimum rotation, from a snug tight condition, 10 percent of the specified proof load, shall be as follows:

<table>
<thead>
<tr>
<th>Bolt Length</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤4 Diameters</td>
<td>240° (2/3 turn)</td>
</tr>
<tr>
<td>&gt; 4 Diameters and ≤ 8 Diameters</td>
<td>360° (1 turn)</td>
</tr>
<tr>
<td>&gt; 8 Diameters</td>
<td>480° (1 1/3 turn)</td>
</tr>
</tbody>
</table>

1080.2.5.4.5 Required Tension. The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test for ASTM A 325 and ASTM A 490 bolts shall be as follows:
### Required Bolt Tensions

<table>
<thead>
<tr>
<th>Diameter, in.</th>
<th>1/2</th>
<th>5/8</th>
<th>3/4</th>
<th>7/8</th>
<th>1.00</th>
<th>1-1/8</th>
<th>1-1/4</th>
<th>1-3/8</th>
<th>1-1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req. Installation Tension, kips</td>
<td>12</td>
<td>19</td>
<td>28</td>
<td>39</td>
<td>51</td>
<td>56</td>
<td>71</td>
<td>85</td>
<td>103</td>
</tr>
<tr>
<td>Turn Test Tension, kips</td>
<td>14</td>
<td>22</td>
<td>32</td>
<td>45</td>
<td>59</td>
<td>64</td>
<td>82</td>
<td>98</td>
<td>118</td>
</tr>
<tr>
<td>Req. Installation Tension, kips</td>
<td>15</td>
<td>24</td>
<td>35</td>
<td>49</td>
<td>64</td>
<td>80</td>
<td>102</td>
<td>121</td>
<td>148</td>
</tr>
<tr>
<td>Turn Test Tension, kips</td>
<td>17</td>
<td>28</td>
<td>40</td>
<td>56</td>
<td>74</td>
<td>92</td>
<td>117</td>
<td>139</td>
<td>170</td>
</tr>
</tbody>
</table>

#### 1080.2.5.4.6 Torque

After the required installation tension has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall be as follows:

\[
\text{Torque} \leq 0.25 \text{PD}
\]

Where:

- Torque = measured torque, foot-pounds
- P = measured bolt tension, pounds
- D = bolt diameter, feet

#### 1080.2.5.4.7 Short Bolts

Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The maximum torque requirement shall be computed using a value of P equal to the turn test tension shown in Sec 1080.2.5.4.5.

#### 1080.2.5.5 Reporting

The results of all tests, including zinc coating thickness, required herein and in the applicable AASHTO/ASTM specifications and the location and date of the tests performance, shall be recorded on the appropriate document. The tests need not be witnessed by an inspection agency. The manufacturer or distributor performing the tests shall certify the results are accurate.

#### 1080.2.5.6 Documentation for High Strength Fastener Assemblies

**1080.2.5.6.1 Mill Test Reports.** A Mill Test Report (MTR) shall be furnished for all mill steel used in the manufacture of the bolts, nuts or washers. The MTR shall indicate the location where the material was melted and manufactured.

**1080.2.5.6.2 Manufacturer Certified Test Reports.** The manufacturer of the bolts, nuts and washers shall furnish a Manufacturer Certified Test Report (MCTR) for each item furnished including the following information:

(a) The lot number of each of the items tested.

(b) The rotational-capacity lot number as required in Sec 1080.2.5.4.2.

(c) The results of the tests required in Sec 1080.2.5.5.

(d) The pertinent information required in Sec 1080.2.5.4.2.
(e) A statement that MCTR for the items are in conformance to this specification and the applicable AASHTO/ASTM specifications.

(f) The location where the bolt assembly components were manufactured.

(g) Rotational capacity testing if completed by the manufacturer.

1080.2.5.6.3 Distributor Certified Test Reports. The Distributor Certified Test Report (DCTR) shall include MCTR for the various bolt assembly components. The rotational-capacity test may be performed by a distributor in lieu of a manufacturer and shall be reported on the DCTR. The DCTR shall indicate the following if not included in the MCTR:

(a) The results of the tests required in Sec 1080.2.5.5.

(b) The pertinent information required in Sec 1080.2.5.4.2.

(c) The rotational-capacity lot number as required in Sec 1080.2.5.4.3.

(d) A statement that the MCTR are in accordance with this specification and the applicable AASHTO/ASTM specifications.

(e) Certification of galvanizing from the galvanizing supplier shall be in accordance with Sec 1080.2.1.

1080.2.5.7 Shipping of High Strength Fastener Assemblies. Bolts, nuts and washers, where required, from each rotational-capacity lot shall be shipped in the same container in proportionate quantities for use. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each shipping container shall be permanently marked by the manufacturer or distributor with the rotational-capacity lot number such that identification will be possible at any stage prior to installation. The appropriate MTR, MCTR or DCTR shall be supplied in accordance with the contract documents.

1080.2.6 Machine Bolts. Machine bolted field connections shall be made with machine bolts having American Standard Regular Heads and Nuts of hexagonal shape and shall be in accordance with ANSI B 18.2.1 and B 18.2.2. Threads shall extend slightly beyond the nut to permit burring. One plain washer in accordance with ANSI B 18.22.1 shall be used at all slotted holes.

1080.2.7 Cast Steel. For cast steel, the foundry shall furnish a certified copy of foundry reports giving the chemical analysis and results of physical tests on the material from each heat. These reports shall be submitted for approval of material being furnished before any required machine work is done on the castings.

1080.2.8 Cast Iron. For gray iron castings, the foundry shall furnish one finished tension test specimen in accordance with AASHTO M 105 from each heat. The required machine work shall not proceed until material being furnished has been approved. If cast steel is furnished in lieu of gray iron, the minimum tensile strength shall be 50,000 psi.

1080.2.9 Identification of Metals. The steel shall be stamped or stenciled and color striped with paint at the mill. Heat numbers shall be steel stamped or stenciled with paint at the mill. Separate markings and color codes shall be in accordance with ASTM A 6. The characteristic color stripes shall be placed on each part cut from the mill piece. For steels not covered by ASTM A 6, the fabricator shall furnish the Engineer the color coding in writing before fabrication begins. Heat numbers shall be painted on all principal pieces and these pieces shall be so noted on the shop drawings. Principal pieces for this requirement shall include all beams, flanges, webs, splice plates, cover plates, bearings, bearing stiffener plates, load bearing members of end diaphragms, pin plates, hanger plates and others as may be directed by the Engineer. Principal pieces shall include individual plates of all truss members, truss gusset plates, splice plates and floor beam connection angles. The color code and heat number markings shall be
placed on the material such that the markings are visible throughout the work of fabrication. Loss of identification on pieces or items will be cause for rejection of the pieces or items.

1080.2.9.1 Fracture Critical Members. Principal pieces requiring identification shall also include components of fracture critical members. Traceability of both heat numbers and impact serial numbers shall be maintained for fracture critical members and attachments.

1080.2.9.2 Direction of Rolling. Unless otherwise indicated in the contract documents, steel plates for main members and splice plates for flanges and main tension members shall be cut and fabricated such that the primary direction of rolling is parallel to the direction of the principal tensile or compressive stresses. The direction of rolling shall be maintained for all principal pieces during fabrication.

1080.2.10 Steel Stamping. Any metal die stamping of match marks and erection marks in structural steel members shall be limited to a position in the end 1 1/2 inches of flange plates and flange splice plates, the middle third of web plates and the outside edge of the middle third of web splice plates. Metal die stamping at other locations or for other purposes may be approved by the Engineer provided low stress dies are used. Low stress dies will be defined as those manufactured to produce impressions that are rounded at the bottom rather than sharp edged. Metal die stamping on pin plates and hanger plates will not be permitted.

1080.3 Fabrication and Inspection.

1080.3.1 Quality Assurance Inspection. The Engineer will be responsible for QA inspection to assure the quality of the fabricated material. QA inspection by the Engineer will not relieve the Contractor of the responsibility to provide fabricated structural steel items in accordance with the contract documents. Sufficient QC, as necessary to assure work being performed conforms to the contract documents, shall be the responsibility of the Contractor and fabricator. Following adequate notification that QC inspections and testing by the fabricator have been performed, QA inspection will be at the option of the Engineer. Regardless of the location and degree of QA inspection, material and workmanship not meeting specified performance criteria or conforming to the contract documents or recognized good practice may be rejected at any time prior to final acceptance of the work.

1080.3.1.1 Locations of Inspection. QA inspection of fabricated material will ordinarily be made in the shop for fabricating shops within the 48 contiguous States and for shops outside the U. S., but within 1000 miles of St. Charles, MO. High strength bolts, nuts and washers shall be presented for sampling at the fabrication shop performing the primary fabrication or at a location agreed to by the Engineer. In some cases, QA inspection in the fabrication shop may be waived and inspection made when the fabricated material is delivered to the project site. All costs of QA inspection at fabricating shops located both outside the 48 contiguous States and more than 1000 miles from St. Charles, shall be at the Contractor’s expense. In such cases, the Contractor will be charged with transportation costs and expenses of QA inspectors for trips made from St. Charles to locations to which the inspectors must travel for shop inspection work. These transportation costs and expenses of QA inspectors will be deducted by St. Charles County from monies due the Contractor.

1080.3.1.2 Notification of Inspection. The Engineer shall be notified at least four working days prior to the beginning of the shop fabrication so a QA inspector may be present if so desired and to allow the QA inspector to make travel arrangements. If the fabricator notifies and requests inspection and the QA inspector arrives at the location of inspection to find the material is not ready for inspection as indicated in the request, any travel costs incurred by St. Charles County for additional inspection shall be paid by the Contractor.

1080.3.1.3 Access for Inspection. The Engineer shall have full access to all parts of the shop or project site where material is being fabricated or assembled and shall be provided with every reasonable facility for determining the character of material and workmanship.
1080.3.1.4 Field Inspection. No increased time or compensation will be allowed for additional work, delays or additional costs as a result of QA inspection at the project site, including required repairs, including where samples were removed, refabrication, securing samples for chemical analysis and physical tests.

1080.3.1.5 Not Used

1080.3.1.6 Certifications. All structural steel fabricators performing work for the following listed components of steel structures shall be certified prior to the start of fabrication under the appropriate category of the AISC Certification Program for Steel Bridge Fabricators or the AISC Certification Program for Bridge and Highway Metal Component Manufacturers as follows:

(a) Fabricators of unspliced rolled beams and temporary bridges shall be certified to the Simple Bridge (SBr) requirements.

(b) Fabricators of straight or curved (radius over 500 feet) rolled beams with field or shop splices, built-up welded constant depth straight or curved (radius over 500 feet) I-shape plate girders, built-up welded variable depth straight or curved (radius over 1000 feet) I-shape plate girders, and trusses with a total length less than 200 feet or substantially pre-assembled and shipped in no more than three subassemblies shall be certified to the Intermediate Bridge (IBr) requirements.

(c) Fabricators of bridges beyond the listed structures of 1080.3.1.6(a) or 1080.3.1.6(b) shall be certified to the Advanced Bridge (ABr) requirements.

(d) Fabricators of fracture-critical members indicated in the contract plans shall also meet the requirements for fracture-critical certification in addition to the other bridge certifications.

(e) Fabricators of overhead sign trusses, steel bearings, POT bearings, finger plate expansion devices, and flat plate expansion devices shall be certified to the Bridge and Highway Metal Component Manufacturers requirements unless the fabricator is certified to one of the Steel Bridge Fabricator levels (SBr, IBr, or ABr).

(f) AISC certification will not be required for manufacturers of simple laminated or elastomeric bearing pad assemblies or PTFE bearing pad assemblies.

(g) Fabricators that apply steel painted coatings in the fabrication shop shall be certified to the AISC Applicators of Complex Coatings Endorsement (SPE) or SSPC QP3 – Shop Painting Certification Program.

1080.3.2 Shop Drawings. Shop drawings for structural steel and miscellaneous metals shall be required and shall be prepared in strict accordance with the design details shown on the plans. If details are lacking, the details shall be supplied and shall conform to the design plans and specifications. All drawings shall be clear and complete and shall be thoroughly checked before submittal. Shop drawings shall be completely titled in accordance with the contract plans and shall pertain to only a single structure. Four sets of the shop drawings for railroad structures and two sets for other structures shall be submitted to St. Charles County for approval. The prints submitted shall be legible and shall have distinct details of sufficient contrast. Prints that do not have the desired clarity and contrast will be returned for corrective action. One set of prints will be returned marked reviewed or approved subject to noted corrections. The Contractor shall promptly make necessary corrections and resubmit for final approval. When shop drawings are approved, the Contractor shall furnish as many additional prints as requested. Reproductions on cloth or film of the original shop drawings shall be required for railroad structures and shall be delivered to the Engineer prior to completion of the work. The approval of shop drawings will cover only the general design features and in no case shall this approval be considered to cover errors or omissions in shop details. The Contractor shall be responsible for the accuracy of the shop drawings, the fabrication of material and the fit of all connections. All changes in the fabrication and erection work caused by errors in shop drawings and any changes in fabrication necessary for satisfactory results shall be at the Contractor’s expense. After shop drawings have been approved, no
changes in dimensions or substitutions of sections shall be made without written approval from the Engineer. Shop drawings shall be revised to show any authorized changes and the required number of prints shall be furnished to the Engineer.

1080.3.2.1 Non-Domestic Shop Drawings. Shop drawings from fabricators located outside the 48 contiguous States, whether marked approved or approved subject to the corrections noted, will be returned to the Contractor and the Contractor shall be responsible for transmitting the drawings to the fabricator for further handling. Should such fabricator also be the Contractor, all prints will be returned to the office located on the project.

1080.3.2.2 Weld Procedures. All welding procedures to be used shall be prepared by the manufacturer, Contractor or fabricator as a written procedure specification. For new welding procedures, two copies shall be submitted for approval prior to submitting shop drawings. Approved weld procedures will be kept on file by St. Charles County and may be considered for use on multiple projects. Any changes to the parameters of an approved welding procedure shall require submittal for approval. The shop drawings submitted for approval shall indicate the welding procedure to be used for each joint.

1080.3.2.3 Verification of Work. By submission of shop drawings, the Contractor represents to St. Charles County that all material, field measurements, construction requirements, performance criteria and similar data have been verified. The Contractor further represents that the shop drawings have been coordinated and verified with the details of the work to be performed by other fabricators and entities on the project. No allowance for additional costs or delays will be made to the Contractor for incorrect fabrication as a result of failure to coordinate or perform these verifications.

1080.3.3 Fabrication. Fabrication of all parts of the structure shall be carefully done in strict accordance with the approved shop drawings.

1080.3.3.1 Straightening. Straightening of any deformed structural material shall be performed by non-injurious methods prior to being worked in the shop. Sharp kinks and bends will be cause for rejection.

1080.3.3.2 Holes. Holes for connections of main members shall be subpunched or subdrilled and reamed while assembled in the shop or may be drilled from the solid with main members and each splice plate fully assembled in their final erected positions. Holes for floor beams and framed stringer connections shall be drilled or reamed to a steel template of sufficient thickness to center the drill accurately and all members to be secured through the same group of holes shall be drilled or reamed from the same template. Holes may be punched full size in secondary members such as lateral, longitudinal and sway bracing, lacing bars, stay plates and diaphragms. Stacking of web splice plates during drilling or reaming operations on straight girders will be permitted.

1080.3.3.3 Reaming and Finishing of Holes. Reaming or drilling full size from the solid shall be done while the truss, girder, continuous I-beam or other component as noted, is assembled, either in an upright position or on its side, properly adjusted for camber and sweep and after the connecting parts have been firmly fastened together. A minimum of one full span, from bearing to bearing, shall be fully assembled before reaming or drilling full size begins. Connecting parts assembled in the shop for the purpose of reaming or drilling holes for field or shop connections shall not be interchanged or reversed and shall be matchmarked. A diagram showing such marks shall be detailed on the shop drawings. Burrs resulting from reaming, drilling or punching shall be removed. All connections shall be disassembled after drilling or reaming to make these holes accessible for deburring. Required cleaning and painting shall be done after disassembly. Reamed, drilled or punched holes shall be round and perpendicular to the member. Any hole out of round more than 1/16 inch will be cause for rejection of the plate. Eighty-five percent of the holes in any group shall not show an offset greater than 1/32 inch between adjacent thicknesses of metal after reaming or drilling. All holes shall be drilled or reamed and aligned such that a bolt of the specified diameter will enter the hole and the head and nut will seat on the metal before tensioning.
1080.3.3.4 Applicable Codes. All welding, oxygen cutting, shearing and clipping and dimensional tolerances shall be in accordance with the ANSI/AASHTO/AWS D1.5: 2002, Bridge Welding Code. Tubular steel structures shall be governed by the current edition of the AWS D1.1, Structural Welding Code - Steel, in effect at the time of the contract, unless specified otherwise. Aluminum structures shall be governed by the current edition of the AWS D1.2, Structural Welding Code - Aluminum, except as amended by Sec 903, unless otherwise indicated.

1080.3.3.5 Modifications to the Bridge Welding Code. The following modifications to the ANSI/AASHTO/AWS D1.5 2002, Bridge Welding Code (AWS), shall apply:

1080.3.3.5.1 AWS Sec 1.3 Paragraph 1.3.4 - Paragraph 1.3.4 shall be replaced with the following:

The gas metal arc welding process shall not be used on any structural components of bridges. Approved gas metal arc processes may be used for incidental, non-structural components as may be specifically approved by the Engineer. Tack welding with an approved gas metal arc process will be permitted for joints that will subsequently be welded using an approved submerged arc automatic welding process.

1080.3.3.5.2 AWS Sec 1.3 Paragraph 1.3.7 - A new Paragraph 1.3.7 shall be added as follows:

All primary shop welds shall be made by approved submerged arc automatic welding processes. The automatic welding process shall be one in which the wire or electrode feed, speed of travel and guidance are all mechanically controlled. Noncompliance with this requirement will be cause for rejection of the welded material unless prior approval is granted by the Engineer for welding the specified joints by the use of other processes. The automatic welding process requirement for primary shop welds shall be shown on the shop drawings for each joint. Primary shop welds will be defined as flange and web butt welded splices in I-beams, box members and plate girders, plate girder or box flange to web fillet welds and cover plate to flange fillet welds.

1080.3.3.5.3 AWS Sec 2.8 Paragraph 2.8.1.1 - Paragraph 2.8.1.1 shall be replaced with the following:

The minimum fillet weld size, except for fillet welds used to reinforce groove welds, shall be as shown in the following table or as calculated using procedures established to prevent cracking in accordance with Paragraph 4.2.2. In both cases, the minimum size will apply if the size is sufficient to satisfy design requirements.

<table>
<thead>
<tr>
<th>Material Thickness of Thicker Part Joined, in.</th>
<th>Minimum Size of Fillet Welda, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>To 3/4</td>
<td>1/4b</td>
</tr>
<tr>
<td>Over 3/4 to 2 1/2</td>
<td>5/16b</td>
</tr>
<tr>
<td>Over 2 1/2</td>
<td>1/2</td>
</tr>
</tbody>
</table>

a Except that the weld size need not exceed the thickness of the thinner part joined.
b Single pass welds must be used.

1080.3.3.5.4. AWS Sec 3.2 Paragraph 3.2.2.2 (4) - A new Paragraph 3.2.2.2 (4) shall be added as follows:

Quenched and tempered steel plate may be thermally cut provided sufficient preheating is applied according to the steel producer's written recommendations. Procedures for thermal cutting of quenched and tempered steel plate, along with the steel producer's written report, shall be submitted to the Engineer for approval prior to the start of such work.

1080.3.3.5.5 AWS Sec 3.2 Paragraph 3.2.3.4 - Paragraph 3.2.3.4 shall be replaced with the following:

The corrective procedures described in Table 3.1 shall not apply to discontinuities in rolled base-metal surfaces. Such discontinuities may be corrected by the fabricator in accordance with ASTM A 6 (AASHTO M 160), except that
repair by welding will be permitted only when approved by the Engineer. Approval will be limited to areas where there will be less than the maximum design stress in the finished structure. When surface imperfections in alloy, low alloy and carbon steel plates are repaired by grinding, the surfaces shall have edges faired to the plate surface with a maximum slope of 1 in 10.

1080.3.3.5.6 AWS Sec 3.2 Paragraph 3.2.11 - A new paragraph 3.2.11 shall be added as follows:

Sheared edges of plates not to be welded that are more than 5/8 inch thick and carrying calculated stress shall be planed to a depth of 1/4 inch.

1080.3.3.5.7 AWS Sec 3.3.8 - Sec 3.3.8 shall be replaced with the following:

Temporary welds shall be subject to the same WPS requirements as final welds. Temporary welds shall be removed unless otherwise permitted by the Engineer and the surface shall be made flush with the original surface. Unless previously approved in writing by the Engineer, there shall be no temporary welds for fabrication, transportation, erection or other purposes on main members except at locations more than 1/6 the depth of the web from the flanges of beams and girders. There shall be no temporary welds in tension zones of members of quenched and tempered steels. Temporary welds at other locations shall be shown on shop drawings and shall be made with approved consumables. Removal of temporary welds shall conform to Paragraphs 3.3.7.3 and 3.3.7.4.

1080.3.3.5.8 AWS Sec 3.4 Paragraph 3.4.6 - Paragraph 3.4.6 shall be replaced with the following:

All shop splices in each component part of a cover-plated beam or built-up member shall be made and all required nondestructive testing completed and approved by the Engineer before the component part is welded to other component parts of the member. Long members or member sections may be made by shop-splicing subsections, each made in accordance with this subsection (See 2.17.6). All shop splices shall be made using full penetration welds that fully develop the capacity of the original member. Additional shop splices required due to length limits of available material may be used if detailed on the shop drawings and placed at locations approved by the Engineer. No additional payment will be made for any additional shop splices placed in the members at the option of the Contractor, including shop splices that may be required as a result of material limitations.

1080.3.3.5.9 AWS Sec 3.5 Paragraph 3.5.1.8.1 - A new Paragraph 3.5.1.8.1 shall be added as follows:

The maximum permissible variation from specified width for rolled or burned flange plates shall be -1/8 inch to +3/8 inch.

1080.3.3.5.10 AWS Sec 3.5 Paragraph 3.5.1.9 - Paragraph 3.5.1.9 shall be replaced with the following:

The bearing ends of bearing stiffeners shall be flush and square with the web and shall have at least 75 percent of this area in contact with the inner surface of the flanges. The remaining 25 percent of the area of the bearing stiffener shall be within 0.010 inch of the inner surface of the flanges. When bearing against a steel base or seat, all steel components shall fit within 0.010 inch for 75 percent of the projected area of web and stiffeners and not more than 1/32 inch for the remaining 25 percent of the projected area. Girders without stiffeners shall bear on the projected area of the web on the outer flange surface within 0.010 inch. The included angle between web and flange shall not exceed 90 degrees in the bearing length. The top surface of a flange or shelf plate supporting a steel bearing rocker shall be considered a flat surface with a tolerance of 0.003 inch per inch in any direction over the projected area of the rocker. The top surface of a flange or shelf plate in direct contact with elastomeric bearings shall not deviate from a true plane surface by more than 1/16 inch.

1080.3.3.5.11 AWS Sec 3.5 Paragraph 3.5.1.16 - A new Paragraph 3.5.1.16 shall be added as follows:
Permissible variation in length of assembled beams or girders between the centerline of bearing devices shall not exceed plus or minus 1/4 inch for any one span or plus or minus 1/2 inch for any two or more spans within the assembled unit. The actual centerline of any bearing device shall lie within the thickness of the bearing stiffener.

1080.3.3.5.12 AWS Sec 3.7 Paragraph 3.7.2.5 - A new Paragraph 3.7.2.5 shall be added as follows:

If, after three repairs to the same area of a weld requiring radiographic quality, there is any part of the original defect remaining or there is a new rejectable indication, the total joint shall be cut apart, all deposited weld metal removed, joint preparation made and the total joint rewelded.

1080.3.3.5.13 AWS Sec 3.7 Paragraph 3.7.2.6 - A new Paragraph 3.7.2.6 shall be added as follows:

The gas metal arc welding process shall not be used for the repair of welds except when repairing welds made with the GMAW process.

1080.3.3.5.14 AWS Sec 5.21 Paragraph 5.21.6.2 - A new Paragraph 5.21.6.2 shall be added as follows:

Any cost involved in qualifying welders, welding operators and tackers, including all material costs, finishing of test specimens, the physical testing of finished specimens and any radiography required shall be borne by the Contractor. Required radiography and physical testing of finished specimens shall be performed at test facilities approved by the Engineer.

1080.3.3.5.15 AWS Sec 6.6 Paragraph 6.6.5 - Paragraph 6.6.5 shall be replaced with the following:

If the Engineer subsequently requests nondestructive testing, not specified in the original contract agreement, the Contractor shall perform any requested testing or shall permit any requested testing to be performed. Handling, surface preparation, repair welds and any nondestructive testing requested by the Engineer, as a result of weld repair, shall be at the Contractor’s expense. Payment for any non-destructive testing that does not indicate the need for repair to the tested weld will be in accordance with Sec 109.4.

1080.3.3.5.16 AWS Sec 6.7 Paragraphs 6.7.1, 6.7.1.1 and 6.7.1.2 - Paragraphs 6.7.1, 6.7.1.1 and 6.7.1.2 shall be replaced with the following:

Radiographic inspection shall be required for areas of both shop and field butt welds as specified herein. One hundred percent inspection shall be required for flanges of rolled beams and girders and 100 percent of transverse butt welds in webs for a distance of no less than one-sixth of the web depth from each flange and 25 percent of the remainder of the web depth. At least one-third of the length of all longitudinal web splices shall be radiographed at even intervals throughout the length of the splice. When a rejectable defect is found by radiography in any partially tested joint, either initially or in a later additional radiograph, tests shall be conducted on either side of and adjacent to the rejectable test area. If a rejectable defect is found in any additional areas, then 100 percent of vertical web splices and an additional 10 percent of total weld length in longitudinal web splices shall be tested. The location of these additional test areas shall be as directed by the Engineer. All complete joint penetration groove welds in T- and corner joints shall be tested by ultrasonic testing.

1080.3.3.5.17 AWS Sec 6.10 Paragraph 6.10.3.4 - A new Paragraph 6.10.3.4 shall be added as follows:

Edge blocks shall be used when radiographing butt welds greater than 1/2 inch in thickness. The edge blocks shall have a length sufficient to extend beyond each side of the weld centerline for a minimum distance of 2 inches and shall have a thickness equal to the thickness of the weld, plus or minus 1/16 inch. The minimum width of the edge blocks shall be no less than 1 inch. The edge blocks shall be centered on the weld with a snug fit against the plate being radiographed, allowing no more than 1/16 inch gap. Edge blocks shall be made of radiographically clean steel.
and the surface shall have a finish of ANSI 125µin. or smoother (refer to ANSI/AWS D1.1-98 Structural Welding Code - Steel, Sec 6.17, Paragraph 6.17.13 and Figure 6.15).

**1080.3.3.5.18 AWS Sec 6.10 Paragraph 6.10.11.2** - Paragraph 6.10.11.2 shall be replaced with the following:

If the greatest and least thickness of a weld connecting parts of different thickness cannot be rendered with adequate contrast on a single film with a single exposure, a dual film or dual exposure technique shall be used to obtain suitable density for both the greatest and the least thickness of the weld.

**1080.3.3.5.19 AWS Sec 6.12 Paragraph 6.12.4** - A new Paragraph 6.12.4 shall be added as follows:

After completion of all radiographic inspection, the Contractor shall submit to the Engineer one set of drawing details showing the location and identification numbers of all radiographs taken.

**1080.3.3.5.20 AWS Sec 6.26 Paragraph 6.26.2.1** - Paragraph 6.26.2.1 shall be replaced with the following:

For any welds, the greatest dimension of any porosity or fusion type discontinuity that is 1/16 inch or larger in greatest dimension shall not exceed the size, B, indicated in Figure 6.8 for the effective throat or weld size involved. The distance from any porosity or fusion type discontinuity described above to another such discontinuity, to an edge or to the toe or root of any intersecting flange-to-web weld shall not be less than the minimum clearance allowed, C, indicated in Figure 6.8 for the size of discontinuity under examination.

**1080.3.3.5.21 AWS Sec 6.26 Paragraph 6.26.2.2 and Figure 6.9** - Delete paragraph 6.26.2.2 and Figure 6.9.

**1080.3.3.5.22 AWS Sec 6.26 Paragraph 6.26.3.1** - Paragraph 6.26.3.1 shall be replaced with the following:

Welds subjected to ultrasonic testing in addition to visual inspection shall conform to the requirements of Table 6.3.

**1080.3.3.6 Calibrated Tapes.** When the contract involves fabrication of a bridge with a bearing-to-bearing span of 100 feet or more, certifications and identifying numbers of calibrated measuring tapes or numbered tapes matched to a calibrated master shall be kept on file for review by the Engineer. Certification of the measuring tape to be used or certification of the master from which the tape was matched shall be traceable to the U. S. National Bureau of Standards. Certification of tapes for shop use shall be renewed at least every two years.

**1080.3.3.7 Connection Angles.** Connection angles for floor beams and stringers shall be flush and shall be correct as to position and length of member. If milling is required, no more than 1/16 inch shall be removed from the thickness of the angles.

**1080.3.3.8 Longitudinal Stiffeners.** Longitudinal girder web stiffeners shall be a single length if possible. If more than a single length is necessary, such lengths shall be joined by a full penetration butt weld. The location of these butt welds shall be shown on the shop drawings for each joint and shall be subject to approval by the Engineer. Runoff plates in accordance with AWS Section 3.12 shall be used. The welds shall be radiographically tested and accepted in accordance with AWS Sec 6.10 prior to being attached to the web.

**1080.3.3.9 Pins.** Pins shall be furnished true to size and shall be straight, smooth and free from flaws. Pins shall be provided with hexagonal chamfered nuts. The screw ends shall be sufficiently long to permit burring the threads when members are connected. Pilot and driving nuts shall be furnished for each size of pins where required. Threads for all pins and bolts shall conform with the ANSI B 1.1 Free Fit - Class 2 Series except that when recessed nuts are specified, pin ends requiring a threaded diameter of 1 3/8 inches or more shall have six threads per inch. If standard nuts are specified for this size pin, a minimum of four threads to the inch shall be used.
1080.3.3.10 Pin Holes. Pin holes shall be bored true to size, smooth and straight, at right angles to the axis of the member and parallel with each other. The boring shall be done after the member is assembled and welded. The center-to-center distance of pin holes shall be correct within 1/32 inch for an individual component or member. The diameter of pin holes shall not exceed that of the pin by more than 1/50 inch for pins 4 inches or less in diameter or no more than 1/32 inch for pins larger than 4 inches in diameter.

1080.3.3.11 Casting. Castings shall be free from inclusions of foreign material, casting faults, injurious blow holes or other defects which render the castings unsuitable for the service intended. Castings shall be properly filleted at re-entrant angles. No tolerance will be allowed below the dimensions shown on the plans for thicknesses over an appreciable area of the casting. A reasonable oversize will not be cause for rejection.

1080.3.3.12 Bent Plates. Bent plates shall be cold bent and taken from the stock plates such that the bend line will be at right angles to the direction of rolling. The radius of bends, measured to the concave face of the metal, shall be in accordance with the requirements as shown in the table below, in which "T" is the thickness of the plate. If a shorter radius is required, the plates shall be hot bent. Hot bent plates shall be bent at right angles to the direction of rolling. Before hot or cold bending, the corners of the plate shall be rounded to a radius of 1/16 inch throughout that portion of the plate at which the bending is to occur.

<table>
<thead>
<tr>
<th>Angle Through Which Plate is Bent</th>
<th>Minimum Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 degrees to 90 degrees</td>
<td>1.0 T</td>
</tr>
<tr>
<td>Over 90 degrees to 120 degrees</td>
<td>1.5 T</td>
</tr>
<tr>
<td>Over 120 degrees to 150 degrees</td>
<td>2.0 T</td>
</tr>
</tbody>
</table>

1080.3.3.13 Surface Finish. Bearing plates of rolled steel not requiring a surface finish shall be straightened to a plane surface. The surfaces of plates of rolled steel or cast material which are to be in contact shall be finished as shown on the plans and the final finish shall be prepared in a manner to give at least 50 percent contact as indicated by standard machinist's blue test. Rockers and pedestals made from rolled steel shall be finished after welding. If a flat surface is shown on the plans, the tolerance shall be 0.003 inch per inch in any direction. Flat surfaces in full contact shall be finished at right angles to each other. Bearing plates shall be assembled in sets. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the following surface roughness requirements as defined in ANSI B 46.1, Surface Roughness, Waviness and Lay, Part I:

<table>
<thead>
<tr>
<th>Surface Roughness Requirements</th>
<th>Micro inches, Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Slabs</td>
<td>2000</td>
</tr>
<tr>
<td>Heavy Plates in Contact in Shoes to be Welded</td>
<td>1000</td>
</tr>
<tr>
<td>Milled Ends of Compression Members, Stiffeners and Fillers</td>
<td>500</td>
</tr>
<tr>
<td>Bridge Rollers and Rockers</td>
<td>250</td>
</tr>
<tr>
<td>Pins and Pin Holes</td>
<td>125</td>
</tr>
<tr>
<td>Sliding Bearings</td>
<td>125</td>
</tr>
</tbody>
</table>

1080.3.3.14 Horizontally Curved Rolled Beams and Plate Girders. If the plans show rolled beams or welded plate girders to be finished to a horizontal curvature, fabrication shall be as follows:

(a) Rolled beams shall be curved by the heat curving procedure.

(b) Welded plate girders may be fabricated by cutting the flanges to the specified curvature before the girders are attached to the webs or, if not prohibited by the contract, may be curved by the heat curving procedure.

(c) If the heat curving procedure is used, the procedure shall comply with the following requirements:
Material. Heat curving of rolled beams and welded plate girders shall be limited to AASHTO M 270 Grade 36, AASHTO M 270 Grade 50, AASHTO M 270 Grade 50W and AASHTO M 270 Grade HPS 70W.

Type of Heating. Beams and girders may be curved by either continuous or V-type heating.

Temperature. The heat curving operation shall be conducted such that the temperature of the steel never exceeds 1100°F as measured by temperature-indicating crayons or other suitable means applied before heating. The heating of the steel to a temperature greater than 1200°F will be considered destructive heating and will be conclusive cause for rejection of the steel. Quenching with water or water and air, will not be permitted. Cooling with dry compressed air will be permitted after the steel has cooled to 600°F.

Position for Heating. The girder may be heat curved with the web in either a vertical or a horizontal position, unless noted on the contract plans. When curved in the vertical position, the girder shall be braced or supported in such a manner that the tendency of the girder to deflect laterally during the heat curving process will not cause the girder to overturn. When curved in the horizontal position, the girder shall be supported near the ends and at intermediate points, if required, to obtain a uniform curvature. When the girder is positioned horizontally for heating, intermediate safety catch blocks shall be maintained at the mid-length of the girder within 2 inches of the flanges at all times during the heating process.

Sequence of Operations. Heat curving shall be completed before the girder is painted. The Contractor shall submit a curving procedure addressing the attachment of stiffeners, connection plates and cover plates for review prior to commencement of the heat curving process.

1080.3.3.15 Shop Assembly.

1080.3.3.15.1 If required by the contract, the structural steel for bridges shall be completely shop assembled for inspection, supported only at points of bearing. Long bridges required to be entirely shop assembled may be divided into units for assembly with each unit extending from expansion device to expansion device.

1080.3.3.15.2 Beams and girders of all other bridges shall be assembled for inspection in line assemblies with a minimum length assembled of one complete span, from bearing to bearing.

1080.3.3.15.3 During shop assembly, connecting parts shall be firmly fastened together and held in alignment with a minimum of four drift pins and four make-up bolts per flange splice plate, web splice plate or similar connecting part, until assembly inspection is complete.

1080.3.3.15.4 All trusses, plate girders and continuous I-beams shall be assembled to permit inspection of all parts. QA inspection of the assembly will be at the option of the Engineer.

1080.3.4 Shear Connector Studs. Shear connector studs may be attached to the beams or girders either in the fabricating shop or in the field. If the shear connector studs are to be attached in the field, the Contractor shall
notify the Engineer no less than one week before the Contractor begins welding shear connectors to the beams or girders so the Engineer may inspect for approval the proposed welding procedure and equipment. Only welding procedures, equipment and operators meeting the requirements of Sec 1080.3.4, Sec 1080.3.3.5 and Sec 712 shall be used. Areas to which shear connectors are to be attached shall be cleaned of all foreign material, such as oil, grease or paint by a suitable method. Where a shop coat of inorganic zinc primer has been applied, removal shall be limited to the minimum area necessary to apply the studs. After completion of the welding operations, the primed area shall be touched up with a suitable inorganic zinc primer or epoxy mastic paint (non-aluminum).

1080.3.5 Shipping. Fabricated material shall not be shipped before a "Fabrication Inspection Shipment Release" is issued by the Engineer. All parts shall be loaded and protected to prevent damage in transit. Pins, nuts, bolts and other small parts shall be boxed or crated. The "Fabrication Inspection Shipment Release" shall be delivered by the Contractor to the Engineer at destination prior to erection of steel.

1080.4 Weathering Steel.

1080.4.1 Description. This section contains provisions that shall modify, supplement and expand the requirements of the contract plans and other provisions of Sec 1080 when the use of weathering steel is specified for structures. Weathering steel will be defined as structural steel specified under AASHTO M 270 Grades 50W, HPS 50W and HPS 70W that is intended to be primarily used in a bare, uncoated application for the structure.

1080.4.2 High Performance Steels.

1080.4.2.1 Material Requirements. All high performance steel shall be in accordance with the latest edition of AASHTO M 270 and supplements. As an option, HPS 50W and HPS 70W thermomechanical-controlled-processing (TMCP) steel plates available from the manufacturer in limited thicknesses may be directly substituted for the quenched and tempered product.

1080.4.2.2 Fabrication Requirements. All fabrication shall be in accordance with the latest edition of the AASHTO Guide Specifications for Highway Bridge Fabrication with HPS70W Steel, an addendum to be used in conjunction with ANSI / AASHTO / AWS D1.5: 2002, except as modified by this section. Only fabricators meeting the requirements of the AISC Quality Certification Program Major Steel Bridges (Cbr) or approved equal may be used to fabricate HPS 50W (HPS 345W) and HPS 70W (HPS 485W) steel. Whenever magnetic particle testing is conducted, only the yoke technique will be permitted as described in Sec 6.7.6.2 of AWS D1.5: 2002, modified to test using alternating current only.

1080.4.2.3 Welding Requirements for HPS. All welding for high performance steel shall be in accordance with AASHTO / ANSI / AWS D1.5: 2002 Bridge Welding Code except as modified herein and by the latest edition of the AASHTO Guide Specifications for Highway Bridge Fabrication with HPS70W Steel. Only submerged arc and shielded metal arc welding processes shall be permitted when welding Grade HPS 70W steel. The matching submerged arc consumables using the ESAB electrode and Lincoln flux combinations, recommended in Appendix A of the guide specification shall not be allowed. Filler metals used for single pass fillet welds or for complete joint penetration groove welds connecting Grade HPS 70W plate to ASTM A 709 Grade HPS 50W or Grade 50W may conform to the matching or undermatching requirements from AWS D1.5: 2002 as indicated in the guide specification. Moisture resistant coating shall be required for all shielded metal arc welding. The Contractor may request approval of alternate consumables in lieu of the filler metals listed in the guide specification for submerged arc welding in accordance with AWS D1.5 Table 4.1. The request for approval shall include documentation of successful welding and shall include diffusible hydrogen tests indicating the levels of diffusible hydrogen to meet the requirements of the guide specifications. Grade HPS 50W may be welded under the same requirements as ASTM A 709 Grade 50W.

1080.4.3 Cleaning. Except for the areas of the structure to be partially coated as described in Sec 1080.4.4, all surfaces of the structural steel shall be blast cleaned in the fabrication shop to meet the requirements of the Steel Structures Painting Council (SSPC) SSPC-SP6 and may be left uncoated. Faying surfaces of connections to be shop
Bolted shall be blast cleaned prior to permanent assembly of the connections. After blast cleaning, the steel shall be kept clean of all foreign material. If the steel becomes contaminated, the steel shall be cleaned with a method approved by the Engineer. Girders contaminated with concrete or grout splatters shall be washed off before the material is allowed to dry.

1080.4.4 Partial Coating. The surfaces of all structural steel located under expansion joints, but not in contact with concrete, shall be coated with complete System H within a distance of 1 1/2 times the girder depth, but no less than 10 feet, from the centerline of all deck joints. Within this limit, items to be coated shall include all surfaces of beams, girders, diaphragms, stiffeners, bearings and miscellaneous structural steel items. The prime coat for the specified paint system shall be applied to the structural steel within the above limits in the fabrication shop. The intermediate and finish coats shall be applied in the field in accordance with Sec 1081.3.10. The color of the finish coat shall be brown. Portions of the structural steel embedded in or in contact with concrete, including but not limited to the top flanges of girders, shall be coated with no less than 2.0 mils of the prime coat for System H. Shear connectors may not be coated or protected from overspray.

1080.4.4.1 Surface Preparation. All surface preparation and application of the partial coating described herein shall be as specified in Sec 1081. Required work shall include blast cleaning for all areas to receive the specified prime coat to SSPC-SP-10 (Near White Blast Cleaning) in accordance with Sec 1081.3.2, except that areas to be primed that will be embedded in concrete may be prepared to no less than SSPC-SP-6. The limits of the areas to be shop and field coated shall be masked to provide crisp, straight lines to prevent overspray on adjacent areas.

1080.4.4.2 Drain Bracket Coating. The galvanized surfaces of drain support brackets shall be prepared according to the coating manufacturer's recommendation and field coated with a gray epoxy mastic primer (non-aluminum) within a distance of 6 inches from the point of connection to the weathering steel structure.

1080.4.5 Bolting and Fasteners. All fasteners, such as bolts, nuts and washers, that bolt directly to the weathering grade structural steel, including fasteners located in areas of the structure to be partially coated and fasteners for expansion device supports and similar items shall be high strength weathering fasteners with atmospheric corrosion resistance and weathering characteristics comparable with the A 709 weathering steel. Bolts shall be in accordance with ASTM A 325, Type 3. Nuts shall be in accordance with the requirements of ASTM A 563 and shall be Grades C3 or DH3. Washers shall meet the requirements of ASTM F 436, Type 3. All other requirements of Sec 712 and Sec 1080 relating to high strength fastener assemblies and fastener assembly installation shall remain in effect. Fasteners for slab drain brackets may be plain uncoated assemblies in accordance with Sec 1080.2.5 and coated in accordance with Sec 1080.4.5.1.

1080.4.5.1 Coated Connections. Weathering grade fasteners in contact with coated structural steel items or located in areas of the structure to be partially coated shall be initially prepared and coated in the field with a gray epoxy mastic (non-aluminum) after the erection of the structure in accordance with the same procedure specified in Sec 1081. The epoxy-primed fasteners shall be subsequently coated with the System H field coats specified for the structure in areas to be partially coated.

1080.4.5.2 Cleaning. Prior to field bolting connections of high strength fasteners, the faying surfaces shall be cleaned of loose rust by abrasive blast, power hand tools or other approved methods. Tightly adhering rust will not be required to be removed.

1080.4.6 Welding. All welds shall utilize welding processes and electrodes as required that will provide corrosion resistance and weathering characteristics for the welds comparable to the base metal, in accordance with the Section 4 of AWS D1.5: 2002 or as modified in Sec 1080.4.2.3.

1080.4.7 Bearings and Anchor Bolts. Steel bearings, plate steel for elastomeric and PTFE bearings, structural steel for POT bearings, anchor bolts, sole plates, masonry plates and associated items shall be in accordance with ASTM A 709 Grade 50W. Anchor bolt nuts shall be heavy hexagon nuts in accordance with ASTM A 563, Grades C3 or DH3.
The exposed surfaces of all bearings for weathering steel structures under expansion joints shall be shop primed and field coated with the complete System H in accordance with Sec 1080.4.4 and Sec 1081.

1080.4.8 Protection of Concrete Masonry. All substructure concrete shall be protected from the effects of rust staining during construction in accordance with Sec 711.

1080.4.9 Storage of Weathering Steel. Weathering steel shall be stored under conditions that will prevent unsightly, uneven weathering and excessive corrosion. If uneven weathering occurs, the Contractor shall reclean the steel to the satisfaction of the Engineer. If cleaning does not produce satisfactory uniformity in appearance or if in the judgment of the Engineer, excessive corrosion or chemical contamination has occurred, the Contractor shall replace the material at the Contractor’s expense. As a minimum, the following conditions shall be avoided and the Contractor shall take additional precautions as deemed necessary:

(a) Storage in transit, open cars or trucks for an extended period of time.

(b) Standing water on material in storage or entrapment of moisture.

(c) Contact with chemically treated lumber used for blocking or other types of foreign matter.

(d) Exposure to chlorides or other chemical contamination.

1080.5 High Strength Bolt Installation. Shop installed high strength bolts shall be in accordance with Sec 712.

1080.6 Coating of Structural Steel. Shop coating of structural steel shall meet the requirements of Sec 1081.
SECTION 1081
COATING OF STRUCTURAL STEEL

1081.1 Scope. This specification covers coating new and existing bridges and structures made of structural steel and miscellaneous metals.

1081.2 Systems of Coatings. The required system and color or choice of systems and color will be specified on the plans. Each coat of the specified system shall be applied to all structural steel, unless the contract specifically delineates otherwise. The system and color of coating to be shop-applied shall be shown on the shop drawings. All coatings shall comply with local Volatile Organic Compound (VOC) regulations where the paint is applied. The system and color shall not vary for any portion of the entire structure, including material for field repairs, and shall be compatible products of a single manufacturer. The Contractor shall coordinate the various items of work to ensure compliance with the requirements of this section. Approved material specification and dry film thickness for the coating systems shall be as indicated in the following table:

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating</td>
<td>Section</td>
<td>Dry Film Thickness, mils</td>
<td>Coating</td>
</tr>
<tr>
<td>Prime Coat</td>
<td>1045.3</td>
<td>3.0 min.-6 max.</td>
<td>Prime Coat</td>
</tr>
<tr>
<td>Epoxy Intermediate Coat</td>
<td>1045.4</td>
<td>3.0 min.-5 max.</td>
<td>Waterborne Acrylic, Intermediate Coat</td>
</tr>
<tr>
<td>Polyurethane Finish Coat, Gray or Brown</td>
<td>1045.5</td>
<td>2.0 min.-4 max.</td>
<td>Waterborne Acrylic, Finish Coat, Gray or Brown</td>
</tr>
</tbody>
</table>

1081.3 Protective Coating of Structural Steel.

1081.3.1 Scope. This specification covers the preparation of previously uncoated structural steel surfaces, furnishing and applying specified coatings, protection and drying of coatings, furnishing protection from coating spatter and disfigurement, and final cleanup.

1081.3.2 Surface Preparation.

1081.3.2.1 Cleaning. Oil, grease and other contaminants shall be removed in accordance with procedures from Steel Structures Painting Council specification SSPC-SP1 prior to blast cleaning. Where high strength bolts are installed prior to blast cleaning or finish coat, the lubricant on high strength bolt assemblies shall also be removed in accordance with SSPC-SP1. Surfaces to be prime coated shall be blast cleaned with abrasives in accordance with SSPC-SP10, producing a height of profile 1.5 mils minimum and 3.0 mils maximum for all systems. The appearance of the final blast cleaned surface shall be in accordance with SSPC-Vis1, Photograph A SP-10, B SP-10, C SP-10, or D
SP-10. Conformance with the corresponding SP-5 photographs will also be acceptable. The blast profile shall be assessed with replica tape per ASTM D 4417, Method C. The Contractor shall make available to the Engineer access to all SSPC specifications referenced for cleaning and coating operations.

**1081.3.2.2 Preparation for Coating.** After blast cleaning, all surfaces shall be cleaned to remove any trace of blast products, dust or dirt from the surface and from all pockets and corners. The blast-cleaned surfaces shall be given the specified prime coat as soon as practical, but within 24 hours after blast cleaning. If blast cleaned surfaces rust before coating is accomplished, the surface shall be reblasted by the Contractor at the Contractor’s expense. All rusted, damaged or uncoated areas, including ungalvanized nuts, bolts and washers to be prime coated in the field, shall be blast cleaned to the same degree as specified above for the applicable coating system. Care shall be exercised to ensure the blasted steel remains free of grease and oil during handling.

**1081.3.2.3 Recleaning.** When there is contamination of any blast-cleaned surface to be coated, the material shall be recleaned to the requirements of SSPC-SP10.

**1081.3.3 Limits of Coating Application.** Unless otherwise indicated on the plans, the application of the intermediate and finish coats (defined as field coats) for Systems G and H shall be applied to the surfaces of all structural steel, including surfaces of beams, girders, bearings, diaphragms, stiffeners and miscellaneous structural steel items. Areas of steel to be in contact with concrete shall not receive the intermediate and finish coats.

**1081.3.3.1 Bridges over Roadways.** This section will not apply to bridges over railroads.

**1081.3.3.1.1** The field intermediate coat for beam and girder spans shall be applied to the surfaces of all structural steel, except that areas of steel to be in contact with concrete shall not receive the intermediate coat. The intermediate coat shall also be applied to the bearings, except where bearings will be encased in concrete. The finish coating for beam and girder spans shall include the fascia girder or beams. The limits of the fascia girders or beams shall include the bottom of the top exterior flanges, top of the bottom exterior flanges, the exterior web area, the exterior face of the top and bottom flange and the bottom of the bottom flange. Areas of steel to be in contact with concrete shall not receive the finish coat. The finish coat shall also be applied to the exterior bearings, except where bearings will be encased in concrete.

**1081.3.3.1.2** The surfaces of all structural steel located under expansion joints of beam and girder spans shall be field coated for a distance of 1 1/2 times the girder depth, but no less than 10 feet from the centerline of the joint. Within this limit, the items to be field coated shall include all surfaces of beams, girders, bearings, diaphragms, stiffeners and miscellaneous structural steel items. Areas of steel to be in contact with concrete shall not receive the field coats. The limits of the field coatings shall be masked to provide crisp, straight lines and to prevent overspray on adjacent areas.

**1081.3.3.1.3** For all truss or steel box girder spans, the above limits will not apply and all structural steel for these span types shall be field coated, except the areas of steel to be in contact with concrete.

**1081.3.3.2 Bridges Over Streams or Railroads.**

**1081.3.3.2.1** The field coating for beam and girder spans shall include the fascia girders or beams. The limits of the fascia girders or beams shall include the bottom of the top exterior flanges, top of bottom exterior flanges, the exterior web area, the exterior face of the top and bottom flange and the bottom of the bottom flange. Areas of steel to be in contact with concrete shall not receive the field coats. The field coatings shall also be applied to the exterior bearings, except where bearings will be encased in concrete. The interior beams or girders shall only have the prime coat applied with no other field coating required.

**1081.3.3.2.2** The surfaces of all structural steel located under expansion joints of beam and girder spans shall be field coated for a distance of 1 1/2 times the girder depth, but no less than 10 feet from the centerline of the joint.
Within this limit, the items to be field coated shall include all surfaces of beams, girders, bearings, diaphragms, stiffeners and miscellaneous structural steel items. Areas of steel to be in contact with concrete shall not receive the field coats. The limits of the field coatings shall be masked to provide crisp, straight lines and to prevent overspray on adjacent areas.

1081.3.2.3 For all truss or steel box girder spans, the above limits will not apply and all structural steel for these span types shall be field coated, except the areas of steel to be in contact with concrete.

1081.3.4 Coating Thickness Measurement. The dry film thickness of the coatings will be measured by magnetic type gauges in accordance with Steel Structures Painting Council specification SSPC-PA2. At the option of the Engineer, the adhesion of the prime coat will be measured in accordance with ASTM D 3359, Test Method A. When the adhesion is tested, each test result shall equal or exceed scale 3A. Locations for adhesion tests shall be randomly selected. Test locations shall be in areas of least visibility in the completed structure and shall be touched up in an approved manner after completion of the test. When satisfactory test results are not obtained, additional adhesion tests shall be taken to determine the area of insufficient adhesion. For these areas, the surface shall be prepared in accordance with Sec 1081.3.2.1 and the area recoated in accordance with these specifications. If additional prime coat is required to provide the specified minimum thickness, the prime coat shall be applied as soon as possible, but within 24 hours of the initial application.

1081.3.5 Coating Material Storage. All coating material shall be stored in accordance with the coating manufacturer's recommendations. Exposure to storage temperatures outside the range recommended in the manufacturer's specifications will be cause for rejection of the coating material.

1081.3.6 Weather Conditions.

1081.3.6.1 Temperature Limitations. The prime coat shall be applied in accordance with the manufacturer's recommendations, except that the minimum air and steel temperature shall not be less than 34°F. Finish and intermediate coats applied over the prime coat shall be applied in accordance with the manufacturer's specifications, which shall be furnished to the Engineer. The minimums and maximums or additional requirements established by the coating manufacturers written specifications for recommended air or metal temperature or relative humidity shall apply if those requirements are more restrictive than those specified in the contract documents.

1081.3.6.2 Moisture Limitations. Coatings shall not be applied in rain, snow, fog or mist, or when the steel surface temperature is less than 5°F above the dew point. The dew point shall be determined in accordance with MoDOT Test Method T 38. Coatings shall not be applied to wet, damp, frosted or ice-coated surfaces.

1081.3.6.3 Application in Protected Areas. When coatings are applied in a protected area to eliminate the weather conditions, the coated steel shall remain in the protected area until the coatings are cured.

1081.3.6.4 Damaged Coatings. Any uncured coatings exposed to freezing, excess humidity, rain, snow, condensation or curing temperatures outside the range recommended by the manufacturer will be considered damaged. Damaged coatings shall be permitted to dry, then shall be removed and the surface blast cleaned and recoated at the Contractor's expense.

1081.3.7 Thinning. Thinners will be permitted as recommended by the manufacturer's written specifications, provided VOC limits are not exceeded.

1081.3.8 Application. Coatings shall be applied in accordance with the Steel Structures Painting Council specification SSPC-PA1 unless otherwise specified by the product manufacturer. The manufacturer's written specifications for application, upon request, shall be submitted to the Engineer for review.
1081.3.8.1 Application Repairs. If deficiencies in the quality of work or material result in rejection, the Contractor shall submit a repair proposal for approval by the Engineer.

1081.3.8.2 Curing of Coatings. Curing time for recoating shall be within the limits of the manufacturer's recommendations. Application of the finish coat over the intermediate coat shall be accomplished within the recoat time for proper adhesion established by the manufacturer's written specifications.

1081.3.9 Shop Coating. All surfaces of fabricated structural steel, including areas which will be inaccessible after assembly, contact surfaces of high strength bolted connections, and all surfaces to be in contact with concrete in the completed structure shall be coated in the shop with the prime coat. The primer shall be of the type and thickness specified, except as modified by Sec 1081.3.9.1 and Sec 1081.3.9.2. Structural steel sway bracing for substructure may be prepared and coated in the field.

1081.3.9.1 Contact Surfaces. Contact surfaces of high strength bolted field splice and diaphragm connections shall be prime coated to produce a dry film thickness no less than 1.5 mils or more than 2.5 mils. The limits of the coating thickness for these surfaces shall be shown on the shop drawings. The maximum limit of 2.5 mils may be increased provided acceptable test results in accordance with the Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints (AISC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts", Appendix A) are submitted and approved by the Engineer. Revised shop drawings will not be required upon acceptance of the test results. The tests shall meet the requirements for the slip coefficient and creep resistance for Class B coatings and shall be performed by a nationally recognized independent testing laboratory. Any change in the formulation of the coating will require retesting, except when thinned within the limits of manufacturer's written specifications. At the Contractor's option, the contact surfaces of connections for all non-slab bearing diaphragms on non-curved girders may be prime coated with a dry film thickness of no less than 3.0 mils or no more than 6.0 mils, unless noted otherwise on the plans.

1081.3.9.2 Inaccessible Surfaces. Surfaces which will not be in contact, but which will be inaccessible after assembly, shall be prime coated to produce a dry film thickness of no less than 3.0 mils and no more than 6.0 mils. Dry film thickness on surfaces which will be in contact with concrete may be reduced to 2.0 mils provided thorough and complete coverage is obtained. Although shear connectors need not be coated, protection of the connectors from overspray when coating other parts of the beam or girder will not be necessary. Coating thickness measurements will not be made on shear connections.

1081.3.9.3 Touch-up of Galvanized Bolts. The galvanized coating of nuts, bolts and washers damaged during shop installation shall be shop repaired in accordance with Sec 1081.3.10.1 and Sec 1081.3.10.1.1.

1081.3.9.4 Inspection Prior to Coating. No coatings shall be applied before shop inspection of fabrication has been completed. Surfaces of steel within 2 inches of edges to be field welded shall not be coated in the shop.

1081.3.9.5 Erection Match Marks. Erection match marks shall not be visible in the completed structure.

1081.3.10 Field Coating. Intermediate and finish coats for the specified coating system shall be applied in the field. The Contractor shall be responsible for final cleanup and field touch-up of any shop applied coating, including surface preparation and coating of field connections, welds or bolts, areas masked in the shop, and all damaged or defective coating and rusted areas. Surface preparation for field touch-up shall be performed in accordance with Sec 1081.3.2, unless otherwise approved by the Engineer. The touchup field coat shall consist of the same coating used for the shop applied coat. Contact surfaces of high strength bolted connections shall be protected from the intermediate and finish coats. Damage to the coating of galvanized bolts, nuts and washers where bare steel is exposed shall be repaired in accordance with these specifications or, the connection may be prepared as specified in Sec 1081.3.2, followed by a touch-up field coat application of the required coating system.
1081.3.10.1 Field Touch-up of Galvanized Bolts. The galvanized coating of nuts, bolts and washers damaged during installation shall be repaired. Lubricants shall be removed in accordance with SSPC-SP1. Rust shall be removed in accordance with SSPC-SP-2 or SSPC-SP-3. Touch-up shall consist of the application of an approved gray epoxy mastic. The touch-up material shall be compatible with and from the same manufacturer as the coating system to be used for the structure. Prior to field coating operations, the Contractor shall submit information on the specific products to be used, including compatibility data and applicable recoating times to the Engineer for review. Subsequent coatings shall be applied within the recoat time recommended by the manufacturer.

1081.3.10.1.1 Touch-up Color. For areas of the structure that will not receive a field coat, the color of the touch-up material for bolts specified in Sec 1081.3.10.1 shall be similar to galvanized metal.

1081.3.10.1.2 Previously Repaired Material. If repairs to the galvanized coating of shop-installed nuts, bolts and washers have previously been performed in accordance with Sec 1081.3.9.3 or if epoxy mastics are otherwise shop-applied to structural steel, the Contractor shall be responsible for any special field preparation required for proper adhesion of subsequent field coats to the epoxy coating. Prior to field coating operations, the Contractor shall submit manufacturer's recommendations to the Engineer.

1081.3.10.1.3 Masking. Previously coated or adjacent areas shall be masked or otherwise protected from material used to touch-up the galvanized coating of fasteners.

1081.3.10.2 Sequence of Work. Field coatings, except for touch-up and coating of inaccessible surfaces, shall not be applied until the concrete deck has been placed, the forms removed, and all concrete spatter, foreign material and contaminants are removed from existing coatings unless otherwise approved by the Engineer. Prior to submittal of alternative application methods, the Contractor shall present methods to be used to prevent damage to the intermediate and final field coatings. The sequence of work shall be arranged to provide ample time for each coat to cure before the next coat is applied. The intermediate field coats shall be free of all oil, grease, dust or dirt prior to application of the next coat. Intermediate or prime coats that have been exposed to chlorides used in snow removal operations shall be cleaned by power washing as defined in Sec 1081.5.3.2.2 prior to application of the subsequent intermediate or final coats. In no case shall a coat be applied until the previous coat has been approved by the Engineer. Excessive rust streaks or coatings on concrete masonry shall be removed by sandblasting or by other approved methods without damage to the masonry.

1081.3.10.3 Work Under Stage Construction Contracts. If complete field coating is not included in the contract for erection of structural steel, the touch-up coating of newly erected work and the coating of surfaces which will be inaccessible after erection shall be included as part of the work to be performed under the contract for erection. Field coating under any contract that does not include the erection shall include cleaning, preparation of any previously applied coatings, repairs and spot application of coatings required at the time the work is performed. Prior to field coating of structural steel that was erected under a previous contract, the Contractor shall submit the manufacturer's recommendations to the Engineer, outlining requirements for cleaning and preparation of all existing coatings. The manufacturer's recommendations shall include requirements for preparation of epoxy mastics previously applied for touch-up or other purposes.

1081.3.10.4 Partial Applications. If partial application of the field finish coats to a structure as provided in Sec 1081.3.3 is required or permitted, the Contractor shall perform field touch-up coating to areas of the structural steel outside the limits to receive the intermediate and finish coats. Touch-up shall be in accordance with in Sec 1081.3.10 and at the Contractor's expense.

1081.3.11 Identification. The Contractor shall, at the completion of the coating application, stencil in black paint on the structure the number of the bridge, the word "COATED", the system used and the month and year the coating was completed. The letters shall be capitals approximately 3 inches high. The legend shall be stenciled on the outside face of an outside stringer or girder near each end of the bridge as directed by the Engineer.
1081.3.12 Property and Traffic Protection. The Contractor shall protect pedestrian, vehicular, railroad and other traffic, persons and property, upon, beneath and in the vicinity of the structure, and all portions of the bridge against damage or disfigurement by blast media, blast residue, coatings, coating material, equipment or by any other operations.

1081.4 Recoating of Structural Steel (System G or H).

1081.4.1 Scope. This specification covers the field preparation of structural steel surfaces to be recoated, furnishing and applying specified coatings, protection and drying of coatings, furnishing protection from coating spatter and disfigurement, and final cleanup.

1081.4.2 Systems of Protective Coatings. All structural steel shall be recoated by the Contractor in the field using one of the complete systems, including prime coats in accordance with Sec 1081.2, unless noted otherwise. Recoating of structural steel, including surface preparation, weather conditions, application, touch-up and protection, shall be in accordance with all requirements of Sec 1081.3.

1081.4.3 Surface Preparation. Cleaning and painting of the structural steel shall proceed in areas or sections as approved by the Engineer, usually consisting of one or more complete spans. The cleaning and application of the coatings for each specified section shall be entirely completed and accepted by the Engineer prior to proceeding with additional cleaning or coating. Surface preparation shall be in accordance with Sec 1081.3. All existing coatings and paint shall be removed by blast cleaning unless specifically indicated otherwise in the contract.

1081.4.3.1 Environmental Regulations. The paint removal operation shall comply with all local, state and federal regulations, including but not limited to the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) Standards 29 CFR 1910 and 1926.62, and the Missouri Code of State Regulations, including 10 CSR 10 Air Conservation Commission, 10 CSR 20 Clean Water Commission, 10 CSR 25 Hazardous Waste Commission, and 10 CSR 80 Solid Waste Management.

1081.4.3.2 Collection of Non-Lead Based Residue. The Contractor shall collect the residue from the cleaning operations for disposal. The residue from cleaning operations shall be stored in Contractor furnished, watertight containers free from rust, paint or other structural defects. Containers shall remain closed at all times, except when necessary to add additional residue, and shall be labeled to indicate the contents. Material, other than the residue from the cleaning operations, shall not be placed in the containers. Clothing, tarps, hoses and other waste material shall be properly disposed of by the Contractor at the Contractor’s expense. At the end of each day’s work, the containers shall be stored outside the flood plain in a secure area for bridges over streams or near the bridge site in a secure area for other bridges. The Contractor shall properly dispose of all non-hazardous residues. Any testing required for the disposal of residues shall be the responsibility of the Contractor. Hazardous residues shall be disposed of in accordance with Sec 1081.4.3.3.

1081.4.3.3 Collection of Lead Based Residue. The Contractor shall collect the heavy metal contaminated residue from the cleaning operations for disposal. All residues shall be considered hazardous waste until tested to verify otherwise. The residue shall be stored in containers and locations as described in Sec 1081.4.3.2, and the containers shall be labeled to indicate hazardous material storage with approved labels. Heavy metal contaminated residue shall be transported to a lead smelter or hazardous waste disposal facility by a Missouri licensed hazardous waste transporter. For more information concerning approved smelters or hazardous waste disposal facilities, the Contractor shall contact the Missouri Department of Natural Resources, Hazardous Waste Program. The Contractor shall be responsible for contacting the Engineer to coordinate the paperwork required for shipping of the heavy metal contaminated material. Clothing, tarps, hoses and other cleaning material shall be tested for heavy metal contamination and shall be disposed of in accordance with all local, state or federal regulations. The Contractor shall maintain an inventory of the quantity of heavy metal contaminated residue delivered to the storage site and either to the lead smelter or the hazardous waste disposal facility. Copies of the inventory shall be provided to the Engineer.
1081.4.4 Joints. All seams and joints which cannot be satisfactorily sealed or coated shall be adequately caulked with compounds compatible with the coating system being applied. Caulking material shall be in accordance with the coating manufacturer's recommendations and shall meet the approval of the Engineer. Caulking shall be satisfactorily completed for an entire joint or seam after application of the prime coat and before application of any specified finish or intermediate coats.

1081.4.5 Identification. The Contractor shall, at the completion of recoating, stencil in black paint on the structure the number of the bridge, the word "RECOATED", the system used and the month and year the coating was completed. The letters shall be capitals approximately 3 inches high. The legend shall be stenciled on the outside face of an outside stringer or girder near each end of the bridge as directed by the Engineer.

1081.4.6 Property and Traffic Protection. The Contractor shall provide protection in accordance with Sec 1081.3.12.

1081.5 Overcoating of Structural Steel (Calcium Sulfonate System).

1081.5.1 Scope. This specification covers the field preparation of structural steel surfaces to be recoated, disposal of paint residues and power washing water, furnishing and applying the specified coatings, protection and drying of the coatings, furnishing protection from coating spatter or disfigurement and final cleanup.

1081.5.2 System of Protective Coatings. All exposed and accessible surfaces of structural steel and steel bearings shall be coated with the Calcium Sulfonate paint system in accordance with Sec 1081.2 unless otherwise noted. The color of the topcoat shall be as shown on the contract plans. Recoating of the structural steel shall be in accordance with all requirements of Sec 1081.3.

1081.5.3 Surface Preparation. Surface preparation shall be in accordance with Sec 1081.4.3, except that blast cleaning will not be required.

1081.5.3.1 Removal of Existing Paint. The existing steel shall be cleaned by a combination of approved mechanical methods and power washing in accordance with Sec 1081.5.3.2.

1081.5.3.1.1 Water for Power Washing. The water used for power washing shall be clean, potable water free from contaminants. The wastewater shall be collected and disposed of in accordance with all applicable state, local and federal clean water regulations. The wastewater shall not be discharged onto the ground or into waters of the state without a permit. Water that is collected from the power washing operation shall not be reused in the power washing operation.

1081.5.3.1.2 Environmental Regulations. The paint removal operation shall comply with all local, state and federal regulations including those defined in Sec 1081.4.3.1.

1081.5.3.1.3 Collection of Non-Lead Based Residue. The residue from both the mechanical and power washing operations shall be stored in containers and locations as described in Sec 1081.4.3.2. The containers shall remain closed at all times except when necessary to add additional residue or wastewater. The containers shall be labeled to indicate the contents. Material other than the residue or wastewater from the cleaning operations shall not be placed in the containers. Clothing, tarps, hoses and other waste material, non-hazardous, filtered wastewater and remaining non-hazardous residues shall be properly disposed of by the Contractor. Any testing required for the disposal of the wastewater or residues shall be the responsibility of the Contractor. Copies of all testing data, required certifications and shipping manifests shall be provided to the Engineer.

1081.5.3.1.4 Collection of Lead Based Residue. All residue and wastewater shall be considered hazardous waste until tested to verify otherwise. The residue shall be stored in containers and locations as described in Sec 1081.4.3.2, and the containers shall be labeled to indicate hazardous material storage with approved labels. Heavy
metal contaminated residue shall be transported to a lead smelter or hazardous waste disposal facility by a Missouri licensed hazardous waste transporter. For more information concerning approved smelters or hazardous waste disposal facilities, contact the Missouri Department of Natural Resources, Hazardous Waste Program. The Contractor shall be responsible for contacting the Engineer to coordinate the documentation required for shipping of the heavy metal contaminated material. Clothing, tarps, hoses and other cleaning materials shall be tested for heavy metal contamination and disposed of in accordance with all local, state or federal regulations. Wastewater collected during cleaning operations, that test results indicate as a hazardous waste as determined by 40 Code of Federal Regulations 261.24 (Methods for Determining Hazardous Waste Characteristics of Toxicity), shall be filtered to remove as much heavy metal contamination as possible. If further tests indicate the wastewater is still considered contaminated, the wastewater shall be transported to a hazardous waste disposal facility in accordance with all applicable regulations. Wastewater that has been tested and determined to be non-hazardous shall be discharged in accordance with Sec 1081.5.3.1.1. The Contractor shall maintain an inventory of the quantity of heavy metal contaminated residue delivered to the storage site and either to the lead smelter or the hazardous waste disposal facility. The Contractor shall also keep an inventory of the quantity of heavy metal contaminated water generated and delivered to the storage site and the quantity of heavy metal contaminated water, which has been disposed. Copies of the inventory shall be provided to the Engineer.

1081.5.3.1.5 Testing of Water Samples. At the conclusion of the power washing operation, the Contractor shall obtain samples of the filtered wastewater in the presence of the Engineer. The samples shall be analyzed by an independent testing laboratory for total metals, oil and grease, biochemical oxygen demand, total suspended solids, pH and Toxicity Characteristic Leaching Procedure (TCLP) heavy metals. Samples shall be collected and analyzed in accordance with EPA approved methods. Copies of all test reports shall be supplied to the Engineer. Additional testing required to comply with any federal, state or local regulations shall be provided by the Contractor.

1081.5.3.2 Cleaning of Structural Steel. All exposed steel surfaces shall be mechanically cleaned and power washed prior to application of the coating.

1081.5.3.2.1 Mechanical Cleaning. Exposed structural steel where mechanical cleaning is required shall be cleaned in accordance with SSPC-SP2 or SSPC-SP3. Mechanical cleaning will be required for areas of rusted steel, loose, cracked or brittle paint or areas indicated by the Engineer. The cleaning shall be performed 2 inches beyond the areas of rust or defective paint in all directions or until tightly adhered paint is obtained with no rust or blisters. Edges between the bare steel and the paint shall be feathered. Collection of the material removed shall be in accordance with Sec 1081.5.3.1.

1081.5.3.2.2 Power Wash Cleaning. After completion of the mechanical cleaning to the satisfaction of the Engineer, the steel shall be cleaned by a low-pressure power wash to remove loose paint, dirt and other loose deleterious material. The maximum pressure for the power washing shall be 1500 psi. If necessary, solvent cleaning in accordance with SSPC-SP1 shall be employed to augment the power washing. Collection of the wastewater, solvents and other residues from the power washing operation shall be in accordance with Sec 1081.5.3.1. After the power washing operation, areas that have remaining rust or loose paint shall be re-cleaned in accordance with Sec 1081.5.3.2.1, except that vacuum power tools will be required for power tool cleaning. All surfaces washed shall be completely free of all foreign matter, surface dry and approved by the Engineer prior to application of the coating.

1081.5.4 Application. The coating shall be applied in accordance with Sec 1081.3 and the manufacturer’s recommendations. The steel shall be free of all cleaning residues prior to coating. Areas that have been cleaned to bare steel shall be prime coated on the same day as the cleaning. Any areas that rust prior to application of the prime coat shall be re-cleaned. The prime coat and topcoat shall be applied to all steel surfaces with the exception of steel encased in concrete. Any existing paint that curls or lifts after application of the Calcium Sulfonate system shall be removed, the area re-cleaned and the coating reapplied. Application of the rust penetrating sealer will only be required if specified in the contract documents or as determined by the Engineer. Application of the rust penetrating sealer shall be in accordance with the rust penetrating sealer manufacturer’s recommendations.
1081.5.5 Identification. The Contractor shall, at the completion of the final coating application, stencil in black paint on the structure the number of the bridge, the word "RECOATED - Calcium Sulfonate" and the month and year the coating was completed. The letters shall be capitals approximately 3 inches in height. The legend shall be stenciled on the outside face of an outside girder near each end of the bridge as directed by the Engineer.

1081.5.6 Property and Traffic Protection. The Contractor shall provide protection in accordance with Sec 1081.3.12.

1081.6 Galvanized Metal. Galvanizing shall be applied after fabrication. Galvanized material on which the galvanizing has been damaged will be rejected or may, with approval of the Engineer, be repaired in the field by the zinc alloy stick method. Required field welds and adjacent areas on which galvanizing has been damaged shall be galvanized by this same method. The area to be regalvanized shall be thoroughly cleaned, including the removal of slag on welds. Touch-up of galvanizing of sheet material less than 3/16 inch may be completed by the use of an approved aluminum epoxy mastic coating if the material will not be in direct contact with concrete or with an approved non-aluminum epoxy mastic coating if the material will be in direct contact with concrete.
1091.1 Lighting Poles.

1091.1.1 Pre-Approval. Fabricators shall submit two copies of shop drawings and supporting calculations to the Engineer. Submittals shall be approved by the Engineer in writing prior to fabrication of the lighting poles. Shop drawings shall indicate complete design details required for pole fabrication, including material grades and thicknesses, welding and orientation of any longitudinal seams. Shop drawings shall provide pole installation and hardware details. Design details for all possible pole combinations shown on the plans may be submitted. All welding procedures shall be prepared by the manufacturer as a written procedure specification and shall be submitted with the shop drawings for approval. Approval of the weld procedures will be required before approval of the shop drawings. Shop drawings shall indicate the specific approved welding procedure to be used for each joint. Shop drawings and supporting stress calculations shall be signed and sealed by a registered professional Engineer in the State of Missouri. Upon written approval, pre-approved drawings may be used on any project where the design conditions of the shop drawings are not exceeded.

1091.1.2 Requirements. Lighting poles shall be steel or aluminum in accordance with the contract and shall be of the same material and design throughout the project. Poles shall be of the type shown on the plans. The fabricator may furnish poles with other shapes, gages and dimensions meeting or exceeding those shown on the plans and specifications. The mounting height of the slipfitter above the pavement and the pole design numbers will be specified by numbers following the pole type designation. Clamps shall be provided for connecting bracket arms to poles to obtain the specified mounting height. All poles shall have removable raintight metal pole caps. All handhole covers and pole caps shall be attached to the pole with a chain constructed of the same material as the pole and firmly secured. The chain shall be securely attached to the inside of the pole and of sufficient length to allow removal of the cover or cap for maintenance access. An aluminum or stainless steel identification tag with embossed or engraved letters and numbers shall be provided with all poles as shown on the plans. The tag shall be attached to the pole 6 inches above the top of the handhole or 18 inches above the base plate over the transformer base door. Shims may be used between the pole base or transformer base and the foundation for leveling purposes. Four copies of applicable pre-approved drawings shall be supplied with the poles and shall be provided to the Engineer.

1091.1.2.1 Type AT. Each Type AT pole shall be provided with a transformer base in accordance with Sec 901. A grounding conductor shall be attached to the ground lug in each transformer base as shown on the plans.

1091.1.2.2 Type B and MB. Each Type B and MB pole shall have a wiring handhole with a suitable metal cover near the base using a grounding lug inside the pole as shown on the plans. A grounding conductor shall be attached to the ground lug in each pole as shown on the plans.

1091.1.2.3 Steel. Steel lighting poles shall be round or octagonal shaft poles. The shaft section shall be fabricated from basic oxygen or open hearth steel sheet, No. 11 gage, as one continuous shaft or as individual segments no less than 10 feet in length, joined together using electrically welded, intermediate, transverse, full penetration, circumferential joints. Each sheet shall be formed into a tube with one continuous-welded longitudinal seam. After manufacture, the material shall have a minimum yield strength of 48,000 psi, including the weld. Poles shall be manufactured with steel shoe bases or base plates attached to the lower end of the shafts and arranged for bolting to a transformer base or to a foundation. All base plates and shoe bases shall be equipped with four cast steel or cast iron nut covers in accordance with AASHTO M 103 or M 105 or four aluminum nut covers and shall have four galvanized or stainless steel screws for securing covers to the pole. Welding and fabrication of the assemblies shall be in accordance with the ANSI/AWS D1. 1 Structural Welding Code-Steel. All poles, shoe bases, base plates and cast steel or cast iron nut covers shall be fully galvanized after fabrication.

1091.1.2.3.1 For shoe base-type poles, each shoe base shall be a one-piece casting in accordance with AASHTO M 103, Grade 65-35 with four anchor bolt holes. Each shoe base shall consist of a collar, flange and gussets, all
integrally cast. Ample fillet radii shall be provided at the juncture of these components to reduce the effects of stress concentration. The flange of the base shall be flat and continuous around the outside of the collar. The base shall telescope from the shaft and be secured by two continuous welds. One weld shall be on the inside of the base at the end of the shaft and the other weld shall be on the outside at the top of the base. The shoe base shall be arranged for bolting to a transformer base or to a foundation.

1091.1.2.3.2 For base plate-type poles, the base plate shall be no less than 13 inches square and no less than 1 1/4 inches thick.

1091.1.2.4 Aluminum.

1091.1.2.4.1 Aluminum lighting poles shall be round shaft poles. Each shaft shall be manufactured as a two-piece pole by the spun drawn method from seamless extruded aluminum tubing, ASTM B 221, Alloy 6063-T6 and shall have a nominal wall thickness for the lower section of 0.250 inch and a nominal wall thickness for the upper section of 0.188 inch. The one-piece shaft for 30 foot mounting height shall have a nominal wall thickness of 0.188 inch, except those with twin-truss type arms shall have a nominal wall thickness of 0.250 inch. Shoe base-type poles shall be manufactured with heavy cast aluminum shoe bases attached to the lower ends of the shafts. Each shoe base shall be a permanent mold casting in accordance with ASTM B 108, Alloy 356.0-T6 and shall be free from cracks, pits and blowholes. The shoe base shall be arranged for bolting to a transformer base or to a foundation. The base shall have four anchor bolt holes, shall be equipped with four cast aluminum bolt covers and shall have four stainless steel fasteners for securing the covers to the shoe base. Each shoe base shall consist of a collar, flange and gussets, all integrally cast. Ample fillet radii shall be provided at the juncture of these components to reduce the effects of stress concentration. The flange of the base shall be flat and continuous completely around the outside of the collar. The base shall telescope from the shaft and be secured by two continuous welds. One weld shall be on the inside of the base at the end of the shaft and the other weld shall be on the outside at the top of the base. The base and shaft shall be welded in the T4 temper with filler alloy 4043 and precipitation heat treated, artificially aged, to the T6 temper by an approved method after welding. Welding shall be in accordance with Article 6.9 of AASHTO’s Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

1091.1.2.4.2 At the fabricator’s option, the shafts for aluminum lighting poles may be formed from one piece of aluminum sheet, ASTM B 209, Alloy 5086-H34, having one continuous weld. The one-piece shaft for the 30 foot mounting height shall have a 9 inch diameter at the base and a nominal wall thickness of 0.135 inch. Shafts for 35 to 55 foot mounting heights shall have a 13.4 inch diameter at the base and a nominal wall thickness of 0.135 inch for both sections. Each shoe base shall be a permanent mold casting having an integral cast aluminum riser and shall be in accordance with ASTM B 108, Alloy 356.0-T6 and shall be free from cracks, pits and blowholes. The integral riser shall be designed to slip-fit into the pole shaft a sufficient distance to develop the full strength of the pole. The riser shall be bonded to the shaft with a structural epoxy adhesive that shall develop the strength of the pole. The epoxy shall develop a minimum of 1200 psi in shear when tested in accordance with ASTM D 1002. The shoe base shall have four anchor bolt holes, shall be equipped with four cast aluminum bolt covers and shall have four stainless steel fasteners for securing the covers to the shoe base. Each shoe base shall consist of a collar, flange and gussets, all integrally cast. The flange of the shoe base shall be flat.

1091.2 Transformer Bases. Transformer bases shall be permanent mold castings in accordance with ASTM B 108, Alloy 356.0-T6 and shall be free from cracks, pits and blow holes. The transformer base shall be designed to accommodate and provide access to electrical equipment. The base shall have internal lugs for mounting on a foundation and shall be designed for bolting to the base plate of the lighting pole using flat and lock washers. A grounding lug shall be provided in each base. The access opening shall have a hinged fiberglass or plastic door with a tamper-resistant fastening device. The outside of the door shall be imprinted or adequately labeled with the warning, "DANGER - HIGH VOLTAGE". No direct payment will be made for transformer bases.

1091.3 Circular Steel Pile Foundations. Circular steel pile foundations, the steel connector plate and steel closure plate shall be of the dimensions shown on the plans. The slotted hole may be saw cut or flame cut. All sharp edges
shall be ground smooth. The steel connector plate and steel closure plate shall be welded to the steel pile foundation. The foundation assembly shall be fully galvanized after fabrication. Bolts shall project no less than 1/4 inch or more than 5/8 inch beyond the nut when properly tensioned. Flat and lock washers shall be used for attachment.

1091.4 Steel H-Pile Foundations. Steel H-pile foundations and steel connector plates shall be of the dimensions shown on the plans. The steel connector plates shall be welded to the H-pile foundation. The foundation assembly shall be fully galvanized after fabrication. Bolts shall project no less than 1/4 inch or more than 5/8 inch beyond the nut when properly tensioned. Flat and lock washers shall be used for attachment.

1091.5 Screw Anchor Foundations. Screw anchor foundations and steel connector plates shall be of the dimensions shown on the plans. The slotted hole may be saw cut or flame cut. All sharp edges shall be ground smooth. The steel connector plates shall be welded to the screw anchor shaft. The foundation assembly shall be fully galvanized after fabrication. Bolts shall project no less than 1/4 inch or more than 5/8 inch beyond the nut when properly tensioned. Flat and lock washers shall be used for attachment.

1091.5.1 Fabricators for screw anchor foundations shall submit four (4) copies of shop drawings to the Engineer. Shop drawings shall indicate complete design details required for fabrication, including material grades, dimensions, thicknesses and welding. Shop drawings shall provide installation procedures and indicate the maximum torque ratings of the foundations.

1091.5.2 Submittals shall be approved by the Engineer in writing prior to fabrication. Upon written approval, pre-approved drawings may be used on any project where the design conditions of the shop drawings are not exceeded.

1091.6 Bracket Arms. Bracket arms shall be similar in design to those shown on the plans, arranged for 2 inch slipfitter luminaire mounting, and shall be attached to the poles as shown on the plans. Bracket arms shall be of the same material as the pole. Bracket arm mounting plates shall match the shape of the pole. A one inch pipe nipple shall be welded in place in the wire entrance hole on the mounting plate. The welds shall be placed on the side of the plate away from the pole. Flat and lock washers shall be used for attachment.

1091.7 Luminaires.

1091.7.1 Roadway Luminaire, LED 250 Watt Equivalent. Light Emitting Diode (LED) cobra head luminaire shall meet or exceed the following requirements:

(a) Operational wattage shall be between 80W-135W, while operating voltage is between 110-277V at a frequency of 50/60 Hz.

(b) Lumens produced shall be greater than or equal to 12,000 when operating at 1 amp.

(c) Its aluminum housing color shall be white, and it shall have a universal four-bolt slip fitter mount to 1-1/4” to 2” (1-5/8” to 2-3/8” O.D.) diameter mast arms.

(d) It shall provide 40 individual LED’s, together driven at 1 amp. The fixture will allow dimming to be easily performed in the field by simply moving a wire to change amperage from 1,000 milliamps to 700 milliamps.

(e) Its typical conventional equivalent shall be a 200W-250W HPS-High Pressure Sodium and a MH-Metal Halide luminaire.

(f) It shall produce a type 3 medium roadway pattern.

(g) It shall be IP66 rated for dust and water, U.L listed, and 3G vibration rated.
(h) Light engine(s) shall be surge protected to 10,000 volts or greater.

(i) A NEMA photocell socket with cap shall be included with its socket, or this socket shall not be provided.

(j) Light produced shall be neutral/cool white in color with a CCT-Correlated Color Temperature between 4,000k and 5,100k.

(k) The BUG rating shall be equal to or better than B3 U0 G3 when driven at one amp, and equal to or better than B2 U0 G2 when driven at 700 milliamps.

1091.7.2 Underpass Luminaire. Luminaires for underpass lighting shall be high-pressure sodium. The luminaires shall consist of a pre-wired unit for wall mounting, with raintight cast aluminum housing, cast aluminum door with integral cast guard, heat-resistant glass prismatic refractor, asymmetric aluminum reflector and socket for horizontal lamp position, complete with 150-watt lamp and 240-volt or 480-volt ballast as required. Type IV short distribution, non-cutoff light distribution shall be set in accordance with the manufacturer’s recommendations, unless otherwise directed by the engineer or shown on the plans. The door shall have a stainless steel hinge along the bottom, stainless steel latches at the top and non-ferrous metal or stainless steel safety chains. Provisions shall be made for attaching the unit directly to a wall or to an outlet box stud with nonferrous metal or stainless steel hardware. Ballasts for underpass luminaires shall be in accordance with Sec 901. The ballast power cables shall be individually fused with in-line fuse holders between the line and load, in the junction box or the luminaire housing if no junction box is shown on the plans. The fuse rating shall be three amps unless otherwise shown on the plans.

1091.7.2.1 Painted or finished luminaire surfaces exposed to the environment shall exceed a rating of six per ASTM D1654 after 1000 hours of testing per ASTM B117. Each luminaire shall have aluminum housing with two 2 inch slipfitters or one 4-bolt slipfitter or one 2 inch slipfitter with a longitudinal leveling system. The housing shall have a natural aluminum or gray baked enamel finish. The coating shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6. All metal parts, such as springs on the latches and hinges, U-bolts and screws shall be made from non-ferrous metal or stainless steel. All parts of the luminaire shall be fabricated from corrosion resistant material.

1091.7.2.2 Luminaire shall start and operate in ambient temperature range specified. Maximum rated case temperature of driver and other internal components shall not be exceeded when luminaire is operated in ambient temperature range specified. Wiring inside the luminaire housing shall be protected by suitable heat resistant insulating material. Mechanical design of protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation. Liquids or other moving parts shall be clearly indicated in submittals, shall be consistent with product testing, and shall be subject to review and approval by the Engineer. Luminaire designation indicated “ANSI C136.41, 7-pin” on New Product Evaluation Form shall be fully prewired and shall incorporate an ANSI C136.41 compliant receptacle. If a dimmable LED driver is specified, the 0-10V or DALI control wires shall be connected to the receptacle pads as specified in ANSI C136.41; connection of the two remaining pads shall be by Manufacturer, as directed by Engineer.

1091.7.2.3 Luminaire shall be listed for wet locations by a U.S. Occupational Safety Health Administration (OSHA) Nationally Recognized Testing Laboratory (NRTL), shall have locality-appropriate governing mark and certification, and shall meet the performance requirements specified in ANSI C136.2 for dielectric withstand, using the DC test level and configuration. Luminaire shall meet the performance requirements specified in ANSI C136.2 for electrical immunity, using the combination Enhanced Wave Test Level (10kV/5kA) for whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire. Luminaire shall comply with FCC 47 CFR part 15 interference criteria for Class A (non-residential) digital devices, and shall comply with section 5.2.5 (luminaires rated for outdoor use) of ANSI C82.77 at full input power and across specified voltage range.
1091.7.2.4 Color Rendering Index (CRI) shall be no less than 50. Nominal Correlated Color Temperature (CCT) shall be 3000k with allowable IES LM-79 Chromaticity Values of 2870 to 3220 measured CCT (k) and -0.006 to 0.006 Measured Duv. Luminaire shall have an external label per ANSI C136.15 and shall have an internal label per ANSI C136.22.

1091.7.3 Pre-Approval. Before approval and purchase, the Contractor must submit vendor provided literature for County approval. The Contractor shall submit to the Engineer 4 copies of the proposed luminaire specifications in a submittal showing required specifications have been met or exceeded.

1091.7.4 Warranty. A written product warranty shall be provided with or before the project closeout paperwork. It shall provide a full replacement coverage warranty for a minimum duration of ten years. Negligible light output from more than 10 percent of the LED diodes constitutes luminaire failure. Warranty period shall begin 90 days after date of invoice, or on the day it has been installed and made operation, whichever occurs later. Manufacturer or local sales representative shall provide installation and troubleshooting support via telephone and/or email.

1091.8 Control Stations. Control stations shall consist of all equipment and material necessary for the distribution of secondary electrical power as shown on the plans. Control stations will be specified by the secondary voltage.

1091.8.1 Cabinets. Control cabinets shall be of sufficient size to house all equipment as shown on the plans. All equipment such as circuit breakers, switches, contactors, fuses, photoelectric controls and terminal blocks shall be installed on the panel as shown on the plans. Control cabinets shall have a control panel constructed of the same material as the cabinet. Cabinets shall be NEMA 4, dust-tight, watertight and constructed of 0.125 inch minimum reinforced sheet aluminum alloy and be of clean-cut design and appearance. All hinges, catches and other hardware shall be non-ferrous metal or stainless steel. Cabinets shall have a No. 2 Corbin cabinet lock and provisions for locking with a padlock. Two keys for cabinet locks shall be furnished by the Contractor. Mounting shall be as shown on the plans.

1091.8.2 Lightning Arrestors. Lightning arrestors shall be of the rated voltage as shown on the plans.

1091.8.3 Photoelectric Controls. Photoelectric controls shall be of the cadmium-sulfide or solid-state type operating on 120 volts or 240 volts, as shown on the plans and shall operate on a line supply of 50 to 60 hertz. The load capacity of the photoelectric cell relays shall be a minimum of 1000 watts. Photoelectric cells shall operate a lighting system through mercury load relays or contactors as shown on the plans. The photoelectric cell circuitry shall be designed to be normally closed at night. The photoelectric cell shall be configured such that in the event of failure, the lights shall be on. The turn-on range shall be adjustable from 1.0 to 3.0 footcandles. A turn-on setting of 1.0 footcandle and a turn-off setting of 2.0 footcandles shall be made at the factory. The photoelectric cell shall have a time delay to avoid operation due to lightning and transient light. A suitable bracket for mounting the photoelectric cell shall be provided. The photoelectric cell shall be mounted into a three-prong twist lock socket. All top mount photoelectric controls shall face an open sky and side mount photoelectric controls shall face north. Each photoelectric control unit shall include a lightning arrester. Test switches used with photoelectric controls shall be three-position switches or two single-pole breakers as shown on the plans. Test switches shall be clearly labeled and mounted in the control cabinet.

1091.8.4 Contactors. Contactors shall be NEMA Type 1 enclosed, magnetic-type, two-pole, single phase for 600 volts, 60-hertz service. The operating coil shall be designed for 120-volt or 240-volt operation as shown on the plans. The contactor shall be electrically held, have the minimum rating and shall be housed in the control cabinet as shown on the plans. Mercury load relays shall be two-pole, normally-open, mercury contact, magnetic-type with load capacity as shown on the plans.

1091.8.5 Circuit Breakers. All circuit breakers shall be molded-case thermal-magnetic circuit breakers. The number and trip rating of circuit breakers shall be as shown on the plans. All breakers shall be designed for panel mounting with cable connections on the line and load sides.
1091.8.5.1 **Type A Circuit Breakers.** Type A circuit breakers shall have a minimum of 18,000 amps alternating current interrupting rating at 240 volts alternating current and 14,000 amps alternating current interrupting rating at 480 volts alternating current. Breakers shall be full-size and designed to accept wire sizes up to 2/0 AWG. Terminals shall be provided for the wire sizes as shown on the plans.

1091.8.5.2 **Type B Circuit Breakers.** Type B circuit breakers shall have a minimum of 10,000 amps alternating current interrupting rating at 240 volts alternating current. Type B circuit breakers shall have a nominal size no greater than one inch wide by 4 inches high by 3 inches deep. Terminals shall be configured for the wire sizes as shown on the plans. If the breaker terminals are not designed for the required wire sizes, suitable terminal adapters, connectors or terminal blocks shall be used to convert the wire sizes.

1091.9 **Power Supply Assembly.**

1091.9.1 Disconnect cabinets shall be NEMA 4, dust-tight and watertight. The operating handle shall have full cover interlock to prevent the door from opening when the breaker is on. The enclosure shall have provisions for padlocking the enclosure and for padlocking the switch in the on or off position.

1091.9.2 Meter boxes shall be NEMA 3R or NEMA 4.

1091.10 **Cable Splicing.**

1091.10.1 Splice blocks shall be designed for the wire size used, shall have one port per wire and the wires secured with set screws. The set screw holes shall be protected with removable plugs.

1091.10.2 Resin splice kits shall consist of a protective plastic case designed for the type of connector used, filled with a resin insulating compound mixed in accordance with the manufacturer's recommendations.