MISSOURI
HIGHWAYS and TRANSPORTATION COMMISSION

JEFFERSON CITY, MISSOURI

GENERAL SPECIAL PROVISIONS AND
SUPPLEMENTAL SPECIFICATIONS TO 1999

MISSOURI STANDARD SPECIFICATIONS FOR
HIGHWAY CONSTRUCTION

EFFECTIVE JULY 1, 2002

CONTENTS

GENERAL SPECIAL PROVISIONS

Division	Title	Page
Div 100	Opportunity to Partner	4
	Section 404 Nationwide Permit General Conditions	4
	Section 401 Water Quality Certification Conditions	9
	Certification of Blasters	9
Div 200	Disposal of Excess Material	11
Div 300	Aggregate Shoulders	12
	Bituminous Pavement Coldmillings Substituted for Aggregate Base	12
Div 400	Micro-Surfacing	12
	Scrub Seal	17
Div 500	Tinting of Concrete for ADA Ramps	20
	Portland Cement Concrete for Early Open Pavement	21
	Portland Cement Concrete Unbonded Overlay	22
Div 600	"Give 'em a BRAKE" Signs	24
	“Show Me Progress” Signs	25
	“No Center Stripe” Signing	25
	White and Yellow Acrylic Waterborne Traffic Marking Paint	26
	Roll-Up Construction Signs	28
	Use of Law Enforcement Services	29
	Temporary Median Crossovers	29
	Special Field Laboratory	29
	Rock Ditch Liner	31
	Snowplowable Raised Pavement Markers	33
Div 800	Alternate Temporary Erosion Control Methods	36
Div 900	Substitution of Manufactured Items	37
	Flexible Delineator Posts	38
Div 1000	Concrete for MSE Systems and Other Commercial Precasting Works	42
	High Range Water-Reducing Admixtures	43

SUPPLEMENTAL SPECIFICATIONS

ERRATA CORRECTIONS TO 1999 MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION 45

REVISIONS TO 1999 MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION

Section	Title	Page
Sec 101	Definition of Terms	46
Sec 102	Bidding Requirements and Conditions	47
Sec 103	Award and Execution of Contract	47
Sec 104	Scope of Work	47
Sec 105	Control of Work	48
Sec 106	Control of Material	49
Sec 107	Legal Relations and Responsibility to the Public	49
Sec 108	Prosecution and Progress	51
Sec 109	Measurement and Payment	51
Sec 201	Clearing and Grubbing	57
Sec 202	Removals	60
Sec 203	Roadway and Drainage Excavation, Embankment and Compaction	70
Sec 206	Excavation for Structures	71
Sec 207	Linear Grading	72
Sec 301	Plant Mix Bituminous Base Course	72
Sec 303	Rock Base	73
Sec 306	Modified Subgrade	73
Sec 310	Aggregate Surface	74
Sec 401	Plant Mix Bituminous Pavement	74
Sec 402	Plant Mix Bituminous Surface Leveling	74
Sec 403	Asphaltic Concrete Pavement	75
Sec 407	Tack Coat	79
Sec 501	Concrete	79
Sec 502	Portland Cement Concrete Pavement	80
Sec 504	Concrete Approach Pavement	85
Sec 505	Bridge Deck Concrete Wearing Surface	85
Sec 601	Field Laboratories	86
Sec 602	Markers	86
Sec 603	Water Line Installation	86
Sec 604	Miscellaneous Drainage	87
Sec 606	Guardrail, End Terminals, Crash Cushions, One-Strand Cable – Access Restraint and Guard Cable	87
Sec 608	Concrete Median, Median Strip, Sidewalk, Steps and Paved Approaches	91
Sec 611	Embankment Protection	91
Sec 613	Pavement Repair	92
Sec 614	Drainage Fittings	93
Sec 616	Traffic Control Plan	93
Sec 617	Concrete Traffic Barrier	93
Sec 620	Pavement Marking	96
Sec 622	Pavement Surface Texturing and Removal	106
Sec 702	Bearing Pile	106
Sec 703	Concrete Masonry Construction	112
Sec 705	Prestressed Concrete Members for Bridges	113
Sec 710	Epoxy Coated Reinforcing Steel	113
Sec 712	Structural Steel Construction	113
Sec 725	Metal Pipe and Pipe-Arch Culverts	117
Sec 726	Rigid Pipe Culverts, Storm Drains and Sewers	120
Sec 729	Placing State-Owned Pipe	124
Sec 730	Polyethylene Pipe Culverts	124
Sec 734	Jacking Pipe	126
Sec 735	Culvert Pipe Liner	127

Section	Title	Page
Sec 802	Mulching	128
Sec 803	Sodding	128
Sec 806	Erosion and Sediment Control	129
Sec 901	Highway Lighting	135
Sec 902	Traffic Signals	147
Sec 903	Highway Signing	174
Sec 1002	Aggregate for Asphaltic Concrete	175
Sec 1005	Aggregate for Concrete	175
Sec 1006	Aggregate for Surfacing	175
Sec 1015	Bituminous Material	176
Sec 1017	Ground Granulated Blast Furnace Slag	176
Sec 1018	Fly Ash for Concrete	177
Sec 1019	Cement	177
Sec 1020	Corrugated Metallic-Coated Steel Culvert Pipe, Pipe-Arches and End Sections	178
Sec 1026	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe	179
Sec 1033	Precast Reinforced Concrete Manhole and Drop Inlet Sections	179
Sec 1034	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe	183
Sec 1035	Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe	183
Sec 1037	Shear Connectors	183
Sec 1040	Guardrail, End Terminals, Crash Cushions, One-Strand Cable – Access Restraint and Guard Cable Material	184
Sec 1042	Highway Sign Material	190
Sec 1043	Fence Material	195
Sec 1045	Paint for Structural Steel	196
Sec 1046	Pipe Liner	203
Sec 1047	Corrugated Polyethylene Culvert Pipe	204
Sec 1048	Pavement Marking Material	204
Sec 1049	Precast Concrete Box Culverts	210
Sec 1050	Lumber, Timber, Piling, Posts and Poles	211
Sec 1051	Slotted Drain	211
Sec 1057	Material for Joints	211
Sec 1061	Electrical Conductors	212
Sec 1070	Water	212
Sec 1071	Asphalt Release Agents and Fiber Additives	212
Sec 1072	Dampproofing and Waterproofing Material	212

(seal & signature)

Date:_____

GENERAL SPECIAL PROVISIONS

OPPORTUNITY TO PARTNER

1.0 Description. The successful bidder will have the opportunity to enter into a cooperative partnership agreement with the state for the contract. The objective of this agreement is the effective completion of the work, on time and to the standard of quality that will be a source of pride to both the State and the contractor. The "Partnering" agreement will not affect the terms of the contract. It is intended only to establish an environment of cooperation between the parties.

2.0 Basis of Payment. An initial two-day training session is recommended to initiate the partnership agreement. The cost of this training to the contractor will be approximately $5000.00.

2.1 Participation in "Partnering" is voluntary and not required of the contract. Therefore, the costs associated with "Partnering" should not be included in the bid.

SECTION 404 NATIONWIDE PERMIT GENERAL CONDITIONS

General Conditions. The following general conditions must be followed in order for any authorization by an NWP to be valid:

1.0 Navigation. No activity may cause more than a minimal adverse effect on navigation. (Contractor Responsibility)

2.0 Proper Maintenance. Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety. (Contractor Responsibility)

3.0 Erosion and Siltation Controls. Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. (Contractor Responsibility)

4.0 Aquatic Life Movements. No activity may substantially disrupt the movement of those species of aquatic life indigenous to the waterbody, including those species which normally migrate through the area, unless the activity's primary purpose is to impound water. (Contractor Responsibility)

5.0 Equipment. Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance. (Contractor Responsibility)

6.0 Regional and Case-by-Case Conditions. The activity must comply with any regional conditions which may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state or tribe in its Section 401 water quality certification. (Contractor Responsibility)

7.0 Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status; unless the appropriate Federal agency, with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely effect the Wild and Scenic River designation, or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service.) (Contractor Responsibility)

8.0 Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights. (Contractor Responsibility)

9.0 Water Quality Certification. In certain states, an individual Section 401 water quality certification must be obtained or waived (see 33 CFR 330.4(c)). (MoDOT Responsibility - refer to Section 401 Water Quality Certification Conditions special provision)

10.0 Coastal Zone Management. In certain states, an individual state coastal zone management consistency concurrence must be obtained or waived (see Section 330.4(d)). (Not Applicable in Missouri)

11.0 Endangered Species.

(a) No activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act, or which is likely to destroy or adversely modify the critical habitat of such species. Non-federal permittees shall notify the District Engineer if any listed species or critical habitat might be affected or is in the vicinity of the project, and shall not begin work on the activity until notified by the District Engineer that the requirements of the Endangered Species Act have been satisfied and that the activity is authorized.

(b) Authorization of an activity by a nationwide permit does not authorize the take of a threatened or endangered species as defined under the Federal Endangered Species Act. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with incidental take provisions, etc.) from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service, both lethal and non-lethal takes of protected species are in violation of the Endangered Species Act. Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. Fish and Wildlife Service and National Marine Fisheries Service or their World Wide Web pages, respectively, at

http://www.fws.gov/r9endspp/endspp.html and
http://kingfish.spp.mnfs.gov/tmcintyr/prot_res.html#ES and Recovery

(MoDOT and Contractor Responsibility)

12.0 Historic Properties. No activity which may affect historic properties listed, or eligible for listing, in the National Register of Historic Places is authorized, until the DE has complied with the provisions of 33 CFR Part 325, Appendix C. The prospective permittee must notify the District Engineer if the authorized activity may affect any historic properties listed, determined to be eligible, or which the prospective permittee has reason to believe may be eligible for listing on the National Register of Historic Places, and shall not begin the activity until notified by the District Engineer that the requirements of the National Historic Preservation Act have been satisfied and that the activity is authorized. Information on the location and existence of historic resources can be obtained from the State Historic Preservation Office and the National Register of Historic Places (see 33 CFR 330.4(g)). (MoDOT and Contractor Responsibility)

13.0 Notification.

(a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the District Engineer with a Pre-Construction Notification (PCN) as early as possible and shall not begin the activity:

(1) Until notified by the District Engineer that the activity may proceed under the NWP with any special conditions imposed by the District or Division Engineer; or

(2) If notified by the District or Division Engineer that an individual permit is required; or

(3) Unless 30 days (or 45 days for NWP 26 only) have passed from the District Engineer's receipt of the notification and the prospective permittee has not received notice from the District or Division Engineer. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Notification. The notification must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), regional general permit(s) or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity;

and

(4) For NWPs 14, 18, 21, 26, 29, 34, and 38, the PCN must also include a delineation of affected special aquatic sites, including wetlands (see paragraph 13(f));

(5) For NWP 21 - Surface Coal Mining Activities, the PCN must include an OSM or state approved mitigation plan.

(6) For NWP 29 - Single-Family Housing, the PCN must also include:

(i) Any past use of this NWP by the individual permittee and/or the permittee's spouse;

(ii) A statement that the single-family housing activity is for a personal residence of the permittee;

(iii) A description of the entire parcel, including its size, and a delineation of wetlands. For the purpose of this NWP, parcels of land measuring 0.5 acres (0.20 ha) or less will not require a formal on-site delineation. However, the applicant shall provide an indication of where the wetlands are and the amount of wetlands that exists on the property. For parcels greater than 0.5 acres (0.20 ha) in size, a formal wetland delineation must be prepared in accordance with the current method required by the Corps. (See paragraph 13(f));

(iv) A written description of all land (including, if available, legal descriptions) owned by the prospective permittee and/or the prospective permittee's spouse, within a one mile radius of the parcel, in any form of ownership (including any land owned as a partner, corporation, joint tenant, co-tenant, or as a tenant-by-the-entirety) and any land on which a purchase and sale agreement or other contract for sale or purchase has been executed;

(7) For NWP 31 - Maintenance of Existing Flood Control Projects, the prospective permittee must either notify the District Engineer with a Pre-Construction Notification (PCN) prior to each maintenance activity or submit a five year (or less) maintenance plan. In addition, the PCN must include all of the following:

(i) Sufficient baseline information so as to identify the approved channel depths and configurations and existing facilities. Minor deviations are authorized, provided that the approved flood control protection or drainage is not increased;

(ii) A delineation of any affected special aquatic sites, including wetlands; and,

(iii) Location of the dredged material disposal site.

(8) For NWP 33 - Temporary Construction, Access, and Dewatering, the PCN must also include a restoration plan of reasonable measures to avoid and minimize adverse effects to aquatic resources.

(c) Form of Notification. The standard individual permit application form (Form ENG 4345) may be used as the notification but must clearly indicate that it is a PCN and must include all of the information required in (b) (1)-(7) of General Condition 13. A letter may also be used.

(d) District Engineer's Decision. In reviewing the pre-construction notification for the proposed activity, the District Engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. The prospective permittee may, optionally, submit a proposed mitigation plan with the pre-construction notification to expedite the process and the District Engineer will consider any optional mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects of the proposed work are minimal. If the District Engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects are minimal, the District Engineer will notify the permittee and include any conditions the DE deems necessary.

Any mitigation proposal must be approved by the District Engineer prior to commencing work. If the prospective permittee elects to submit a mitigation plan, the District Engineer will expeditiously review the proposed mitigation plan, but will not commence a second 30-day (or 45-day for NWP 26) notification procedure. If the net adverse effects of the project (with the mitigation proposal) are determined by the District Engineer to be minimal, the District Engineer will provide a timely written response to the applicant stating that the project can proceed under the terms and conditions of the nationwide permit.

If the District Engineer determines that the adverse effects of the proposed work are more than minimal, then he will notify the applicant either:

(1) that the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit;

(2) that the project is authorized under the NWP subject to the applicant's submitting a mitigation proposal that would reduce the adverse effects to the minimal level; or

(3) that the project is authorized under the NWP with specific modifications or conditions.

(e) Agency Coordination. The District Engineer will consider any comments from Federal and State agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

(1) For NWPs 14, 21, 26 (between 0.40 and 1.20 ha of impact), 29, 33, 37, and 38. The District Engineer will, upon receipt of a notification, provide immediately, e.g., facsimile transmission, overnight mail or other expeditious manner, a copy to the appropriate offices of the Fish and Wildlife Service, State natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO), and, if appropriate, the National Marine Fisheries Service. With the exception of NWP 37, these agencies will then have five calendar days from the date the material is transmitted to telephone or fax the District Engineer notice that they intend to provide substantive, site-specific comments. If so contacted by an agency, the District Engineer will wait an additional ten calendar days (sixteen calendar days for NWP 26 PCNs) before making a decision on the notification. The District Engineer will fully consider agency comments received within the specified time frame, but will provide no response to the resource agency. The District Engineer will indicate in the administrative record associated with each notification that the resource agencies' concerns were considered. Applicants are encouraged to provide the Corps multiple copies of notifications to expedite agency notification.

(2) Optional Agency Coordination. For NWPs 5, 7, 12, 13, 17, 18, 27, 31, and 34, where a Regional Administrator of EPA, a Regional Director of USFWS, or a Regional Director of NMFS has formally requested general notification from the District Engineer for the activities covered by any of these NWPs, the Corps will provide the requesting agency with notification on the particular NWPs. However, where the agencies have a record of not generally submitting substantive comments on activities covered by any of these NWPs, the Corps district may discontinue providing notification to those regional agency offices. The District Engineer will coordinate with the resources agencies to identify which activities involving a PCN that the agencies will provide substantive comments to the Corps. The District Engineer may also request comments from the agencies on a case-by-case basis when the District Engineer determines that such comments would assist the Corps in reaching a decision whether effects are more than minimal either individually or cumulatively.

(3) Optional Agency Coordination, 401 Denial. For NWP 26 only, where the state has denied its 401 water quality certification for activities with less than 1.0 acre (0.40 ha) of wetland impact, the EPA regional administrator may request agency coordination of PCNs between 0.3 and 1.0 acre (0.13 and 0.40 ha). The request may only include acre (hectare) limitations within the 0.3 to 1.0 acre (0.13 to 0.40 ha) range for which the state has denied water quality certification. In cases where the EPA has requested coordination of projects as described here, the Corps will forward the PCN to EPA only. The PCN will then be forwarded to the Fish and Wildlife Service and the National Marine Fisheries Service by EPA under agreements among those agencies. Any agency receiving the PCN will be bound by the EPA time frames for providing comments to the Corps.

(f) Wetlands Delineations. Wetland delineations must be prepared in accordance with the current method required by the Corps. For NWP 29 see paragraph (b)(6)(iii) for parcels less than 0.5 acres (0.20 ha) in size. The permittee may ask the Corps to delineate the special aquatic site. There may be some delay if the Corps does the delineation. Furthermore, the 30-day period (45 days for NWP 26) will not start until the wetland delineation has been completed and submitted to the Corps, where appropriate.

(g) Mitigation. Factors that the District Engineer will consider when determining the acceptability of appropriate and practicable mitigation include, but are not limited to:

(1) To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of the overall project purposes;

(2) To the extent appropriate, permittees should consider mitigation banking and other forms of mitigation including contributions to wetland trust funds, in lieu fees to organizations such as The Nature Conservancy, state or county natural resource management agencies, where such fees contribute to the restoration, creation, replacement, enhancement, or preservation of wetlands. Furthermore, examples of mitigation that may be appropriate and practicable include but are not limited to: reducing the size of the project; establishing wetland or upland buffer zones to protect aquatic resource values; and replacing the loss of aquatic resource values by creating, restoring, and enhancing similar functions and values. In addition, mitigation must address wetland impacts, such as functions and values, and cannot be simply used to offset the hectares of wetland losses that would occur in order to meet the hectare limits of some of the NWPs (e.g., for NWP 26, 12 acres (5 hectares) of wetlands cannot be created to change a 15 acre (6 ha) loss of wetlands to a 2.5 acre (1 ha) loss; however, five created acres (two created hectares) can be used to reduce the impacts of a 7.5 acre (3 ha) loss). (MoDOT Responsibility)

14.0 Compliance Certification. Every permittee who has received a nationwide permit verification from the Corps will submit a signed certification regarding the completed work and any required mitigation. The certification will be forwarded by the Corps with the authorization letter and will include: a.) A statement that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions; b.) A statement that any required mitigation was completed in accordance with the permit conditions; c.) The signature of the permittee certifying the completion of the work and mitigation. (MoDOT Responsibility)

15.0 Multiple Use of Nationwide Permits. In any case where any NWP number 12 through 40 is combined with any other NWP number 12 through 40, as part of a single and complete project, the permittee must notify the District Engineer in accordance with paragraphs a, b, and c on the Notification General Condition number 13. Any NWP number 1 through 11 may be combined with any other NWP without notification to the Corps, unless notification is otherwise required by the terms of the NWPs. As provided at 33 CFR 330.6(c) two or more different NWPs can be combined to authorize a single and complete project. However, the same NWP cannot be used more than once for a single and complete project. (MoDOT Responsibility)

Section 404 Only Conditions:

In addition to the General Conditions, the following conditions apply only to activities that involve the discharge of dredged or fill material into waters of the U.S., and must be followed in order for authorization by the NWPs to be valid:

1.0 Water Supply Intakes. No discharge of dredged or fill material may occur in the proximity of a public water supply intake except where the discharge is for repair of the public water supply intake structures or adjacent bank stabilization. (Contractor Responsibility)

2.0 Shellfish Production. No discharge of dredged or fill material may occur in areas of concentrated shellfish production, unless the discharge is directly related to a shellfish harvesting activity authorized by NWP 4. (Not Applicable in Missouri)

3.0 Suitable Material. No discharge of dredged or fill material may consist of unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.,) and material discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act). (Contractor Responsibility)

4.0 Mitigation. Discharges of dredged or fill material into waters of the United States must be minimized or avoided to the maximum extent practicable at the project site (i.e., on-site), unless the District Engineer approves a compensation plan that the District Engineer determines is more beneficial to the environment than on-site minimization or avoidance measures. (Contractor Responsibility)

5.0 Spawning Areas. Discharges in spawning areas during spawning seasons must be avoided to the maximum extent practicable. (Contractor Responsibility)

6.0 Obstruction of High Flows. To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters). (Contractor Responsibility)

7.0 Adverse Effects from Impoundments. If the discharge creates an impoundment of water, adverse effects on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized to the maximum extent practicable. (Contractor Responsibility)

8.0 Waterfowl Breeding Areas. Discharges into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable. (Contractor Responsibility)

9.0 Removal of Temporary Fills. Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting elevation. (Contractor Responsibility)

SECTION 401 WATER QUALITY CERTIFICATION CONDITIONS

1.0 Description. When a Clean Water Act Section 404 Nationwide Permit is in effect, the contractor is automatically permitted to perform this work under a Water Quality Certification (Section 401) by the Missouri Department of Natural Resources (MDNR). The contractor shall adhere to the following conditions:

1.1 During construction, clearing of vegetation shall be kept to the minimum necessary to accomplish the project.

1.2 Petroleum products, equipment and solid waste shall not be stored after construction working hours below the ordinary high water mark.

1.3 Equipment shall not be operated, except where permitted, nor petroleum products stored in wetlands.

1.4 Riparian areas and stream banks shall be restored to a stable condition as soon as possible after final contouring.

1.5 Work done in streams shall be conducted during low flows whenever possible.

1.6 Petroleum products spilled into any water of the state, or in areas where material could enter waters of the state, shall be cleaned up immediately and disposed of properly.

1.7 The following material shall not be used for streambank stabilization: earthen fill, gravel, fragmented asphalt, broken concrete with exposed rebar, tires, vehicle bodies and liquid concrete, including grouted riprap.

CERTIFICATION OF BLASTERS

1.0 Description. This provision sets forth the training, experience and certification required for a blaster to supervise blasting operations on Commission projects.

2.0 Training Requirements.

2.1 A person shall have attended at least 20 hours of instruction within any 24-month period covering the following topics:

(a) Selection of the type of explosives to be used.

(b) Blast designs, to include:

(1) Geologic and topographic considerations.
(2) Design of a blast hole.
(3) Pattern design, field layout and timing of blast holes.

(c) Loading blast holes.

(d) Initiation systems and blasting machines.

(e) Blasting vibrations, airblast and flyrock.

(f) Secondary blasting applications.

(g) Federal and State laws and regulations.

(h) Blast records.

(i) Schedules.

(j) Preblast surveys.

(k) Blast-plan requirements.

(l) Signs, warning signals and site control.

(m) Unpredictable hazards, to include:

(1) Lightning.
(2) Stray currents.
(3) Radio waves.
(4) Misfires.

2.2 Training shall be received from any competent source, to include, but not limited to, universities, manufacturers or distributors of explosive products, government agencies or professional consultants.

2.3 Training material may be obtained through the University of Missouri-Rolla, Rock Mechanics and Explosive Research Center at a nominal fee.

2.4 The provider of the training shall issue a certificate of training to each person whom successfully passes the training course. The certificate shall indicate dates of training, how many hours of training and topics covered.

3.0 Testing Requirements. To qualify as a blaster, a person shall successfully pass a written exam developed and administered by the University of Missouri-Rolla, Rock Mechanics and Explosive Research Center.

3.1 To qualify to take the exam, a person shall provide to the university a certificate of training as specified in Section 2.4, showing the person has taken a minimum of 20 hours of training.

3.2 Upon successfully passing the exam, the person will receive a certificate from the university. It shall be the responsibility of the person whom receives the certificate to provide a copy of the certificate whenever requested.

4.0 Certification of Blasters. For a blaster to be approved to supervise blasting operations on Commission projects, they must be pre-approved by Project Operations.

4.1 To apply for pre-approval, the following documentation shall be submitted to the Missouri Department of Transportation, General Headquarters Project Operations, P.O. Box 270, Jefferson City, MO 65102:

(a) Training certificate showing the person has attended a minimum of 20 hours of instruction within any 24-month period as specified in Section 2.0.

(b) Certificate from the University of Missouri-Rolla (UMR) indicating the person successfully passed the UMR tests on explosives.

(c) Written confirmation from a current employer, former employer or other qualified source that the person has 2 years or 2000 hours of experience using explosives as a regular part of employment.

4.1.1 All of the above documents shall show the person's full name and social security number.

4.1.2 The person's address shall also be provided. Update of the address shall be the blaster's responsibility.

4.2 Documentation as required under Section 4.1 (a) and (b) may be waived if the person holds a valid blaster's certificate or license issued by the Missouri Limestone Producers Association, or the controlling authority of any city, county or state whose training, testing and experience requirements meet or exceed the requirements set forth in this provision.

4.3 When approved, the person will receive a blaster's certificate, and the blaster's name will be placed on a pre-approved list maintained by the department.

4.4 The blaster's certificate will be valid for three years from the date of expiration of the previous certificate.

5.0 Re-certification of Blasters.

5.1 Continuing education/training for re-certification shall cover any blasting related topic. Priority shall be given to topics on new products, change in laws and regulations and recent safety concerns within the industry. Appropriate presentations at professional meetings, conferences, safety courses and seminars can be useful to fulfill this requirement.

5.2 The minimum training for re-certification will be 8 hours since the previous certification period. If certification lapses for a period of more than one year, the blaster will apply for new certification as detailed by Section 4.0 through 4.4 inclusive.

5.3 It shall be the certificate holder's responsibility to attend training, provide adequate documentation of such training, and apply for re-certification.

DISPOSAL OF EXCESS MATERIAL

1.0 Description. This specification covers regulations on the disposal of excess material.

1.1 The Missouri Solid Waste Management Law and its ancillary regulations, 10 CSR 80-1 through 9, provide for the proper disposal of solid waste.

1.2 MoDOT and its contractors must comply with the provisions 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.

2.0 Construction Requirements. Many types of excess material are not regulated by 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 that 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.

2.1 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.

3.0 Basis of Payment. No direct payment will be made for any expense incurred by the contractor by reason of his compliance with these requirements.

AGGREGATE SHOULDERS

1.0 Description. In the limits designated on the plans, the contractor shall restrict any grading to the shoulder width only, and such grading and shaping shall consist of only that necessary to ensure placement and compaction of at least the aggregate thickness specified. Vegetation on existing shoulders shall be mowed or cut and such cuttings shall be disposed of prior to placement of any aggregate material. If additional material is required, the material shall consist of the aggregate material specified for the shoulder.

2.0 Method of Measurement. Measurement of aggregate will be by weight as specified in Sec 304.4.2.

3.0 Basis of Payment. The accepted quantities of aggregate placed on the shoulders 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 any shaping of shoulders, processing of aggregate for shoulders, and mowing or cutting and disposing of vegetation required for placing the aggregate in the limits designated on the plans.

BITUMINOUS PAVEMENT COLDMILLINGS SUBSTITUTED FOR AGGREGATE BASE

1.0 Description. The contractor may substitute cold millings for aggregate base material for roadways that shall be removed before final acceptance of the project or as indicated.

2.0 Material. If available, the contractor may use bituminous pavement cold millings in lieu of aggregate base for any temporary surfaces, 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 in advance before the millings are used, and shall notify the engineer of the location from where the millings will be removed.

3.0 Construction Requirements. The millings shall be installed to the same dimensions shown in the plans for the aggregate base. Combining the millings with the aggregate base for placement will not be permitted.

3.1 Millings shall not be placed in greater than 4-inch (100 mm) lifts, and each lift shall be compacted by a minimum of three passes with a 10 ton (9 Mg) roller.

4.0 Basis of Payment. Payment shall be made for the aggregate base quantity as provided for in the plans, regardless of whether millings or the aggregate base is used. No direct payment will be made for hauling of millings, cold milling operations, or other material or labor necessary to substitute bituminous pavement millings for aggregate base.

MICRO-SURFACING

1.0 Description. This specification covers material and construction requirements for producing and placing a mixture of cationic latex modified asphalt emulsions, mineral aggregates, Portland cement, water, and a set retarder in locations shown on the plans. Typical locations are roadway surfaces, bridge decks, or shoulders. In some cases, more than one lift may be required to obtain any specified thickness.

1.1 There are three different pay items possible. Any or all three applications might be used. Type A is typically used for light (<3500 ADT) traffic application and no rutting. Type B is typically used for minor (<1/2 inch or <13 mm) rutting and for heavier traffic applications. Type B is applied in 2 lifts, the first of which is intended to level or fill low areas, followed by the final lift to complete the quantity specified. Type R is used for filling deeper ruts or otherwise raising grade (e.g., dropped shoulders) to a level elevation in a single lift and is typically followed by A or B as needed for the traffic level.

1.2 Unless otherwise allowed, the mixture shall set to allow rolling traffic on a 1/2-inch (13 mm) thick surface within one hour after placement at 75 F (25 C) and 50 percent humidity.

2.0 Material.

2.1 Emulsion. The emulsion shall be a latex-modified asphalt emulsion and shall be a grade CSS-lh. It shall show no separation after mixing. A minimum of 2.5 percent latex content, by mass, of an approved latex 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 and shall comply with the following requirements:

	Min	Max	Test Method
Tests on Emulsion:			
Viscosity, Saybolt Furol at 25 C,s	20.00	100.00	AASHTO T 59
Storage stability test, 24 hr., percent	--	1[a]	AASHTO T 59
Particle charge test	positive[b]		AASHTO T 59
Sieve test, percent	--	0.50	AASHTO T 59
Distillation:			
Residue, percent	57.00	--	AASHTO T 59
Tests on Residue from Distillation Test:			
Penetration, 25 C, 100 g, 5s,	40.00	90.00	AASHTO T 49
Ductility, 25 C, 5cm/min, cm,	40.00	--	AASHTO T 51
Solubility in Trichloroethylene, percent	97.50	--	AASHTO T 44

[a]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.

[b]If the particle charge test is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

2.2 Mineral Aggregate. The mineral aggregate shall meet all requirements of Sec 1002.1 and be flint chat from the Joplin area, an approved crushed porphyry or an approved crushed steel slag. Blast furnace slag may be used from sources with a documented history of satisfactory use and that have been previously approved by MoDOT for use in micro-surfacing. For non-traffic areas such as shoulders, the mineral aggregate may also be crushed limestone or crushed gravel in accordance with Sec 1002.1. The aggregate shall be free of cemented or conglomerated lumps and shall not have any coating or injurious material.

2.2.1 Blends of approved aggregates may be supplied provided:

a) The individual aggregates are reasonably uniform in gradation and other qualities.

b) They are uniformly blended with designated proportions using cold feeds capable of calibration with controlled feeders into a separate stockpile prior to use.

c) The proportion is not changed from the design mix during the course of placement. However, aggregate may also be blended directly into the nurse truck provided the blending device has been calibrated, gate settings are unchanged, and belt samples indicate material gradation compliance.

2.2.2 The final aggregate, or blend of aggregates, shall comply with one of the following gradations. The aggregate shall be within the specified gradation, and in addition, shall be ± 5 percent of the designated job mix gradation for all + No. 200 (75 µm) material and within ± 2 percent for the minus No. 200 (75 µm) material.

Gradation 1		Gradation 2	
Sieve	**Percent Passing**	**Sieve**	**Percent Passing**
1/2 inch (12.5 mm)	100.00	3/8 inch (9.5 mm)	100.00
3/8 inch (9.5 mm)	95 - 100	No. 4 (4.75 mm)	90 - 100
No. 4 (4.75 mm)	85 - 95	No. 8 (2.36 mm)	65 - 90
No. 10 (2.0 mm)	40 - 60	No. 16 (1.18 mm)	45 - 70
No. 40 (425 µm)	12 - 30	No. 30 (600 µm)	30 - 50
No. 80 (180 µm)	8 - 22	No. 50 (300 µm)	18 - 30
No. 200 (75 µm)	5 - 15	No. 100 (150 µm)	10 - 21
		No. 200 (75 µm)	5 - 15

2.2.3 The final aggregate mixture shall meet the required gradation with no oversize material when deposited at the stockpile site. If the stockpile area contains any particles exceeding the specified maximum sieve, all aggregate shall be screened again as it is loaded into the final placement machine.

2.3 Portland Cement. Portland cement shall be Type 1 and shall be free of lumps or any other deleterious material.

2.4 Water. Water shall be potable and free of harmful soluble salts.

2.5 Special Additives. These additives are any other materials that are added to the mixture or to any of the component materials, to provide the required properties. All additives shall be supplied by the emulsion manufacturer.

2.6 Material Acceptance. The micro-surfacing system, including material and procedures, shall be prequalified prior to use. To become prequalified, the micro-surfacing manufacturer shall contact Project Operations - Materials. Prequalification requirements may include but are not limited to laboratory samples, company test results, use history, and field demonstrations. The engineer will notify the manufacturer when prequalification has been completed. After a material has been prequalified, subsequent prequalifications will not be required if the material is not changed and satisfactory results are obtained in the field. Material evaluated prior to this specification has been added to the list of prequalified material.

2.6.1 All applicable requirements of Sec 1015, unless modified herein, shall apply when offering emulsion for use.

2.6.2 The asphalt emulsion manufacturer shall certify that the latex and any special additives are the same as those which were prequalified. At the beginning of the project, three copies of the certification shall be furnished to the engineer.

2.6.3 All aggregate shall be sampled, tested, and approved by the engineer, prior to use.

2.6.4 Portland cement may be accepted for use based on visual examination.

2.6.5 Water shall be approved by the Missouri Department of Natural Resources for drinking purposes.

3.0 Mix Design. The manufacturer of emulsion shall develop the job mix formula and present certified test results for the engineer's approval. The mixture shall be designed according to procedures in Appendix A and shall have a minimum Marshall stability of 8000 pounds (35,586 Newtons). In lieu of that procedure, mixes designed in accordance with International Slurry Surfacing Association (ISSA) recommended standards by an ISSA recognized laboratory and meeting those requirements will be accepted, subject to satisfactory field performance.

3.1 Proportioning and Quantity Requirements. The engineer will approve the design mix and all material and methods prior to use, and will designate the proportions to be used within the following limits. If more than one aggregate is used, the aggregates shall be blended in designated proportions as indicated in the mix design, and those proportions maintained throughout the placement process. If aggregate proportions are changed, a new mix design shall be obtained.

Material	Requirement
Type A Mineral aggregate, lb/sy (kg/m2) dry mass, min.	20 (10.8)
Type B Mineral aggregate, lb/sy (kg/m2) dry mass, min.	36 (19.5)
Type R Mineral Aggregate to fill to top of grade	As necessary
Latex Modified Emulsion (Residual), percent	6.5 min.
Portland Cement, percent by mass of dry aggregate	0.5 to 2.5
Additive	As required

3.1.1 All Types. The minimum dry mass per unit area will be based on a bulk specific gravity (BSG) of 2.65. In the event that crushed steel slag aggregate is used as a part of the blended aggregate, or as the entire aggregate, the BSG of the final aggregate blend shall be determined and shown as part of the mix design criteria. If the BSG is different from 2.65 by more than 0.05, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiplying by the new BSG. (e.g., for a new BSG = 3.15, the new minimum would be 3.15(10.8/2.65) = 23.8 lb./sy (12.8 kg/m^2)). These adjusted values shall be designated on the mix design and shall apply in the field.

3.1.2 Type A. For Type A, if a specified thickness is required, the amount of mineral aggregate per square yard (meter) shall be increased as necessary to obtain the thickness.

3.1.3 Type B. When Type B is specified, it shall be applied in two passes of approximately equal quantities, the first of which is a level course to fill depressions and level the surface for the final pass.

3.1.4 Type R. There are no minimum or maximum unit quantities for Type R. The contractor shall make the determination as to the amount necessary, however, all depressed areas re to be filled level as specified. Type R may be applied in more than one pass at no additional pay. Type R shall not be added to Type A or Type B applications in the field, but shall remain a separate application.

4.0 Equipment.

4.1 Mixing Equipment. The micro-surfacing mixture shall be mixed and laid by a self-propelled mixing machine which shall be able to accurately deliver and proportion the aggregate, Portland cement, water, additive and emulsion to a revolving multi-blade dual mixer and discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, Portland cement, water and additive to maintain an adequate supply to the proportioning controls. The machine shall be continuous loading and shall be operated in that manner.

4.1.1 Individual volume or weight controls for proportioning each item to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked. Each device shall be accessible for ready calibration and so placed that the engineer may determine the amount of each material used at the time.

4.1.2 The mixing machine shall be equipped with a water pressure system and nozzle-type spray bar to provide a water spray to dampen the surface when required immediately ahead of and outside the spreader box as required. No free flowing water shall be present.

4.2 Spreading Equipment. The micro-surfacing mixture shall be spread uniformly by means of a mechanical-type spreader box attached to the mixer. The spreader box shall be equipped with paddles or augers to agitate and spread the material uniformly throughout the box. The paddles or augers shall be designed and operated so all the fresh mix will be agitated and to create a turbulent or laminar flow to prevent the mixture from setting up in the box, causing side buildup and lumps.

4.2.1 The spreader box used for surface course construction shall be equipped with flexible seals in contact with the road to prevent loss of mixture from the box. The box shall be equipped with devices to adjust thickness or grade of the surface, and shall have a squeegee strike-off rear plate.

4.2.2 The spreader box used for rut-filling shall have two metal strike-offs, angled from each side toward the center at approximately 45 degrees. Interrupted flight augers are required ahead of the first strike-off plate to spread the mix and maintain laminar flow. The second strike-off plate is adjusted to produce the desired grade and depth. The first strike-off and augers shall be adjustable up and down in order to maintain a fairly uniform flow or roll of

material in front of the second strike-off. 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. The adjustable metal plate shall have sufficient clearance not to affect the grade established by the second strike-off.

5.0 Construction Requirements.

5.1 Test Strip. A test strip 500 feet (150 m) in length and the width of one lane shall be provided prior to any production. The test strip shall be evaluated for 24 hours and approved by the engineer before any further production. If unsatisfactory, it shall be removed and another strip placed for evaluation. No additional payment will be made for test strip placement.

5.2 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud, and other objectionable material and pre-wetted as required immediately prior to application of the micro-surfacing.

5.3 Application. The micro-surfacing mixture shall be spread to fill cracks and minor surface irregularities and leave a uniform surface. Approved tools shall be used to spread the mixture in areas inaccessible to the spreader box and other areas where hand spreading may be required. A sufficient amount of material shall be carried in all parts of the laydown box at all times so that complete coverage is obtained. No unmixed aggregate, lumps or balls will be permitted in the finished surface. The seam where two passes join shall be neat in appearance. All excess material shall be removed from ends of each run immediately. Any successive passes shall be separated such that the each layer placed undergoes at least 1 full period of overnight traffic for compaction and curing prior to being overlayed.

5.3.1 Type R applications to raise shoulders or fill ruts shall be applied with the rut-spreader box and shall place a strip as designated on the plans or in the contract to raise an area to match the surroundings. Rutting or traffic-bearing applications, excluding shoulders, shall be crowned 1/8-1/4 inch per inch of depth (3–7 mm per 25 mm of depth), to allow for compaction. Shoulder applications shall drain and slope uniformly downward to the shoulder point. A Type A or Type B application may follow as a surface course if specified in the contract documents.

5.3.2 Micro-surfacing shall not be placed over steel expansion plates.

5.3.3 When micro-surfacing is placed on concrete, a tack coat shall be applied first in accordance with Sec. 407 and given adequate time to break.

5.4 Weather Limitations. The modified paving system shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F (10 C), when it is raining, or when there is a chance of temperatures below 32 F (0 C) within 24 hours.

5.5 Any traffic-damaged or marred areas shall be repaired by the contractor at no additional cost to the Commission.

5.6 Areas that cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. Utilities shall be protected from coverage by a suitable method. Work at intersections shall be done in stages, or blotter material shall be used to allow crossing or turning movements. Regardless of the method, no marred sections will be allowed.

6.0 Method of Measurement. Measurement of Type A, B and R micro-surfacing, complete in place, will be made to the nearest square yard (meter). Final measurement of completed Type A and Type B surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Final measurement of Type R surface may be made as necessary to determine the actual areas placed. Field measurement will be based on the estimated width and length dimensions necessary to bring a designated area to a level plane, and not necessarily for the full wetted area. The revision or correction will be computed and added to or deducted from the contract quantity.

7.0 Basis of Payment. The accepted quantity of micro-surfacing will be paid for at the contract unit price for Micro-Surfacing, Type A, Type B or Type R per square yard (meter).

APPENDIX A: MIX DESIGN PROCEDURES

1. Compatibility.

(a) Small amounts of aggregate are hand mixed with 2 percent Portland cement.

(b) Water and additive are added and mixed in quickly.

(c) 10 to 11 percent emulsion is added and mixed for 20 to 40 seconds then poured out to make a patty.

(d) The total time from mixing to breaking is recorded and cohesion tested by lifting the patty's edge.

2. Stability.

(a) Marshall specimens are developed in the normal fashion using AASHTO T 245 for Bituminous Hot Mix concrete.

(b) PG 58-22 asphalt binder (normal emulsion base stock) should be used and mixed with the selected aggregate.

(c) The recommended percent residual is 6.5 percent minimum.

(d) Marshall specimens are made and tested in accordance with AASHTO T 245 procedures for the asphaltic concrete mixtures.

After the asphalt content, stability, flow and voids content have been established using PG binder, the asphalt content is converted to make mixes using latex modified emulsion mix.

3. Mixing and testing procedures.

(a) Enough aggregate is used to prepare three specimens at each asphalt content percent. The moisture content must be calculated and ambient temperatures observed throughout.

(b) Adequate amounts of aggregate and Portland cement are mixed with the proper percentages of water and additive in a power mixer.

(c) The earlier obtained asphalt content is converted to percent of latex modified emulsion by dividing by 64 ± 1/2 percent residual in the latex emulsion. This mass of emulsion, calculated as a percentage of the dry mass of aggregate and Portland cement combined is added and mixed (e.g., 6.4 percent residual requires 10 percent emulsion). The proper mass of emulsion must be preweighed and added to the mixer bowl quickly. While blending or shortly thereafter, the emulsion will begin to plate on the stone very rapidly.

(d) Mixing is continued until a crumbly well-coated material is obtained. This material is then open-air dried for 2 to 3 days.

(e) After air drying, the material is oven heated to a asphalt temperature used in the hot-mix control test phase (usually about 140 C). The material is then compacted in preheated molds as described in AASHTO T 245. Hot spots should be avoided when heating this mixture.

(f) The Marshall specimens are placed in a 60 C water bath and tested as per AASHTO T 245.

SCRUB SEAL

1.0 Description. This specification covers the material and construction requirements for producing and placing a polymer modified asphalt (scrub seal) emulsion intended for use as a surface rejuvenation treatment to fill and seal cracks.

2.0 Material.

2.1 Scrub Seal Emulsion. Scrub seal emulsion shall meet all applicable requirements of Sec 1015 except as modified herein. The seal shall be smooth and homogeneous, polymer modified, contain an asphalt rejuvenator and shall comply with the following requirements:

Tests on Scrub Seal Emulsion	Min.	Max.	Test Method
Saybolt Furol Viscosity, SFS @ 25 C	30	100	ASTM D244
Storage Stability Test[a], 24 hr., %	--	1	ASTM D244
Demulsibility, 35 ml of 0.02N, $CACl_2$, %	--	60	ASTM D244
Sieve Test[b], %	--	0.1	ASTM D244
Residue by Distillation[c] @ 205 C, %	60	--	ASTM D244
Oil Distillate by Volume, %	--	3	

Tests on Residue from Distillation	Min.	Max.	Test Method
Penetration @ 25 C, 5 sec, 100 g, dmm	100	300	ASTM D5
Float Test @ 60 C, sec	1200	--	ASTM D139
Ash, %	--	1	AASHTO T111
Elastic Recovery, 10 C, 200 mm elongation, 60 min. recovery, %	30	--	ASTM D5976
Saturates[d], %	--	20	ASTM D4124

[a]Upon examination of the test cylinder after standing undisturbed for 24 hours, the surface shall show no white, milky colored substance but shall be a homogeneous brown color throughout.

[b]A percentage of 0.30 is acceptable for samples taken at the point of use or shipped to the Central Laboratory for testing.

[c]ASTM D 244 with modifications to include 205 ± 5 C maximum temperature to be held for 15 minutes.

[d]ASTM D 4124 with modification to use Alumina, CG - 20 Grade, available from Aluminum Company of America, Pittsburgh, PA.

2.2 Mineral Aggregate. The mineral aggregate shall conform to Sec 1005.2, except that manufactured sand shall not be used. Aggregate substitutions, such as wet bottom boiler slag, may be allowed as approved by the engineer.

2.3 Special Additives. These additives include any other material added to the mixture or to any of the component material to provide the required properties. All additives shall be supplied by the emulsion manufacturer.

2.4 Material Acceptance. Prior to beginning work, the scrub seal emulsion manufacturer shall supply a set of certified test results for the material being supplied, indicating compliance with all specified material properties. Furthermore, for each load of scrub seal emulsion, the manufacturer shall furnish a certification stating that the emulsion and any special additives are the same as those which were prequalified and that all materials meet the specifications. At least one sample of emulsion will be taken by the inspector during the project and submitted to the Central Laboratory for confirmation purposes.

2.4.1 All aggregate will be sampled, tested and approved by the engineer, prior to use.

2.4.2 Water shall be potable and approved by the Missouri Department of Natural Resources.

3.0 Equipment.

3.1 Aggregate Spreader. The self-propelled aggregate spreader shall be capable of evenly spreading aggregate in a width of 8 to 14 feet at a minimum rate of 12 pounds per square yard (2.4 to 4.2 m at a minimum rate of 6.5 kg/m^2). Motor graders and trucks will not be considered acceptable spreaders.

3.2 The pneumatic tire roller shall meet the requirements of Sec 403.12 with a 5 ton weight (4.5 Mg mass).

3.3 The brooms used in the scrub seal process shall be constructed to meet the nominal dimensions in Figure 1, using the following bill of materials. The final assembly shall be constructed with the nominal dimensions and the arrangement shown in Figure 1.

Qty.	Nominal Dimension	Qty.	Dimension
2	2x6x7 ft (50x150x2130 mm) wood member	112	3/16 in (4.76 mm) nuts
4	2x6x8 ft (50x150x2440 mm) wood member	112	3/16 in (4.76 mm) flat washers
2	2x6x12 ft (50x150x3660 mm) wood member	112	3/16 in (4.76 mm) lock washers
2	2x6x14 ft (50x150x4270 mm) wood member	112	3/16 x 5 in (4.76 x 127 mm) carriage bolts
35	Street brooms with nylon bristles 3-1/2 in W x 6 in H x 16 in L (90 mm W x 150 mm H x 405 mm L)	2	3/8 in x 2 ft (9.53 mm x 610 mm) chain with hooks (minimum)
Weights as determined by the engineer		2	3/8 x 6 in (9.53 mm x 152.4 mm) bolts with nuts, locks and washers

4.0 Construction Requirements.

4.1 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud, and other objectionable material immediately prior to application of the scrub seal emulsion.

4.2 Application. Scrub seal emulsion shall be uniformly applied with a pressure distributor at the rate specified in the contract, or as revised by the engineer. The mixture shall be spread to fill cracks and minor surface irregularities and leave a uniform surface.

4.3 Physical Characteristics for Scrub Seal.

Properties	Minimum	Maximum
Application rate of emulsion, gallons/sq. yard (liters/sq.meter)[e]	0.14 (0.63)	0.18 (0.82)
Emulsion Temperature, F (C)	110 (44)	160 (71)
Application rate of aggregate, pounds/sq. yard (kg/sq.meter)[e]	12 (6.5)	15 (8.1)
Pavement Temperature, F (C)	70 (21)	90 (32)
Time of set prior to opening, hours[f]	2	--
Number of roller passes	2	--

[e] Application rate may change, final decision will be made by the engineer.

[f] The final decision for opening will be made by the engineer.

4.4 Method of Placement. After proper surface preparation, a distributor truck shall place the scrub seal emulsion at the prescribed rate. The distributor truck shall pull the broom assembly to sweep and spread the emulsion uniformly on the surface and into the cracks of the pavement.

4.4.1 Fine aggregate shall be placed immediately after the application of the emulsion by a self-propelled aggregate spreader. Immediately following the aggregate spreader shall be a truck pulling a second broom assembly to combine the aggregate with the emulsion.

4.4.2 The pneumatic tire roller shall immediately follow the second broom and make a minimum of 2 passes.

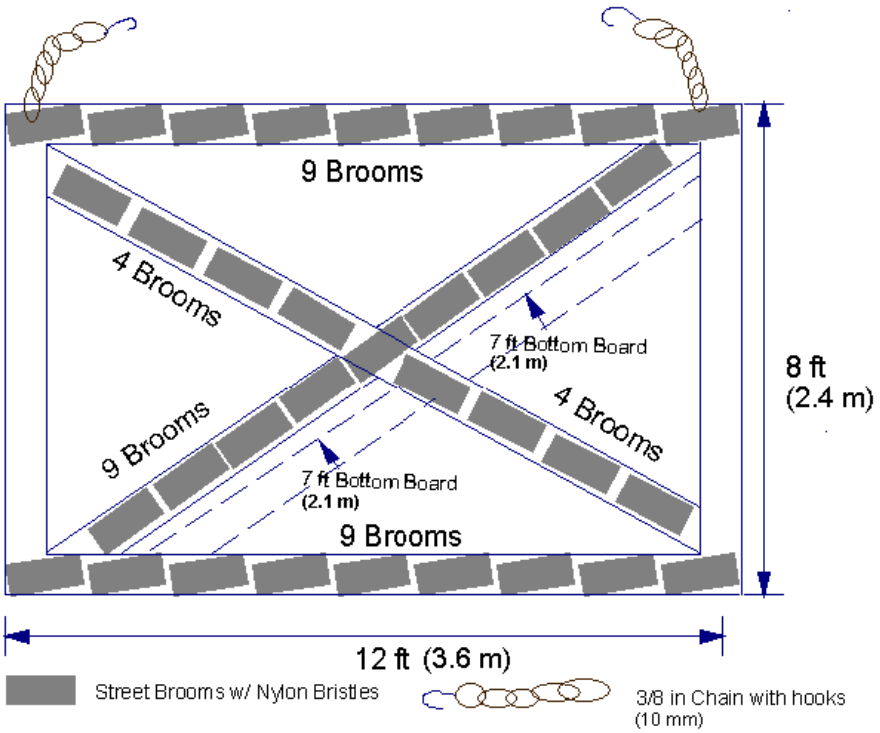
4.5 Weather Limitations. The scrub seal emulsion shall not be placed when any of the following conditions exist: (1) the temperature of the surface on which the mixture is to be placed is below 70 F or above 90 F (21 C or above 32 C), (2) on any wet surface, (3) local weather forecasts predict rain or air temperatures below 60 F (16 C) within the next 72 hours, or (4) weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method T 20.

4.6 Any traffic-damaged or marred areas shall be repaired by the contractor at no additional cost to the Commission.

5.0 Method of Measurement. Measurement of scrub seal emulsion and mineral aggregate, complete in place, including multiple passes or courses, will be made to the nearest square yard (square meter). 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. The revision or correction will be computed and added to or deducted from the contract quantity.

6.0 Basis of Payment. The accepted quantity of scrub seal, in place, will be paid for at the contract unit price, per square yard (square meter).

Figure 1



TINTING OF CONCRETE FOR ADA RAMPS

1.0 Description. This specification covers red tinting of concrete surface where specified in the plans for ADA curb ramps.

2.0 Materials. Tinting material shall be red and shall meet Sec 1056 for surface tinting, or be a dry shake-on surface hardener approved by the engineer and designed for outside sidewalk use.

3.0 Construction.

3.1 When Sec 1056 tinting is used, the 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 1/8 to 1/4 inch (3 to 6 mm) 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 consist of tinting material mixed dry with cement at a 2:1 ratio by weight (mass). This mixture shall be applied at the rate of approximately 45 pounds per 100 square feet (2 kg/m^2) of surface. The actual quantity required to obtain the desired color density may vary from this estimated quantity.

3.2 When a dry shake hardener is used, it shall be applied in two applications. The first application shall be approximately 2/3 the manufacturer's total required amount, followed by the remaining 1/3, both applications troweled in as required to obtain a final minimum tint penetration approximately 1/4" (6 mm) in depth. Dry shake hardener shall be otherwise applied in accordance with the manufacturer's recommendations.

3.3 No additional water shall be added during the tinting process. The final concrete surface coloration shall be medium to dark red as approved by the engineer.

3.4 Tinted concrete shall be cured in accordance with the curing requirements for the contract item for which tinting is specified. If the contractor elects to use membrane curing for those items where its usage is permitted, it shall be of the clear or transparent type. For dry shake-on surface hardeners, any curing compounds used shall be compatible with the hardener.

4.0 Basis of Payment. No direct payment will be made for tinting of concrete surface as required in the plans. All costs will be included in those for the concrete placement as covered elsewhere. If the authorized area of tinted concrete differs from that specified in the plans, compensation to the contractor for the affected concrete will be adjusted on the basis of $2.50 per square yard ($3.00 per square meter) of affected surface, by either adding or subtracting the price adjustment as required for the differing amount.

PORTLAND CEMENT CONCRETE FOR EARLY OPEN PAVEMENT

1.0 Description. At the contractor's option in order to expedite operations, pavement concrete may be furnished as modified by this specification.

1.1 The mix design, material, and curing operation herein described shall provide for opening to all traffic within 72 hours after placing the concrete, provided the concrete strength is at least 3500 psi (24 MPa). If this option is chosen, all requirements herein described shall be followed.

2.0 Materials. All material shall conform to Division 1000, Materials Details unless otherwise noted.

2.1 A water reducer shall be used, except that Type F or G water reducers will not be allowed.

2.2 Type I, II, or III cement may be used. Fly Ash may be used.

2.3 A non-chloride accelerating admixture may be used.

3.0 Concrete Mix Design. All concrete shall comply with the requirements for pavement concrete in Sec 501, except as modified herein.

3.1 The proposed mix design shall be submitted, by the contractor, in writing to the engineer for approval at least 45 days prior to use of the mix.

3.1.1 The design shall include type and source, physical characteristics, proportions and scale weights of all material. It shall also include actual laboratory test results indicating mix proportions, slump, air content, strength in pounds per square inch, psi (megapascals, MPa), and age from molding to testing of 6 inch x 12 inch (152.4 mm x 304.8 mm) cylinders made from concrete produced in accordance with the proposed mix design.

3.1.2 Molding, testing, and curing should replicate field anticipated conditions. Minimum cylinder testing shall be two cylinders, each, for 24, 48 and 72 hours of age. The 72-hour test cylinders shall exceed 3500 psi (24 MPa).

3.2 Type III cement may be used with no change in the required cement factor. If Type I or II cement is used, the cement requirement shall be increased by 94 pounds per cubic yard (55.7 kg/m^3).

3.3 The water/cement ratio of pounds (kg) of water to pounds (kg) of cement shall not exceed 0.40 for design or during operations.

3.4 The design percent air in the mortar shall be 9.0, plus or minus 1.0 percent, at the specified air content.

4.0 Construction. All requirements of Sec 502 shall apply except as modified herein.

4.1 Curing.

4.1.1 The concrete shall be cured until the minimum strength and age requirements have been met. Cylinder test specimens shall be cured in the same manner as the pavement.

4.1.2 Immediately after the surface has been textured, the concrete shall be cured using a white-pigmented curing compound, applied to the surface and exposed edges at the rate of one gallon per 100 square feet (4 liters per square meter).

4.1.3 The contractor is advised that the rate of strength gain is directly related to the amount of heat retained in the concrete during the curing process. If a cover material is used to accelerate the strength gain, the cover material shall be uniform, impermeable to moisture, and sufficiently durable to remain intact until the end of the curing time. Cover material that will not remain intact or that is otherwise perforated shall not be used.

4.2 Joints. All joints shall be sawed as soon as possible without causing excessive raveling, but before uncontrolled shrinkage cracking occurs.

4.3 Opening to Traffic. The concrete pavement shall not be opened to light traffic until the concrete is at least 48 hours old and has attained a minimum compressive strength of 3000 psi (21 MPa). 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 of 3500 psi (24 MPa). All joints in the new slab shall be sawed, cleaned, and sealed in accordance with the details shown on the plans.

PORTLAND CEMENT CONCRETE UNBONDED OVERLAY

1.1 Description. This work shall consist of applying a debonding material and constructing a Portland cement concrete unbonded overlay as required in accordance with details and locations shown on the plans. Work also includes minor surface pavement repair, joint filling, and other associated operations.

1.2 Note to engineer and contractor: Unbonded overlay is intended to be placed with a relatively uniform thickness on a relatively flat, old or new, bituminous surface. If the existing surface is concrete or in case of severe surface elevation problems, there should be provisions elsewhere in the contract for a 1 inch (25 mm) minimum thickness bituminous interlayer. That interlayer is designed to correct irregularities and restore the grade so that the final unbonded concrete pavement is a uniform thickness. In that or other cases of new bituminous surface, there should be no pay item included for a concrete volume or for surface preparation. If unbonded concrete is being placed over old, existing bituminous surface, there should be pay items included for surface preparation, volume of concrete and placement of concrete.

2.0 General. All procedures and material for the concrete unbonded overlay shall meet applicable provisions of Sec 502 for non-reinforced concrete pavement except as herein described.

3.0 Materials. All material shall conform to Division 1000, Materials Details, unless otherwise noted.

3.1 The debonding material between the existing roadway or shoulder surface and the new concrete pavement overlay shall be one of the following.

3.1.1 A white pigmented curing compound meeting Sec 1055 and applied at the rate of 200 square feet per gallon (5 m^2/L).

3.1.2 Whitewash, a mixture of hydrated lime and water mixed at the rate of 100 pounds of lime per 12.5 gallons (1 kg/L) of water, applied at a rate of 200 square feet per gallon (4 m^2/L) of mixture.

3.1.3 An alternate material will be considered provided it can be demonstrated to provide a) lack of bond between asphalt concrete and Portland cement concrete overlay, b) a white coloration to reflect and control heat buildup in the base pavement, c) no detrimental effect to the asphalt and/or concrete overlay as a result of the use, and d) reasonable durability under traffic resisting removal prior to overlay. Upon request, the contractor shall provide any testing necessary to demonstrate these properties. Approval shall be obtained from Project Operations - Materials prior to use. Requests for approval shall include a specific description of the proposed material, applicable material safety data sheets, and the proposed application rate and are subject to uniform and satisfactory application.

3.2 Bituminous patching material for use in repair of minor spalls in the existing surface shall be a commercial bituminous patching material meeting the approval of the engineer.

3.3 Dowel bars shall be 1 1/2 inches (38 mm) in diameter and meet Sec 1057.1.

4.0 Construction. Preliminary work, including joint sealing and patching, may be done under traffic as allowed elsewhere in the contract. Prior to placement of the debonding material, the traffic shall be diverted as shown in the contract documents, and the remaining operations shall commence.

4.1 Surface Preparation.

4.1.1 All existing pavement cracks and joints shall be sealed or re-sealed where required to keep overlay material and incompressibles from penetrating unsealed joints. All holes greater than 2 inches (50 mm) in width and 1 inch (25 mm) in depth in the surface of the traffic lanes, excluding shoulders, shall be patched by filling with the bituminous patching material. It shall be compacted to a flat, tight surface.

4.1.2 When a one inch (25 mm) minimum bituminous interlayer is required in the contract, the existing surface shall be prepared prior to interlayer placement as necessary to ensure a final flat, smooth surface to grade. Any preparation for that work will be included in the price for the interlayer.

4.1.3 Before the unbonded overlay is placed, the base surface shall be free of loose material and relatively flat, without bumps or indentations.

4.1.4 Debonding material shall be uniformly applied at the designated rate. Concrete patches shall be covered at twice the designated rate. If the material is removed by rain, wear or other means to the extent that the reflective or bond-breaking properties may not be effective, it shall be re-applied.

4.1.5 In order to properly locate the saw cuts in the overlay, the location of all transverse expansion (Type E) joints and longitudinal lane joints in the existing pavement shall be identified by a reliable method. The contractor shall receive approval from the engineer for the procedure to be used to mark and relocate existing joints.

4.2 Tie bar, dowel and joint saw depths shall be as shown on plans. Tie bars will be required for both the centerline and shoulder longitudinal joints.

4.3 Dowel bars shall be installed the full width of the unbonded overlay and the baskets firmly anchored to the existing surface.

4.4 New transverse joints are not required to match existing transverse joints, however, new transverse expansion joints and longitudinal lane joints shall be cut or placed to match the underlying joint configuration.

4.5 Any transverse expansion joints in the existing pavement shall be specifically marked and identified as such. The expansion joint shall be precut in the plastic concrete to allow for any slab movement until sawing can begin. As soon as sawing may be possible, the contractor shall saw two full-depth cuts on each side of the precut joint following the edges of the underlying expansion joint, as shown on the details. The concrete between the saw cuts shall be removed and disposed of by the contractor at the contractor's expense at a location meeting the approval of the engineer.

4.6 Concrete pavement thicknesses shown on the plans are nominal dimensions and are expected to be maintained, except for local variations in the grade. The minimum allowable thickness at any point, as determined by sticking the finished, plastic concrete, is plan thickness less 0.6 inches (15 mm).

4.7 Trucks used for transporting concrete will be permitted to drive on the pavement being overlaid and deposit concrete directly in front of the concrete spreader, provided no loose foreign material is tracked onto the surface.

5.0 Method of Measurement.

5.1 When required, measurement for furnishing unbonded overlay concrete will be to the nearest 0.1 cubic yard (meter), using the count of batches incorporated into the unbonded overlay.

5.2 Measurement for placing unbonded overlay concrete will be computed to the nearest 0.1 square yard (meter). 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.

5.3 Measurement for surface preparation of the existing pavement surface will be computed to the nearest square yard (meter), including traffic lanes and shoulders. 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.

6.0 Basis of Payment.

6.1 When there is direct pay for volume of unbonded concrete listed in the contract, the accepted volume of Portland cement concrete for the unbonded overlay will be paid for at the contract unit price for "Unbonded Overlay Concrete", per cubic yard (meter). Further payment for the placement of Portland cement concrete unbonded overlay will be paid for at the contract unit price for "Unbonded Overlay Placement", per square yard (meter). No direct payment will be made for furnishing labor, equipment, dowels, reinforcement and other material to place, finish, texture and cure the overlay including sawing and sealing the joints, in accordance with the plans and specifications. Payment for surface preparation, including application of the debonding material, patching, joint filling of the existing surface and any other incidental work and material necessary to complete this item will be paid for at the contract unit price for "Surface Preparation", per square yard (meter).

6.2 When there is no direct pay for the volume of unbonded concrete, payment for the placement of the Portland cement concrete unbonded overlay will be paid for at the contract unit price for “Unbonded Overlay Pavement”, per square yard (meter) for the thickness specified. No direct payment will be made for labor, equipment, dowels, reinforcement and other material to place, finish, texture and cure the overlay including sawing and sealing the joints, in accordance with the plans and specifications. No direct payment will be made for surface preparation.

6.3 Any adjustments in payment as a result of the profilograph index or pavement thickness deficiency of the unbonded overlay will be made to the contract unit price for "Unbonded Overlay Concrete", "Unbonded Overlay Placement", and "Surface Preparation", each, for the segments involved. For this purpose, the "Unbonded Overlay" per cubic yard (meter) price will be adjusted to a square yard (meter) price based on the plan overlay thickness.

6.4 Payment for full depth and partial depth repairs will be in accordance with Sec 613.

6.5 Payment for bituminous interlayer will be in accordance with Sec 403.

<u>"GIVE 'EM A BRAKE" SIGNS</u>

1.0 Description. This work shall consist of installing "Give 'em BRAKE" signs. The 48 x 48-inch (1200 x 1200 mm) sign panels will be furnished by the Commission. The contractor shall furnish labor, equipment, posts and hardware for installation of the signs in accordance with this provision or as directed by the engineer.

2.0 Construction Requirements. The signs shall be post-mounted and placed approximately 500 feet (150 m) before the "ROAD WORK AHEAD" sign or the "ROAD WORK NEXT XX MILES" sign, if specified, for each direction of travel affected by the project. (A project on only one pavement of a dual divided facility will require only one sign.) The contractor shall maintain all signs until completion of the project.

2.1 Upon completion of the project, the contractor shall disassemble the signs and retain the posts and hardware. The sign panels shall remain the property of the Commission and shall be delivered without damage to locations within the project limits as directed by the engineer.

3.0 Basis of Payment. The accepted quantity of signs will be paid for at the contract unit price per each and will be full compensation for all labor, equipment and material to complete the described work.

"SHOW ME PROGRESS" SIGNS

1.0 Description. This work shall consist of installing a two-sign assembly consisting of a "Show Me Progress" sign panel over a supplemental project description sign panel as shown on the plans. The sign panels will be furnished by the Commission. The contractor shall furnish labor, equipment, posts and hardware for installation of the sign assembly in accordance with this provision or as directed by the engineer.

2.0 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Fiber or Nylon Washers	1042
Steel Channel Posts	1044

3.0 Construction Requirements. The "Show Me Progress" sign assembly shall be post-mounted and placed approximately 500 feet (150 m) before the "GIVE 'EM A BRAKE" sign for each direction of travel affected by the project. A project on only one pavement of a dual divided facility will require only one sign assembly. The contractor shall maintain all sign assemblies until completion of the project. Upon completion of the project, the "Show Me Progress" signs shall remain in place. The sign panels, posts and hardware will remain the property of the Commission.

3.0 Basis of Payment. The accepted quantity of "Show Me Progress" sign assemblies will be paid for at the contract unit price per each and will be considered full compensation for all labor, equipment and material to complete the described work.

"NO CENTER STRIPE" SIGNING

1.0 Description. The Commission will furnish "No Center Stripe" sign(s) in a serviceable and working condition to the job site. The contractor shall request each sign through the engineer. The contractor shall install "No Center Stripe" sign assemblies as shown on the plans or as directed by the engineer, and shall maintain these assemblies until completion of the project.

2.0 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Fiber or Nylon Washers	1042
Steel Channel Posts	1044

3.0 Construction Requirements. "No Center Stripe" sign assemblies shall be installed in accordance with the plans. The 36 x 36-inch (900 x 900 mm) sign panels will be furnished by the Commission.

3.1 Posts shall be of sufficient length to provide the required sign height and minimum embedment of 3 feet (900 mm). Signs shall be mounted with a minimum of two 5/16-inch (8 mm) bolts. Fiber or nylon washers shall be used between the bolt heads and sign face.

3.2 Removal of "No Center Stripe" sign assemblies will be the responsibility of the Commission. All signs, posts and hardware will remain the property of the Commission.

4.0 Method of Measurement. Measurement of "No Center Stripe" sign assemblies will be made per each unit assembled, installed and maintained in place.

5.0 Basis of Payment. Payment for "No Center Stripe" sign assemblies will be paid for at the contract unit price, "Installing No Center Stripe Sign," and will be considered full compensation for all labor, equipment and material to complete the described work.

WHITE AND YELLOW ACRYLIC WATERBORNE TRAFFIC MARKING PAINT

1.0 Description. These specifications cover waterborne traffic paint for application on bituminous or Portland cement concrete pavements at application temperatures of 50 to 150 F (10 to 65 C). The paint shall be capable of receiving and holding glass beads for producing reflectorized traffic markings.

2.0 Materials. Paint shall not contain more than 3200 ppm lead and/or more than 800 ppm chromium, based on dry weight, and shall have limited Volatile Organic Content (VOC), as noted herein.

2.1 Acrylic Emulsion Polymer. The acrylic emulsion polymer used in the manufacture of the paint shall be Rohm & Haas E-2706, Dow DT211, or equal.

2.2 General. The finished paint shall be formulated and manufactured from first-grade 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 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 alkalis and acids, or other ice control materials, or oil, gasoline or diesel fuel drippings from vehicles.

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 for at minimum of six months. The six-month data must include the winter months of December, January and February, and the data shall be obtained from evaluation on a NTPEP test deck in a northern, wet climate region.

2.3.1 Maintained retroreflectivity. Photometric quantity to be measured is coefficient of retroreflective luminance (R_L) in accordance with ASTM E 1743 for 15-meter geometry and ASTM E 1710 for 30-meter geometry. The average R_L for concrete and asphalt surfaces shall be expressed in millicandelas per square foot per foot-candle and shall be at least 100 for 15-meter geometry or 75 for 30-meter geometry, when measured in the wheel path area.

2.3.2 Durability. Paint shall have a durability rating of at least 4 for both concrete and asphalt surfaces when tested in the wheel path area of the NTPEP test deck.

2.4 Mixed Paint. The mixed paint shall conform to the following requirements.

2.4.1 The paint shall be strained before filling, using a screen or strainer no coarser than 40 mesh or equivalent.

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 D 3960.

2.4.3 The paint shall have the following properties:

Physical Properties	
Weight per Gallon, 77ºF (25ºC), lbs.	Report
Viscosity, 77ºF (25ºC), Krebs Units	83-98
Grind (Hegman Gage), min.	3
Laboratory Dry Time, ASTM D 711,minutes, max.	10
Dry Through Time, minutes, max.	150

2.4.3.1 Color. For white, the color shall closely match Color Chip 37925 of Federal Standard 595b and 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 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 ASTM E 1349 using CIE 1931 2º standard observer and CIE standard illuminant D65.

CIE Chromaticity Coordinate Limits (Initial)								
	1		2		3		4	
Color	x	y	x	y	x	y	x	y
White	0.334	0.357	0.334	0.317	0.297	0.357	0.297	0.317
Yellow	0.531	0.483	0.531	0.429	0.471	0.483	0.471	0.429

2.4.3.2 Flexibility. Paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952B.

2.4.3.3 Water Resistance. Paint shall be in accordance with Federal Specification TT-P-1952B. There shall be no blistering or appreciable loss of adhesion, softening, or other deterioration after examination.

2.4.3.4 Freeze-Thaw Stability. Paint shall show no coagulation or change in consistency greater than 10 Kreb Units when tested in accordance with Federal Specification TT-P-1952B.

2.4.3.5 Heat Stability. 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.

2.4.3.6 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.

2.4.3.7 Storage Stability. After 30 days storage in a three-quarters filled, closed container, the paint shall show no caking that cannot readily be remixed to a smooth, homogeneous state, no skinning, livering, curdling, or hard settling. The viscosity shall not change more than 5 Kreb Units from the viscosity of the original sample.

2.4.3.8 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. Contrast Ratio = Black/White.

2.4.3.9 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 not be less than 84 percent for the white paint and shall not be less than 50 percent for the yellow paint.

2.3.3.10 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.

2.3.3.11 No-Tracking Time Field Test. The paint shall dry to a no-tracking condition under traffic in three minutes or less when applied in a 15 ± 1 mil wet film thickness at 130 to 150 F (54 to 66 C), and from 3 to 10 minutes when applied at ambient temperatures with 6 pounds (2.72 kg) of glass beads per gallon (3.8 L) of paint. "No tracking" shall be the time, in minutes, required for the line to withstand the running of a standard automobile over the line at a speed of approximately 40 miles per hour (64 km/h), simulating a passing procedure without tracking of the reflectorized line when viewed from a distance of 50 feet (15 m).

2.3.3.12 Dry Through Time. 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 F ± 2.5 F (22.5 C ± 1 C). The dry through time shall be determined according to ASTM D 1640, except that the pressure exerted shall be the minimum needed to maintain contact with the thumb and film.

2.4 Glass Beads. Unless otherwise specified, Type I moisture-resistant beads shall be used at the minimum rate of 8 pounds per gallon (0.95 kg/L) of paint.

3.0 Acceptance.

3.1 Except as noted herein, each batch or lot of paint shall be sampled and approved prior to use.

3.2 No paint more than 15 months old shall be used.

3.3 Paint furnished by a paint manufacturer who has been listed by the MoDOT Materials Manual as being currently tested and has otherwise complied with all requirements of this specification for a General Services Bid request may be accepted on the basis of a manufacturer's certification stating that the material is the same as that furnished for Bid Request _____. The certification shall include the lot number of the paint furnished.

3.4 The paint manufacturer shall supply certification that the paint supplied meets the requirements of this specification. The certification shall include reference to the specific NTPEP test deck to which the paint was applied, including NTPEP identification numbers and report numbers.

ROLL-UP CONSTRUCTION SIGNS

1.0 Description. Work shall include furnishing, installing, maintaining, relocating and removing roll-up construction signs used in conjunction with temporary sign installations in accordance with the project plans or as directed by the engineer.

2.0 Material.

2.1 Sign Substrate. Sign 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/m^2), as shown, when measured in accordance with ASTM E810. The color specifications shall conform to the latest version of ASTM D 4956 specifications.

Minimum Coefficient of Retroreflection		
Observation Angle, Degrees	**Entrance Angle, Degrees**	**Orange**
0.2	-4	200
0.2	+30	100
0.5	-4	80
0.5	+30	30

2.2 Sign Layout and Design. Sign layouts shall be in accordance with the plans or as directed by the engineer. All borders, legends and symbols shall be silk screened onto the face of the sign as per both the sheeting and ink manufacturer's recommendations.

2.3 Overlays. Overlays shall conform to the requirements of Secs 2.1 and 2.2 of this specification. Overlays, when used, shall be mechanically fastened to the face of the sign in a manner that will ensure the overlay remains securely attached while not detracting from the appearance of the sign when the overlay is not in use.

2.4 Sign 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 their midpoints and their ends securely held to the back of the sign by mechanical means. The design shall ensure the sign remains taut and retains its intended shape when exposed to normal field conditions.

3.0 Certification. The contractor shall provide the engineer with written certification that all signs provided conform to the requirements of this specification and written certification from the manufacturer(s) that each roll-up sign complies with the requirements of NCHRP 350, Test Level 3.

4.0 Construction Requirements. Construction requirements shall be in accordance with Sec 616.3.

5.0 Basis of Payment. Payment for roll-up construction signs will be considered as part of the contract unit price for the construction signs specified in the contract, and will be considered full compensation for all labor, equipment and material to complete the described work. No direct payment will be made for the relocation of roll-up construction signs.

USE OF LOCAL LAW ENFORCEMENT SERVICES

1.0 Description. This item provides for the use of law enforcement personnel and vehicles within the project work zone during periods of construction.

2.0 Eligibility. Law enforcement personnel selected for work shall have full jurisdiction for enforcement of the area to be patrolled.

3.0 Method of Measurement. Measurement for law enforcement services will be paid for by the hour.

4.0 Basis of Payment. Plans will include an estimated number of hours of law enforcement services. Payment will be made for the actual number of hours approved by the engineer. Payment for providing the described law enforcement will be paid for at the contract unit price for "Law Enforcement", per hour.

TEMPORARY MEDIAN CROSSOVERS FOR CONSTRUCTION PROJECTS

1.0 Description. Temporary U-turn crossovers for hauling material will be permitted only at locations indicated in the traffic control plan. No existing crossover can be used unless it is at least 1/2 mile (0.8 km) from any structure that crosses over the freeway and is at least one mile (1.6 km) from any ramp terminal or other access connection, such as a safety rest area. Trailers will not be permitted to use crossovers if the median width is less than 70 feet (21 m) measured from edge of pavement to edge of pavement.

2.0 Construction Requirements. Crossovers shall be signed in accordance with the traffic control plan. Any additional modifications to the crossover median locations in the traffic control plan shall be in accordance with applicable portions of Sec 104. When the project has been completed, new crossovers shall be removed and the area restored to its original condition. Existing crossovers shall be restored to their original condition, including surface material.

3.0 Basis of Payment. No payment will be made for construction and removal of temporary crossovers or for restoring existing crossovers.

SPECIAL FIELD LABORATORY

1.0 Description. This work shall consist of furnishing a special field laboratory for purposes of monitoring Superpave mixtures.

2.0 General.

2.1 A special laboratory shall be furnished in accordance with Sec 601.1 and the following, for Superpave mix field verification purposes. It shall meet the requirements described herein, including location of all specified appurtenances as shown in the attached drawing, "Special Field Laboratory Layout."

2.2 The laboratory shall be in place and functional prior to any asphalt mix placement beginning on the project.

2.3 The contractor shall maintain continuous, round the clock, power and water supply to the laboratory for the duration of the project.

3.0 Special Field Laboratory.

3.1 Exterior. The laboratory shall be a minimum of 320 square feet (30 m^2), 8 feet (2.5 m) wide and 7 feet (2.1 m) high. A laboratory with the equivalent or greater of floor area and wall perimeter may be supplied with the engineer's approval. It shall be substantially constructed and weatherproof. The laboratory may be mounted permanently as a trailer unit or on skids. The floor of the laboratory shall be of adequate strength to support the testing equipment indicated.

3.2 Windows/Doors. The laboratory shall have a minimum of two outside doors and four windows. The necessary keys shall be furnished to the engineer. The outside doors shall be located so as to permit ingress and egress from opposite ends of the building. There shall be windows on at least two sides. Each window shall provide at least 4 square feet (0.37 m^2) of glazed area and permit opening to not less than 45 percent of the window area. At least one window shall provide a direct view of plant operations.

3.3 Interior.

3.3.1 Four anchored tables of the dimensions shown in the attached drawing shall be furnished. All tables shall have smooth one-piece tops.

3.3.2 The laboratory shall be equipped with storage shelves and a minimum of four chairs, one moveable desk, a two drawer filing cabinet, and one fire extinguisher.

3.3.3 An electric or gas hot plate with no less than two burners with adjustable temperature controls capable of accommodating a 14 x 20 inch (355 x 510 mm) sample pan shall be provided.

3.4 Utilities. The contractor shall furnish electrical power, water, gas, if required, and a phone line.

3.4.1 Circuitry shall be such that all indicated equipment can be used without disruption.

3.4.2 A hot and cold potable water supply with a drained, faucet-equipped sink capable of accommodating a 14 x 20 inch (355 x 510 mm) sample pan shall be provided and located as specified.

3.4.3 Lighting facilities of an approved type shall be provided in order to adequately light all working areas inside the building.

3.4.4 An actuated phone and facsimile machine with a private line is recommended to provide for faster communications when mix adjustments are needed.

3.5 HVAC.

3.5.1 The laboratory shall be equipped with ventilation for the forced draft ovens and an exhaust fan capable of moving a volume of air each hour equal to at least ten times the cubic volume of the laboratory. The ventilation and exhaust fan shall be placed as specified in the attached drawing.

3.5.2 Climate control capable of maintaining an ambient temperature range of 72 F to 80 degrees F (22 C to 26 degrees C) shall be provided.

4.0 Basis of Payment. The accepted laboratory will be paid for at the contract lump sum price for "Special Field Laboratory".

4.1 For projects awarded in combination, payment for the special field laboratory will be made only once, regardless if a special field laboratory is specified in each of the individual projects.

4.2 Payment will be considered full compensation for all furnishings, maintenance, relocation from site to site on a project or projects awarded in combination, all utilities, heating and cooling facilities including operation and fuel, and final removal and disposal of the laboratory.

SPECIAL FIELD LABORATORY LAYOUT

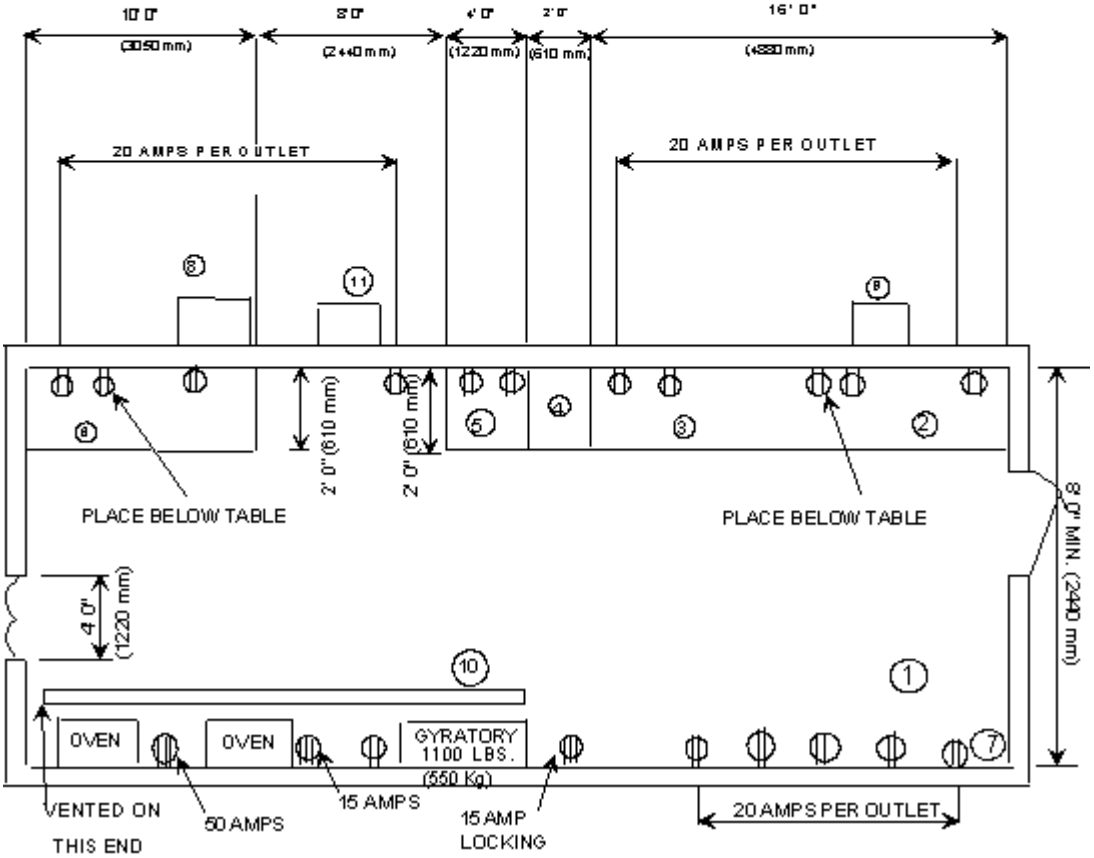
1. MOVEABLE DESK
2. 30" (760 mm) HEIGHT TABLE
3. 30" (760 mm) HEIGHT TABLE
4. SINK
5. 30" (760 mm) HEIGHT TABLE
6. 36" (915 mm) HEIGHT TABLE
7. PHONE
8. AIR CONDITIONER
9. AIR CONDITIONER
10. 6" Ø (150 mm) VENTILATION PIPE ALONG CEILING
11. VENTILATION FAN

110 VOLT OUTLET LOCATED 5 FT (1500 mm) FROM FLOOR (15 AMP - NEMA L6-15R)

220 VOLT OUTLET LOCATED 5 FT (1500 mm) FROM FLOOR (15 AMP - NEMA 6-15R) (50 AMP - NEMA 7-50R)

Dimensions are nominal except where shown as minimums or maximums.

Note: SuperPave QC laboratories previously approved by the engineer are acceptable.



ROCK DITCH LINER

1.0 Description. This work shall consist of constructing rock ditch liners at locations shown on the plans or as directed by the engineer.

2.0 Material. The material for rock ditch liner shall consist of a predominantly one-sized, durable stone, shot rock or broken concrete.

2.1 Type 1 Rock Ditch Liner shall consist of material with a predominant rock size of 3 inches (75 mm), a maximum rock size of 6 inches (150 mm) and minimum such that no more than 15 percent will be less than 1 inch (25 mm).

2.2 Type 2 Rock Ditch Liner shall consist of material with a predominant rock size of 6 inches (150 mm), a maximum rock size of 10 inches (250 mm) and a minimum such that no more than 15 percent will be less than 3 inches (75 mm).

2.3 Type 3 Rock Ditch Liner shall consist of material with a predominant rock size of 12 inches (300 mm), a maximum rock size of 20 inches (500 mm) and a minimum such that no more than 15 percent will be less than 4 inches (100 mm).

2.4 Type 4 Rock Ditch Liner shall consist of material with a predominant rock size of 19 inches (475 mm), a maximum rock size of 28 inches (700 mm) and a minimum such that no more than 15 percent will be less than 6 inches (150 mm).

2.5 Acceptance by the engineer may be made by visual inspection. Bedding material shall be used under Type 3 and Type 4 Rock Liner. Bedding material shall consist of crushed stone or gravel with a gradation consisting of 100 percent passing the 3-inch (75 mm) screen, 30 to 70 percent passing the 1 1/2-inch (37.5 mm) screen and 0 to 15 percent passing the No. 4 (4.75 mm) screen.

3.0 Construction Requirements. Rock ditch liner shall be placed to the approximate shape and thickness shown on the plans for the specified ditch or as directed by the engineer. The rock shall be dumped on a subgrade of reasonably uniform density and left in a rough condition meeting the approval of the engineer.

4.0 Method of Measurement. Rock ditch liner and bedding material will each be measured to the nearest cubic yard (meter) of material.

5.0 Basis of Payment.

5.1 If shown on the plans that the material for rock ditch liner is to be obtained from the right of way or other source furnished by the Commission, the excavating, including all breaking, loading, and hauling, regardless of distance, to the site of the rock ditch liner will be paid for and considered completely covered under such contract items as 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 ditch liner will not be made.

5.2 If the plans show material for rock ditch liner to be secured from such sources and this material is made unsuitable or unattainable by the contractor's operations, the contractor shall provide suitable material and dispose of any surplus material, at his expense.

5.3 If the plans provide for obtaining material from the right of way or other source furnished by the Commission, but all or part of the required quantity of acceptable material is not available, payment will be made at the unit price of $14.00 ($18.25) per cubic yard (meter) for such additional rock ditch liner material that the contractor is required to furnish and haul.

5.4 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 and completely covered by the contract unit price per cubic yard (meter) for Furnishing Rock Ditch Liner.

5.5 Payment for Placing Rock Ditch Liner will be made at the contract unit price per cubic yard (meter).

5.6 The accepted quantity of bedding material, complete in place, will be paid for at the contract unit price. No direct payment will be made for excavation or for any work necessary to prepare the subgrade for the bedding material.

5.7 No direct payment will be made for excavation below the upper surface of the rock ditch liner, nor for any work necessary for preparing the subgrade and backfilling the completed item.

5.8 Payment for Rock Ditch Liner will be made under the following item numbers as they apply:

ITEM NO.	UNIT	TYPE	DESCRIPTION
609-60.10 (609-60.15)	1.0	Cu. Yd. m^3	Furnishing Type 1 Rock Ditch Liner
609-60.20 (609-60.25)	1.0	Cu. Yd. m^3	Furnishing Type 2 Rock Ditch Liner
609-60.30 (609-60.35)	1.0	Cu. Yd. m^3	Furnishing Type 3 Rock Ditch Liner
609-60.40 (609-60.45)	1.0	Cu. Yd. m^3	Furnishing Type 4 Rock Ditch Liner
609-60.41 (609-60.46)	1.0	Cu. Yd. m^3	Placing Type 1 Rock Ditch Liner
609-60.42 (609-60.47)	1.0	Cu. Yd. m^3	Placing Type 2 Rock Ditch Liner
609-60.43 (609-60.48)	1.0	Cu. Yd. m^3	Placing Type 3 Rock Ditch Liner
609.60.44 (609-60.49)	1.0	Cu. Yd. m^3	Placing Type 4 Rock Ditch Liner
609-60.50 (609-60.55)	1.0	Cu. Yd. m^3	Bedding Material for Rock Ditch Liner

SNOWPLOWABLE RAISED PAVEMENT MARKERS

1.0 INSTALLATION OF SNOWPLOWABLE RAISED PAVEMENT MARKERS

1.1 Description. This work shall consist of furnishing and installing permanent snowplowable raised pavement markers (SRPM) as shown on the plans or as directed and approved by the engineer. The SRPM's shall consist of an iron casting to which is attached a replaceable retroreflector for reflecting light longitudinally along the pavement from one or two directions as specified.

1.2 Materials.

1.2.1 Casting. The durable metal base casting shall be shaped to deflect a snowplow blade upward and prevent damage to the reflectors. The casting shall have leveling tabs to ensure proper embedment and shall be fastened to the road surface by an epoxy adhesive. The casting shall be designed for bi-directional plowing and shall be recyclable. The bottom surface of the casting shall be free of scale, dirt, rust, oil, grease or any other contaminant that might reduce bonding to the epoxy adhesive. SRPM's shall be pre-approved prior to installation.

1.2.2 Reflector. The reflector shall have one or two retroreflective lenses to reflect incident light from a single direction or from opposite directions. The lens shall be hermetically sealed and permanently bonded to the reflector base. The manufacturer's trademark shall be molded in the face of the reflector lens or on the reflector body so as to be visible after installation.

1.2.2.1 The reflector shall have nominal dimensions of 2.0" (50 mm) X 4.0" (100 mm) by 0.5" (12.7 mm). The reflector shall fit securely into a recessed area on the upper surface of the casting web. After installation, the reflector shall fit securely in the recessed area and shall not protrude above the profile of the casting. The reflective surface of each lens face shall be a minimum of 1.55 square inches (1000 mm^2) in area.

1.2.2.2 Prior to the placement of the markers, the reflector shall be attached to the casting in accordance with the manufacturer's recommendations. Care shall be taken to ensure no adhesive is on the reflective lens.

1.2.3 Epoxy Adhesive. The epoxy adhesive used to bond the SRPM to the pavement shall be in accordance with the manufacturer's recommendations. The epoxy adhesive shall be machine mixed and applied unless otherwise approved by the engineer. The machine mixer and applicator shall be capable of accurately and uniformly proportioning the components. The mixing chamber shall produce an epoxy adhesive of uniform color with no visible evidence of streaks on the surface or within the mixed epoxy adhesive.

1.3 Construction Requirements. SRPM's shall be installed in accordance with the following requirements.

1.3.1 Markers shall not be installed when the ambient temperature is below 50 F (10 C), the relative humidity is above 80 percent, or the pavement surface is wet.

1.3.1.1 Newly placed bituminous pavement surfaces shall be allowed to cure for a minimum of seven days prior to installing the markers. Working days will not be assessed against the contractor if pavement curing for newly placed bituminous pavement extends beyond the working days established for the contract, providing the contractor continuously and diligently prosecutes the work to completion as soon as the curing and temperature requirements can be met.

1.3.2 Markers shall be installed as shown on the plans or as directed by the engineer. A longitudinal adjustment to the location of the marker shall be made in order to avoid damage to deteriorated pavements or transverse joints. In locations where concrete and bituminous surfaces abut, the SRPM shall be installed in the concrete surface.

1.3.3 The pavement shall be accurately cut to the SRPM manufacturer's specifications. The pavement shall be cut to match the bottom contour of the marker. The entire cut shall be made in a single plunge. Multiple saw cuts to create a slot will not be permitted.

1.3.3.1 The contractor shall check the slot for proper fit using a marker. The marker shall fit easily within the cut with the leveling tabs resting on the pavement and marker tips slightly below the pavement surface. If any force is required to place or remove the marker, or if the leveling tabs do not rest on the pavement surface, the cut shall be modified as necessary.

1.3.3.2 If necessary, installations on crowned pavements, superelevated pavements or ramps shall be cut deeper to provide proper marker fit.

1.3.3.3 When the roadway is opened to traffic during non-working hours, the contractor shall not cut more slots than the number of markers that can be installed in the same day.

1.3.4 The slot shall be clean and dry prior to applying the epoxy adhesive.

1.3.4.1 The slot shall be partially filled with epoxy adhesive, and the marker shall be placed in the slot with sufficient pressure applied to seat the casting. The leveling tabs shall rest on the pavement surface. The marker tips shall be slightly below the pavement surface. After seating the casting, the epoxy shall extrude to the pavement surface, completely filling all voids around and under the casting. There shall be no epoxy adhesive on the reflector.

1.3.4.1.1 For machine-mixed epoxy adhesive applications, the adhesive shall be mixed and the markers shall be installed according to the marker manufacturer's written instructions. Special precautions shall be observed to ensure that the epoxy adhesive has not cured excessively prior to placement of the marker in the slot. The manufacturer's written installation instructions shall be readily available on the project during placement. At the beginning of each day, and at any other time directed by the engineer, the proportioning equipment shall be verified to determine if the actual volume ratio of the components is within the manufacturer's requirements. This shall be accomplished by placing containers before the mixing chamber and the measurement of actual volumes of the components discharged. If volumes are not within the acceptable tolerance range, installation procedures shall be suspended until the contractor has corrected the equipment.

1.3.4.1.2 When hand mixing of epoxy adhesive is permitted, no more than 1 quart (liter) of epoxy adhesive shall be mixed at one time. The markers shall be installed within 5 minutes after mixing operations are started.

1.3.4.2 Additional epoxy adhesive shall be applied to the slot if the original amount does not sufficiently fill the slot after the marker is installed.

1.3.4.3 The epoxy adhesive shall cure within 30-45 minutes. If, after one hour, the epoxy adhesive can be penetrated by a screwdriver or other pointed instrument, the marker shall be removed, cleaned and reinstalled.

1.3.4.4 The installed marker shall be protected against traffic impact until the epoxy adhesive has hardened.

1.4 Method of Measurement. Measurement for the SRPM'S will be made per each.

1.5 Basis of Payment. The accepted quantity of snowplowable raised pavement markers 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 to complete the described work.

2.0 REHABILITATION OF EXISTING SNOWPLOWABLE RAISED PAVEMENT MARKERS

2.1 Description. This work shall consist of rehabilitation of existing SRPM's including removing, furnishing and installing replacement reflectors or castings units as shown in the plans or as directed and approved by the engineer.

2.2 Materials. Replacement reflectors, castings, bonding agents, and other required materials shall meet the specifications for materials recommended by the SRPM manufacturer and shall be in accordance with Section 1.0.

2.3 Construction Requirements.

2.3.1 All work shall be performed in accordance with SRPM manufacturer recommended methods and procedures. The methods and procedures shall be approved by the engineer prior to beginning work.

2.3.2 Existing reflectors shall be removed without causing damage to the existing casting. The casting shall be thoroughly cleaned prior to installation of the reflector. The replacement reflector shall be securely bonded to the casting using a manufacturer approved bonding agent. Any castings damaged due to the contractor's operations shall be replaced at the contractor's expense.

2.3.3 All cracked, broken or missing castings shall be replaced. If the existing hole cannot be used, it shall be patched to the approval of the engineer and the new SRPM shall be installed approximately 2 feet (0.6 m) before or after the existing location in accordance with Section 1.3. All patched areas on bridge decks will be patched with epoxy.

2.4 Method of Measurement.

2.4.1 Measurement for replacement of snowplowable raised pavement marker reflectors will be made per each.

2.4.2 Measurement for replacement of SRPM's will be made per each.

2.5 Basis of Payment. The accepted quantity of replacement of snowplowable raised pavement markers and reflectors 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 to complete the described work.

3.0 PREQUALIFICATION AND PROJECT ACCEPTANCE

3.1 The engineer may have the SRPM's or reflectors inspected and sampled at the point of manufacture, at an intermediate shipping terminal or at destination. The engineer shall be allowed free access to all facilities and records as required to conduct inspection and sampling.

3.2 In order to become prequalified, the product shall have completed testing through AASHTO's National Transportation Product Evaluation Program (NTPEP). A written request shall be sent by the manufacture to the State Project Operations Engineer with the following information included in the request for prequalification:

(a) Brand name of the product.

(b) Actual test results from NTPEP.

(c) Certification that the material meets this specification and is intended for use as described.

(d) Specific installation instructions.

3.3 To become prequalified for MoDOT, for all NTPEP test decks, the SRPM's shall receive minimum average ratings for each of the SRPM components.

3.3.1 The casting shall receive a minimum average rating of 4.0 for housing performance and 3.0 for lens and visibility after one year exposure on both concrete and asphalt test decks.

3.3.2 The reflector shall receive a minimum average rating of 3.0 for lens and visibility after one year exposure on both concrete and asphalt test decks.

3.4 The contractor shall submit a manufacturer's certification for each lot of SRPM's or reflectors furnished with the name of the manufacturer, a certification statement that the SRPM's or reflectors supplied are the same as that prequalified, and the date of prequalification.

3.5 Acceptance will be based on the SRPM's or reflectors prequalified status, the manufacturer's certification that the SRPM or reflector supplied is the same as that prequalified and upon the results of such tests as may be required.

3.6 A retest on approved SRPM's and reflectors must be conducted if the configuration changes.

ALTERNATE TEMPORARY EROSION CONTROL MEASURES

1.0 Description. This specification provides for alternate temporary erosion control measures to those specified in Sec 806 or as shown on the plans.

1.1 This work shall be in accordance with Sec 806, except as herein specified.

2.0 Materials and Design. The major items of the installation shall be the best standard products of the manufacturer and shall be of the manufacturer's latest approved design. The contractor shall furnish a manufacturer's certification that the units furnished are identical in material and design to those approved.

Alternative temporary erosion control measures shall be pre-approved prior to use. The following products have been pre-approved:

Ditch Check Type	*Product*	*Manufacturer*	*Slope*	*Drainage Area*
I	Dura Check Sediment Control Panel	Panel Products, Inc. 3216 S. Saratoga Springfield, MO 65804 Telephone (417) 886-9838	0-10%	3 acres (1.2 ha)
I	Triangular Silt Dike	Triangular Silt Dike Co., Inc. 608 Greenwood Midwest City, OK 73110 Telephone (800) 290-8473	0-10%	3 acres (1.2 ha)
II	Enviro Berm Porous Sediment Control System	Cascade Distribution, Inc. 15620-121A Avenue Edmonton, Alberta Canada T5V 1B5 Telephone (800) 565-6130	0-40%	unlimited

3.0 Installation. Alternate temporary erosion control methods shall be installed in accordance with the manufacturer's suggested recommendations and at the locations shown on the plans.

4.0 Maintenance. Alternate temporary erosion control methods shall be maintained as required by the manufacturer and directed by the engineer.

SUBSTITUTION OF MANUFACTURED ITEMS

1.0 Purpose. The purpose of this specification is to provide a listing of functionally equivalent items which may be substituted, upon approval of the engineer, by the contractor from the contractor's or supplier's inventories in lieu of the metric items shown on the plans or as specified in the standard specifications.

2.0 Material. The following tables of functional equivalents may only be used for the substitution of English measure items for metric measure items where applicable.

CONDUIT SIZES (NOMINAL)

Specified (mm)	Equivalent (in.)
25	1
32	1 1/4
40	1 1/2
50	2
65	2 1/2
75	3
90	3 1/2
100	4
115	4 1/2
125	5

CABLE-CONDUIT SIZES (NOMINAL)

Specified (mm)	Equivalent (in.)
27	1
35	1 1/4

For conductor equivalencies, refer to 'All Other Conductor, Cable and Wire' in next table.

CONDUCTOR, CABLE AND WIRE SIZES (NOMINAL)

Item Description	Metric Pay Items	Specified (mm^2)	Equivalent (AWG)
Pole and Bracket Cable	901-71.15, 902-81.05 & 903-30.05	6	10
3-Pair Interconnect Cable	902-83.16	1.5	16
Signal Control Cable	902-83.22, 902-83.23, 902-83.25, 902-83.27 & 902-83.32	4	12
Solid Neutral Wire	902-84.05	16	6
Loop Detector Cable			
In-Duct	902-85.05	2.5	14
Lead-In	902.85.15	2.5	14

All Other Conductor, Cable and Wire	Specified (mm^2)	Equivalent (AWG)
	0.5	18
	1.0	16
	1.5	14
	2.5	12
	4	10
	6	8
	10	6
	16	4
	25	3
	35	1
	50	0
	70	3/0

3.0 Construction. Value engineering will not be permitted for any of the above substitutions.

4.0 Measurement and Payment. Measurement and payment for substituted items will be made based on the metric dimensions, quantities and prices shown in the contract.

FLEXIBLE DELINEATOR POSTS

1.0 Description. This work shall consist of furnishing and installing reflectorized flexible delineator posts with prismatic retroreflective sheeting at locations, and of the dimensions, shown on the plans.

2.0 Materials.

2.1 Flexible Delineator Posts.

2.1.1 Flexible delineator posts shall be manufactured from virgin polymer, copolymer, or elastomers which will enable them to meet the requirements of this specification. Clean rework material generated from the manufacturer's own production will be permitted. Other reprocessed or recycled material is not permitted. Posts shall be pigmented and stabilized against fading or deterioration by ultraviolet or other light rays by the incorporation of adequate inhibitors. The post shall be white in color and shall meet the requirements for testing described herein. Each post shall be marked with the manufacturer's identification and the month and year produced. The marking shall be permanently affixed on the face away from oncoming traffic with 6 mm minimum height letters. The marking shall be visible after installation of the post. The marking shall be legible and may be either embossed in the post or marked in weatherproof and solvent resistant ink. Flexible delineator posts shall be one of the following types.

2.1.1.1 Type 1. Type 1 posts shall be cylindrical in shape, except the upper 10 to 15 inches (250 to 380 mm) shall be flattened to an oval shape at least 3 inches (75 mm) in width at the major axis. The flattened area shall provide a reasonably flat and smooth surface suitable for the application of reflective sheeting specified herein. If post caps are furnished as a part of the posts, the caps shall be firmly fastened to the top of the posts by adhesive.

2.1.1.2 Type 1 posts shall be capable of insertion into an anchor which will hold the post in a vertical position by a locking mechanism. The mechanism shall be such that when a post is no longer serviceable, the post can be removed and a new post inserted into the anchor and locked into place.

2.1.1.3 Anchoring systems for Type 1 posts may be one of the following classes:

Class A. A chisel pointed, drivable, reusable metal anchor 18 inches (450 mm) in length, into which a post can be inserted and held in place by a locking mechanism.

Class B. A metal anchor designed for embedment in either Portland cement or bituminous concrete into which a post can be inserted and held in place by a locking mechanism.

Class C. A surface mount held in place with a bonding epoxy and having a locking device to secure the post.

2.1.2 Testing.

2.1.2.1 Flexibility Test. Posts, 48 inches (1200 mm) in length, shall be tested at 43 C and -18 C. After being conditioned for at least two hours in a test chamber, the post shall be held securely in a vertical position and bent to a 90-degree angle. The post shall straighten to within ten degrees of vertical within one minute after being bent. The specimens shall be returned to the test chamber for 30 minutes between tests. The time outside the chamber shall not exceed five minutes. This test shall be repeated five times for each conditioning temperature, using a different post for each temperature. Flexibility Acceptance. All posts tested shall pass the straightening requirement. Cracking or permanent deformation shall be cause for rejection.

2.1.2.2 Vehicle Impact Test. The posts shall be capable of withstanding impact by a vehicle traveling at 55 mph (85 km/h).

2.1.2.2.1 Ten posts shall be installed in a straight line in a manner recommended by the manufacturer, at a spacing that does not allow interference with adjacent posts. The posts shall be 48 inches (1200 mm) in height from the ground surface. Half of the posts shall be normal to the direction of travel, and half shall be rotated fifteen degrees from the normal direction.

2.1.2.2.2 The impact vehicle shall be a typical, medium sized American sedan with a bumper, but no sharp contours, sharp hood ornaments, or other discontinuities on the front.

2.1.2.2.3 The impact vehicle shall strike the group of posts with the approximate center of the car successively, in the same direction, for a maximum series of fifteen times at 55 mph (85 km/h). After each run, the tester shall note the number of posts that sustained impact and the number of posts that return to within twenty degrees of vertical within one minute. A post is considered failed if it has torn loose, has pulled out of the ground, has lost more than ten percent of its exposed length, or is at an angle of less than 45 degrees with vertical. In any of those cases, it is to be removed from further consideration. After ten runs, the tester shall note the number of posts remaining and the amount of reflectorized sheeting on each post. If the acceptance criteria has not been met after ten runs, testing may be continued for a maximum of fifteen vehicle runs.

2.1.2.2.4 Acceptance. After ten vehicle runs, there shall be a minimum of six posts remaining, and a minimum of six posts shall each have at least 50 percent of the reflectorized sheeting left. After a maximum of fifteen vehicle runs, a minimum of 100 post impacts shall have been counted (or an average life of ten impacts for the initial ten posts) and a minimum of 100 counts shall have been noted for posts returning to within twenty degrees of vertical.

2.1.2.3 Bend Resistance Test. A post shall be cantilevered horizontally with a 48 inch (1200 mm) unsupported overhang and at room temperature (25 ± 3 C). A 5.5-pound weight (2.5 kg mass) shall be suspended from the end of the post, and the post allowed to support the weight (mass).

2.1.2.3.1 Bend Resistance Acceptance. The post shall deflect 60 degrees or less, from the original horizontal position. The post shall be rejected if the angle exceeds 60 degrees. All posts tested shall pass this requirement.

2.2 Prismatic Retroreflective Sheeting.

2.2.1 The retroreflective sheeting shall be a flexible, colored, wide angle prismatic retroreflective sheeting designed to enhance the day/night visibility of flexible delineator posts and shall have a smooth surface with a distinctive interlocking diamond seal pattern and orientation marks visible from the face. The sheeting shall be precoated with a pressure sensitive adhesive backing protected by a removable liner. The sheeting shall be free from ragged edges, cracks and extraneous material. The sheeting shall be identified by brand, lot, run number or date of manufacture, and color.

2.2.2 Test Methods.

2.2.2.1 Test Conditions. Unless otherwise specified herein, all applied and unapplied test samples and specimens shall be conditioned at the standard conditions of 23 ± 3 C and 50 ± 5 percent relative humidity for 24 hours prior to testing.

2.2.2.2 Test Panels. Unless otherwise specified herein, when tests are to be performed using test panels, the specimens of retroreflective material shall be applied to smooth aluminum cut from ASTM B 209 Alloy 5052-H36,

5052-H38, 5154-H38 or 6061-T6 sheets in 0.020 inch (508 µm), 0.040 inch (1016 µm) or 0.063 inch (160 µm) thickness. The aluminum shall be degreased and lightly acid etched before the specimens are applied. The specimens shall be applied to the panels in accordance with the recommendations of the retroreflective sheeting manufacturer.

2.2.3 Physical Requirements.

2.2.3.1 Color Requirements.

2.2.3.1.1 The four pairs of chromaticity coordinates shown below determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

Color Specification Limits (Daytime)										
Color	**1**		**2**		**3**		**4**		**Reflectance Limit Y (%)**	
	x	**y**	**x**	**y**	**x**	**y**	**x**	**y**	**Min.**	**Max.**
White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40	---
Yellow	0.487	0.423	0.545	0.454	0.465	0.534	0.427	0.483	24	45

2.2.3.1.2 Conformance to color requirements shall be determined by instrumental method in accordance with ASTM E 1164 on sheeting applied to test panels and conditioned as specified in Sec 2.2.2.1 of this specification. The values shall be determined on a Hunterlab Labscan II 0/45 spectrocolorimeter with option CMR 559. Computations shall be made in accordance with ASTM E 308.

2.2.4 Specific Intensity Per Unit Area (SIA). The specific intensity per unit area shall not be less than the minimum values specified. Testing shall be in accordance with AASHTO T 257 except that the table values shall be met at 0 degrees and at 90 degrees orientation without averaging.

Minimum Specific Intensity Per Unit Area (SIA) $cd/lx/m^2$ ($cd/fc/ft^2$) (0 and 90 degree Orientation)			
Observation Angle (degrees)	**Entrance Angle (degrees)**	**White**	**Yellow**
0.2	-4	800	660
0.2	+30	450	340
0.2	+45	200	85
0.2	+60	65	23
0.5	-4	185	160
0.5	+30	125	85
0.5	+45	90	45
0.5	+60	35	20

*The 60-degree entrance angle shall be measured at 90 degrees orientation only.

2.2.4.1 For measurement, the datum mark (orientation arrow) shall be positioned horizontally for the 0 degree orientation and vertically for the 90 degrees (preferred) orientation.

2.2.5 Gloss Retention. The retroreflective sheeting shall have an 85-degree specular gloss of not less than 50 when tested in accordance with ASTM D 523.

2.2.6 Flexibility. The retroreflective sheeting with the liner removed and conditioned as specified in Sec 2.2.2.1 of this specification shall be sufficiently flexible to show no cracking when bent, in a time period of one second, around a 1/8 inch (3 mm) mandrel, with the adhesive contacting the mandrel, at test conditions. Talcum powder shall be spread on the adhesive to prevent sticking to the mandrel.

2.2.7 Adhesive. The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solutions, without breaking, tearing, or removing any adhesive from the backing. The protective liner shall be easily removed following accelerated storage for four hours at 71 C under a force of 2.5 psf (17.2 kPa). The adhesive backing of the retroreflective sheeting shall produce a bond to support a 1.75 pound weight (0.8 kg mass) for five minutes without the bond peeling for a distance of more than 2 inches (50 mm) when applied to a test panel prepared as specified in Sec 2.2.2.2 of this specification. Apply 4 inches (100 mm) of a 1 inch x 6 inch (25 mm x 150 mm) specimen to a test panel. Condition and then position the panel face down horizontally, suspend the weight (mass) from the free end of the sample and allow it to hang free at an angle of 90 degrees to the panel surface for five minutes.

2.2.8 Impact Resistance. The retroreflective sheeting applied according to the sheeting manufacturer's recommendations to a test panel of alloy 6061-T6, 0.040 inch (1016 µm) x 3 inch (75 mm) x 5 inch (125 mm) and conditioned as specified in Sec 2.2.2.1 of this specification, shall show no cracking outside the impact area when the face of the panel is subjected to an impact of a 4 pound weight (2 kg mass), with a 5/8 inch (16 mm) diameter rounded tip, dropped from a height necessary to generate an impact of 100 inch-pounds (11.3 N·m) at test temperatures of 0 C and 22 C.

2.2.9 Resistance to Heat. The retroreflective sheeting, applied to a test panel and conditioned as specified in Sec 2.2.2.1 of this specification, shall be measured in accordance with Sec 2.2.4 of this specification at 0.2 degrees observation and -4 degrees entrance angles at both 0 degrees and 90 degrees orientations and exposed to 77 ± 3 C for 24 hours in an air circulating oven. After heat exposure the sheeting shall retain a minimum of 70 percent of the original coefficient of retroreflection at both orientations when measured at room temperature.

2.2.10 Resistance to Corrosion. The retroreflective sheeting applied to a test panel and conditioned as specified in Sec 2.2.2.1 of this specification, shall show no loss of adhesion, appreciable discoloration or corrosion and after cleaning shall retain a minimum of 80 percent of the original specific intensity per lux per square meter when measured at 0.2 degrees observation, -4 degrees entrance and 0 degrees and 90 degrees orientation angles only, after 1000 hours exposure to a five percent concentration salt spray at 35 C when tested in accordance with ASTM B 117.

2.3 Approval and Acceptance.

2.3.1 Manufacturer and Brand Name Approval. To obtain manufacturer and brand name approval of flexible delineator posts, the manufacturer shall submit to Project Operations, three complete posts (including anchoring system if any), test results from an approved independent testing laboratory for the properties specified in Sec 2.1.2 of this specification and certification for the reflective sheeting.

2.3.1.1 The independent testing laboratory report shall include the name of the manufacturer, brand name of the post, date of manufacture or lot number tested, and post dimensions.

2.3.1.2 The post manufacturer shall submit the sheeting manufacturer's test results for the specified properties of the reflective sheeting which will be used in the fabrication of the reflectorized flexible delineator posts. The report for the reflective sheeting shall also include the name of the manufacturer, brand name of the sheeting, color and lot, run number or date of manufacture of the material tested.

2.3.1.3 Upon approval of the test reports for the flexible post and the reflective sheeting, the manufacturer's brand name will be placed on a prequalified list.

2.3.1.4 Acceptance. Prior to installation of the posts the manufacturer of the posts shall submit a certification to the engineer certifying the posts and reflective sheeting furnished are of the same composition as originally prequalified for manufacturer and brand name approval and in no way has been altered or changed. Final acceptance will be based upon brand name, satisfactory manufacturer's certification and any sampling or testing deemed necessary by the engineer.

3.0 Construction. The posts shall be installed 2 feet (600 mm) off the edge of the shoulder or as shown on the plans. Driven posts shall be installed so the reusable anchor or bottom tip of the post, as applicable, is a minimum of 17 inches (430 mm) in depth from the ground surface. The posts shall be installed vertically, and any post damaged to the extent it is considered unfit for use by the engineer shall be removed and replaced by the contractor without any additional cost to the Commission.

4.0 Basis of Payment. The accepted quantity of flexible delineator posts 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 reflective sheeting or post anchors.

CONCRETE FOR MSE SYSTEMS AND OTHER COMMERCIAL PRECASTING WORKS

1.0 Description. This specification covers the requirements for the manufacturing of precast panels for mechanically stabilized earth (MSE) wall systems and other commercial precasting works.

2.0 Material.

2.1 Cement. Cement shall meet the requirements of Sec 1019.

2.2 Aggregate. Fine and coarse aggregates for the concrete mixture shall meet the requirements of Sec 1005, except that requirements for gradation and percent passing the No. 200 (75 μm) sieve shall not apply.

2.3 Fly Ash. Fly ash shall meet the requirements of Sec 1018.

2.4 Admixtures. Retarding or accelerating admixtures, or any additive containing chloride shall not be used without the approval of the engineer. All admixtures shall meet Sec 1054.

2.5 Reinforcing Steel. Reinforcing steel shall be as specified in the plans, meeting the applicable sections of Sec 1036.

3.0 Mixture.

3.1 Design. The minimum compressive strength of the concrete shall be 4000 psi (27.6 MPa) at 28 days. Units not attaining this strength by 28 days shall be rejected.

3.2 The proportion of cementitious material shall not be less than 564 pounds (330 kg) per cubic yard (meter) of concrete. Fly ash may be used in accordance with Sec 501. Class B or B-1 concrete may be used, in which case material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Sec 501.

3.3 The aggregates shall be sized, graded, proportioned, and thoroughly mixed in a batch mixer with such proportions of cement and water, as will produce a homogeneous concrete mixture of such quality that the panels will conform to the test and design requirements.

3.4 The concrete shall contain 5 1/2 percent air by volume, with an operating tolerance of 1 1/2 percent. The slump shall not exceed 4 inches (100 mm). If a high range water reducer is used, the dosage rate shall be in accordance with manufacturer's recommendation, the air content shall be 6% plus 2 percent or minus 1 1/2 percent and the slump shall not exceed 8 inches (200 mm).

4.0 Manufacture.

4.1 Casting. Unless otherwise indicated, the panels shall be cast front face down on a flat area, without interruption and consolidated to eliminate honeycombing. The rear face shall be screeded. Other units shall be cast as required in the plans.

4.2 Marking. The date of manufacture, production lot number, and piece mark shall be clearly scribed on an unexposed face of each panel or unit.

4.3 Curing. Curing shall be in accordance with applicable provisions of Sec 1026, until the concrete has developed the specified compressive strength. No membrane cure shall be applied to the face of MSE panels. Otherwise, membrane curing is normally allowed unless specifically prohibited in the plans.

4.4 Form Removal. The forms shall remain in place until they can be removed without damage to the unit, at which time curing shall be applied as specified.

5.0 Storage and Handling. All units shall be handled, stored, and shipped in such a manner to prevent chipping, discoloration, cracks, or other defects. Panels in storage shall be firmly supported to protect connection devices and the exposed exterior surface.

6.0 Tolerances.

6.1 MSE Panel Dimensions. All tie strap locations shall be within 1 inch (25 mm), all other dimensions within 3/16 inch (5 mm).

6.2 MSE Panel Squareness. Squareness, as determined by the difference between the two diagonals, shall not exceed 1/2 inch (13 mm).

6.3 Other types of unit tolerances shall be as listed in the plans.

7.0 Acceptance. Units exceeding the allowable tolerances or those that are cracked or have defects due to molding, honeycombing, color variation on the front face or severe cracking will be rejected.

HIGH RANGE WATER-REDUCING ADMIXTURES

1.0 Description. This specification covers the use of high range water-reducing (HRWR) admixtures for fabricating prestressed concrete bridge units for bridge superstructures in accordance with Sec 705 at the fabricator's option and when approved by the engineer.

2.0 Approval. Prior to the use of an HRWR, the fabricator shall submit a request and the manufacturer's certification to the engineer.

2.1 The request shall designate the proposed concrete mixture, the brand, dosage rate of HRWR proposed for use, and the design slump.

2.2 A manufacturer's certification shall be furnished from an authorized representative of the HRWR stating that the admixture being furnished is considered to be compatible with the other admixtures (i.e., air entrainment, retarder, accelerator, etc., by brand name) being used in the mixture. Any changes in sources require a re-submittal of the certification.

3.0 Material.

3.1 Water Reducer. The HRWR shall be one previously approved for use in accordance with Sec 1054.

3.2 Concrete Mixture. The concrete shall meet Sec 501 for the Class specified, except as noted herein.

3.2.1 The minimum water-cement ratio shall not be less than 0.25 (pounds of water per pound of cement)(kg of water per kg of cement), and the maximum allowed gallons (liters) of water for the mixture shall be reduced by 15 percent for concrete mixtures with HRWR.

3.2.2 The air content shall be 6 percent, plus 2 percent, or minus 1 1/2 percent for concrete mixtures with HRWR.

3.2.3 The allowed slump shall be that specified by the contractor, plus or minus 2 inches (50 mm), but in no case shall the slump exceed 8 inches (200 mm).

3.2.4 The liquid portion of the HRWR shall be included in the mix water.

4.0 Construction.

4.1 The HRWR may be added at the plant or on the casting site. If added after the initial mixing sequence, the mixer shall be turned an additional 30 revolutions or more as necessary to accomplish uniform mixing.

4.2 After the addition of the HRWR, no reconditioning of the concrete mixture by adding any kind of material will be permitted. If the batch of concrete loses its slump and cannot be satisfactorily consolidated into the forms, the batch will be rejected.

4.3 All bridge superstructure beam units in the same span shall be cast either using the HRWR or not using it. No mixing of units will be allowed.

ERRATA CORRECTIONS TO 1999 MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION

The following changes are issued to address typographical corrections.

Page	Section	
35	105.15.1	First two sentences should read, "If at any time during the prosecution of the work the contractor completes any section of work one mile (1.5 km) or more in length, the contractor may request the engineer to inspect that section. If the engineer finds upon inspection that the section has been completed in compliance with the contract, the engineer will accept that section as being completed and the contractor will be relieved of further responsibility for that section."
424	712.12.4.2	First sentence should read, "Coatings shall not be applied in rain, snow, fog or mist or when the steel surface temperature is at or below 5 F (3 C) above the dew point."
439	717.2.1	Second row in table should read, "Paint……..1045". Third row in table should read, "Lumber and Timber…….1050"
569	1002.1.2	Second row in table should read, "Absorption, AASHTO 85, percent, max…….4.0".
	1002.1.3	Second row in table should read, "Absorption, AASHTO 85, percent, max…….5.5".
582	1007.1	Last sentence should read, "The fraction passing the No. 40 (425 µm) sieve shall have a plasticity index not to exceed six."
662	1026.28	Second to last sentence in the notes should read, "D-Load to produce a 0.3-mm crack……..140.0".

REVISIONS TO 1999 MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION

SECTION 101 – DEFINITION OF TERMS

Amend Sec 101.1 to include the following: ***01/01; 10/01; 04/02; 07/02***

ESAL Equivalent 18-kip Single Axle Load

MDNR Missouri Department of Natural Resources

MSDS Material Safety Data Sheet

NCHRP 350 National Cooperative Highway Research Program (NCHRP) Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*

NTPEP National Transportation Product Evaluation Program

PWL Percent Within Limits

Amend Sec 101.2 to include the following: ***04/00***

Contract Documents. Notice to Contractors, Plans, Bidding Document, Contract Bond, Contract Agreement, Acknowledgment, Contractor Questionnaire, Job Special Provisions, Standard Specifications, Supplemental Specifications, General Special Provisions, Notice to Proceed and all Supplemental Contracts and Change Orders.

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

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

(a) Standard Specifications. A book of specifications approved for general application and repetitive use.

(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.

Delete the definition for Contract Bond in Sec 101.2 to and substitute the following: ***04/01***

Contract Bond. The form of security approved by the Commission, 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.

Delete the definition for Engineer in Sec 101.2 to and substitute the following: ***04/02***

Engineer. The chief engineer or any other authorized representative of the Commission. Where the term chief engineer is used it shall mean the chief engineer in person. MoDOT pursues its mission through the functional units defined by law. Where a functional unit is stated in the contract documents, it means engineer of the functional unit or designee.

SECTION 102 – BIDDING REQUIREMENTS AND CONDITIONS

Delete Sec 102.1 and substitute the following: ***10/01***

102.1 Notice of Bid Opening. After the date is fixed for the receipt of bids, the notice of bid opening will be mailed upon request and payment of a nominal subscription fee. The notice of bid opening will contain a description of the proposed work, together with instructions and information to the potential bidder regarding bid forms, plans, specifications, combination bids and the reservation of the right of the Commission to reject any and all bids.

Delete Sec 102.2.5 and substitute the following: ***10/01***

102.2.5 All prospective bidders who are corporations organized in states other than Missouri shall furnish, at their 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 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 its 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.

SECTION 103 – AWARD AND EXECUTION OF CONTRACT

Delete Sec 103.4.1 and substitute the following: ***04/01***

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 the State of Missouri, in a form and with surety or sureties acceptable to the Commission, 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 Commission of 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 which 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 Commission 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 which increase the cost of the contract.

SECTION 104 – SCOPE OF WORK

Delete Sec 104.3 and substitute the following: ***04/01***

104.3 Changes in the Work. 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, considered necessary to satisfactorily complete the project. Such changes in quantities and alterations in the work do 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 shall not involve work beyond the termini of the proposed construction, except as may be necessary to satisfactorily complete the project.

Delete Sec 104.11.1 and substitute the following: ***04/02***

104.11.1 Before final acceptance, the contractor shall restore to a condition equal to that existing prior to construction all property, both public and private, within, adjacent to and beyond the limits of construction which have been disturbed or damaged by prosecution of the work. Restoration work shall be at the contractor's expense.

SECTION 105 – CONTROL OF WORK

Delete Sec 105.4 and substitute the following: ***04/00***

105.4 Coordination of Contract Documents. The contract documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They 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) Job Special Provisions

(b) General Special Provisions

(c) Plans

(d) Standard Plans

(e) Supplemental Specifications

(f) Standard Specifications

(g) Bid Items or Quantities

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

Delete Secs 105.16.3 – 105.16.5.2 and substitute the following: ***04/01; 10/01***

105.16.3 If the contractor has any claim against the Commission arising out of the provisions of the contract or the performance or non-performance thereunder, and is not within the scope of Sec 105.16.2, 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 108.10 or 108.13.

(c) As provided in Sec 108.11 upon a termination of the contract for convenience of the Commission.

105.16.4 If the Commission has a claim against the contractor which 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.

105.16.5 If the claim is against the Commission, the written claim shall be personally delivered or sent by certified mail to the Office of the Secretary of the Commission in Jefferson City, 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.

105.16.5.1 This provision shall not extend the claim filing time limits of the contractor or the Commission in the case of a differing site condition or a suspension of the work under Sec 108.14.

105.16.5.2 This provision will not limit the Commission'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 rights not discovered within 60 days of filing of any claim by the contractor.

SECTION 106 – CONTROL OF MATERIAL

Delete Sec 106.1.4 and substitute the following: ***04/02***

106.1.4 Material is 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 allowed. Initial inspection, testing and approval or rejection will be made as early as practicable. The engineer may waive any of the requirements regarding determination of quality and accept material on certification or visual inspection if, in the engineer's judgment, the quantity involved is too small or its use not sufficiently important to warrant tests.

Delete Sec 106.1.5 and substitute the following: ***07/02***

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 include each line number involving material components, each material component of each line, and the proposed supplier of each material. At the option of the engineer, material may be approved at the source of supply before delivery is started.

Delete Sec 106.10.1 – 106.10.3 and substitute the following: ***07/01***

106.10.1 Equipment. Equipment such as scales, concrete and asphalt plants, and placement equipment shall be scaled in, or measured in English units except equipment for metric projects may be in metric units. Equipment requiring calibration will be calibrated using its "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 except as follows. English material may be provided in lieu of metric specified material and metric reinforcing steel may be provided in lieu of English specified reinforcing steel if the material is equivalent or better and used consistently, if other components or aspects are unaffected, and if the material is approved by the engineer. Any cost of re-design due to use of material with units of measure other than as specified by the contract shall be borne by the contractor.

106.10.3 Project Documentation. All project tickets, paperwork for measurement, certifications or reporting of material shall be in the unit measure specified in the contract, except if metric is specified, documentation may be furnished in English units, provided it is done consistently for the project and supplier.

SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Amend Sec 107.2.1 to include the following: ***07/01***

107.2.1 Objects Potentially Affecting Navigable Airspace. The contractor shall comply with all Federal regulations pertaining to constructing, erecting, or installing any object, temporary or permanent, that could potentially affect navigable airspace.

Delete Sec 107.7 and substitute the following: ***04/01***

107.7 Use of Explosives. All blasting operations shall be conducted under the direct supervision of a certified, approved blaster as set forth in the contract. When explosives are used in the prosecution of the work, the contractor shall use the utmost care to prevent personal injury and property damage. The contractor shall be responsible for damage resulting from the use of explosives. The engineer has 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 which 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".

Amend Sec 107.13.2 to include the following: ***04/02***

107.13.2.5 Navigable Waters Insurance Protection.

107.13.2.5.1 Description. The U.S. Army Corps of Engineers has classified the Missouri and Mississippi rivers as part of the "navigable waters of the United States". Any contractor performing contract work on or adjacent to the Missouri and Mississippi rivers shall obtain insurance coverage in accordance with this specification and may also obtain this insurance coverage for any subcontractor who will perform contract work under that contract.

107.13.2.5.2 Insurance Requirements. Jones Act Insurance, Longshore and Harbor Workers' Compensation Act Insurance, and Maritime Law Liability Insurance shall apply.

107.13.2.5.2.1 Insurance under the Jones Act, 46 U.S.C., shall be obtained to provide any employee of the contractor or subcontractor who qualifies as a "seaman" under the Jones Act with coverage for personal injury, disability or death occurring in the course of his or her employment as a "seaman" on the project. The minimum limits of this insurance coverage shall be $1,000,000 per occurrence and in the aggregate, or as may be specified by law, whichever amount is higher.

107.13.2.5.2.2 Insurance under the Longshore and Harbor Workers' Compensation Act, 33 U.S.C., shall be obtained to provide any employee of the contractor or subcontractor who is a "person engaged in maritime employment" with compensation payable in respect of that employee's disability or death resulting from an injury on the project occurring within the limits set forth in 33 U.S.C. The minimum limits of this insurance coverage shall be $1,000,000 per occurrence and in the aggregate, or as may be specified by law, whichever amount is higher.

107.13.2.5.2.3 An additional policy or policies of liability insurance, or endorsement of an existing liability insurance policy or policies, shall be obtained to provide the contractor with liability insurance protection for any work or activity on the project which is potentially subject to maritime law claims. Each such policy of insurance protecting against claims arising under maritime law shall meet all requirements of Secs 107.13.2, 107.13.2.1, 107.13.2.3, and 107.13.2.4. The contractor may also name any subcontractor that is potentially subject to a maritime law claim by the nature or methods of the work the subcontractor performs on the project as an "additional insured" or "additional named insured" on a policy or policies providing maritime law liability insurance protection.

107.13.2.5.2.4 A subcontractor is exempt from meeting the requirements of Secs 107.13.2.5.2.1, 107.13.2.5.2.2 and 107.13.2.5.2.3 if the contractor obtains the necessary insurance coverage specified on behalf of that subcontractor and produces acceptable evidence of the insurance to satisfy the engineer that the subcontractor and its applicable employees are fully covered by the type(s) and amount(s) of insurance required for the project work to be performed by that subcontractor.

107.13.2.5.2.5 A subcontractor is exempt from obtaining the Jones Act insurance coverage if none of its employees will perform work on the project which qualifies that person as a "seaman" under the provisions of 46 U.S.C.

107.13.2.5.2.6 A subcontractor is exempt from obtaining the Longshore and Harbor Workers' Compensation Act insurance coverage if none of its employees will perform work on the project which would qualify that individual as a "person engaged in maritime employment" in accordance with the definitions of the terms "employer" and "employee" contained in 33 U.S.C.

107.13.2.5.2.7 A subcontractor is exempt from obtaining an additional policy or policies of liability insurance providing maritime law claims protection, or endorsing any insurance policies to provide maritime law claims protection if that subcontractor shall not perform any work or activity on the project that is governed by maritime law.

107.13.2.5.2.8 In order to obtain any of the alternative exemptions in Secs 107.13.2.5.2.5, 107.13.2.5.2.6 or 107.13.2.5.2.7, the subcontractor must file an affidavit, executed before a notary public by a responsible engineer in its employ on the project, under penalty of perjury, executing a false affidavit or fraud, specifying that the subcontractor is exempt from applicable insurance requirements of Secs 107.13.2.5.2.5, 107.13.2.5.2.6 or 107.13.2.5.2.7, and detailing the steps personally taken by that engineer and in conjunction with one or more insurance brokers to determine that the subcontractor qualifies for that exemption.

107.13.2.5.2.9 The insurance specified in this provision shall be obtained by the contractor before the contractor or

any subcontractor performs any project work subject to the Jones Act, the Longshore and Harbor Workers' Compensation Act, or to maritime law. The insurance specified in this provision shall be obtained by a subcontractor prior to the subcontractor performing any project work subject to the Jones Act, the Longshore and Harbor Workers' Compensation Act, or to maritime law. Satisfactory proof of insurance issued by the insurance company or its broker must be provided in writing to the engineer at or before that time.

107.13.2.5.2.10 Alternatively, the requisite affidavit showing that a subcontractor is exempt from meeting any or all of the insurance requirements of this provision shall be filed by the subcontractor with the engineer no later than thirty days after the subcontractor commences work on the project job site.

107.13.2.5.3 Basis of Payment. No direct payment will be made for compliance with this provision or to reimburse the contractor or subcontractor for the costs of any insurance, proof of insurance or required affidavit.

SECTION 108 – PROSECUTION AND PROGRESS

Delete Sec 108.1.1 and substitute the following: ***04/00***

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 which will perform the work is particularly experienced and equipped for such work. 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 not less than 40 percent of the total contract cost. Consent to a subcontract shall not constitute the Commission's endorsement of the qualifications of the subcontractor.

Delete Sec 108.9 and substitute the following: ***04/02***

108.9 If the engineer invokes the option under Sec 901, 902 or 903 to have MoDOT personnel or a third party correct a lighting, signal or sign lighting-malfunction, the contractor will be charged for the service. If MoDOT 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 Commission by the third party. However, in no case will the charge be less than $100.

SECTION 109 – MEASUREMENT AND PAYMENT

Delete Sec 109.1 and substitute the following: ***01/00***

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 contract quantity basis as set out elsewhere in these specifications. Method of measurement and basis of payment will be made to the nearest whole number unless specified otherwise in the specifications. When the quantity of any item that is to be paid for on a contract quantity basis is found to include errors, or when an authorized revision of the plan 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.

Delete Sec 109.7 and substitute the following: ***01/00; 04/02***

109.7.2 The engineer may in any payment estimate include the value of any non-perishable material which 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 estimate. The value of such material on a single invoice from one supplier shall not be 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 provision 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 estimate date. Receipted invoices for all material payments previously allowed on the estimate shall be submitted to the engineer within 42 days of the

date of the estimate 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.

Delete Sec 109.7.3 ***07/01***

Delete Secs 109.8 – 109.8.2 and substitute the following: ***07/00; 04/01; 04/02***

109.8 Final Acceptance and Payment. When the project has been accepted as provided in Sec 105.15, the engineer will prepare the final tabulation of the quantities of work performed. All prior partial estimates 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 Commission:

(a) An affidavit, on the form prescribed by the Commission, 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 which may be required by the contract.

109.8.1 If said affidavit 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 Final acceptance will not prevent the Commission from correcting any measurement, estimate or certificate made before or after completion of the contract. The Commission will not be prevented from recovering, from the contractor or surety or both, overpayments made or costs sustained by the Commission for failure of the contractor to fulfill the obligations under the contract. A waiver on the part of the Commission 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 The contractor and surety shall be liable to the Commission for latent defects, fraud or such gross mistakes as may amount to fraud, or as regards the Commission's rights under any warranty or guaranty without prejudice to the terms of the contract.

Delete Sec 109.9 and substitute the following: ***07/01***

109.9 Retained Percentage.

109.9.1 Withholding of Retained Percentage. Retainage may be initiated during contract performance if the engineer determines that certain events have occurred, including:

(a) Events where federal or state law applicable to the contract require payments be withheld to enforce a contract obligation.

(b) Events where the contract otherwise specifically provides for withholding payments to secure performance.

(c) The occurrence of a cause for withholding payment specified in the Missouri Prompt Pay Act, 34.057 RSMo. Retainage withheld under these circumstances will be as allowed by that statute.

109.9.1.1 If retainage is initiated during contract performance, then 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 Sec 109.9. The net amount due on the estimate will be certified to the Commission for payment. This method of retained percentage does not apply to Sec 808.6.

109.9.2 Release of Retained Percentage. As soon as practicable after the final acceptance of the work, and after final quantities have been computed or computations have reached a point where final quantities may be closely estimated, the retained percentage will be paid to the contractor. A portion of any retained percentage may be released after the project is open to all through traffic or the work has been essentially completed. Prior to release of any retained percentage the contractor shall file with the Commission:

(a) An affidavit, on the form prescribed by the Commission, 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 which may be required by the contract.

109.9.2.1 If said affidavit that claims have been paid cannot be given because of a dispute as to the amount or legality of a claim and if the contractor's affidavit clearly sets out the facts as to:

(a) The name and address of the unpaid claimant or claimants.

(b) The amount of the disputed claim.

(c) A brief statement of the cause of the dispute, the engineer, with the consent of the surety, may consent to and make payment of all of the final amounts and percentage due the contractor if 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 and if the engineer is further satisfied that there is good and sufficient bond to fully protect said claimant.

Amend Sec 109.9 to include the following: ***04/02***

109.9.3 If said affidavit 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 and percentage 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.

Delete Sec 109.10 and substitute the following: ***07/02***

109.10 Assignments. Neither the contract, nor any duties or obligations or rights of the contractor or its 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 Commission absent the express written consent of the surety and the Commission and upon a written request and compliance with such requirements as the engineer or Commission may provide.

Delete Sec 109.12 and substitute the following: ***04/01***

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 its

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 Commission 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 which increase the cost of the contract.

Amend Sec 109 to include the following: ***01/00; 07/01***

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 Commission, 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 subcontract 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 estimate applicable to that payment.

(b) The amount of any material allowance under Sec 109.7.2.

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

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 thirty days of the satisfactory completion of the subcontractor's work or services or a supplier's final delivery of material 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 material as not conforming to the contract or such areas or items of work or material are deemed not suitable for payment.

(b) Unsatisfactory job progress.

(c) Defective construction work or material 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 107.13.2.4.

(g) Substantial evidence of the subcontractor or supplier’s failure to make timely payments for labor, equipment or material; 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 107.13.2.4.

(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.

Amend Sec 109 to include the following: ***10/00; 10/01***

109.14 Fixed Cost Items. The following fixed prices shall be used when referenced in the specifications:

Sec	Item #	Item of Work	Unit	Fixed Price
201.4.3	201-30.00	Clearing and Grubbing	Ac	$3500.00
	201-30.10	Clearing and Grubbing	Ha	$8500.00
203.7.3	≤ 500 Cu Yd (380 Cu m)			
	203-20.00	Class C Excavation	Cu Yd	$15.00
	203-20.05	Class C Excavation	Cu m	$19.60
	203-30.00	Sandstone Excavation	Cu Yd	$15.00
	203-30.05	Sandstone Excavation	Cu m	$19.60
	> 500 Cu Yd (380 Cu m) but < 2,000 Cu Yd (1,530 Cu m)			
	203-20.00	Class C Excavation	Cu Yd	$10.00
	203-20.05	Class C Excavation	Cu m	$13.10
	203-30.00	Sandstone Excavation	Cu Yd	$10.00
	203-30.05	Sandstone Excavation	Cu m	$13.10
	≥ 2,000 Cu Yd (1,530 Cu m)			
	203-20.00	Class C Excavation	Cu Yd	$8.00
	203-20.05	Class C Excavation	Cu m	$10.50
	203-30.00	Sandstone Excavation	Cu Yd	$8.00
	203-30.05	Sandstone Excavation	Cu m	$10.50
203.7.4	≤ 500 Cu Yd (380 Cu m)			
	203-40.00	Igneous Rock Excavation	Cu Yd	$18.00
	203-40.05	Igneous Rock Excavation	Cu m	$23.50
	> 500 Cu Yd (380 Cu m) but < 2,000 Cu Yd (1,530 Cu m)			
	203-40.00	Igneous Rock Excavation	Cu Yd	$15.00
	203-40.05	Igneous Rock Excavation	Cu m	$19.60
	≥ 2,000 Cu Yd (1,530 Cu m)			
	203-40.00	Igneous Rock Excavation	Cu Yd	$11.00
	203-40.05	Igneous Rock Excavation	Cu m	$14.40
206.6.2	206-36.00	Supplemental Foundation Test Holes	Ft	$6.00
	206-36.05	Supplemental Foundation Test Holes	m	$19.70
206.6.3.1	206-10.03	Class 1 Excavation in Rock	Cu Yd	$100.00
	206-10.07	Class 1 Excavation in Rock	Cu m	$130.00
206.6.3.2	206-20.03	Class 2 Excavation in Rock	Cu Yd	$150.00
	206-20.07	Class 2 Excavation in Rock	Cu m	$195.00
206.6.3.3	206-31.00	Class 3 Excavation in Rock	Cu Yd	$65.00
	206-32.00	Class 3 Excavation in Rock	Cu m	$85.00
301.15	301-05.00	Sample of Compacted Plant Mix Bituminous Base	Each	$75.00
303.5.1.2	303-06.00	Furnishing Rock Base Material	Sq Yd	$6.00
	303-06.05	Furnishing Rock Base Material	Sq m	$7.20
306.5	306-10.10	Modified Subgrade	Sq Yd	$1.00
	306-10.20	Modified Subgrade	Sq m	$1.20
401.15	Sec 620	Traffic Striping	Lane Mile	$250.00
	Bid Items	Traffic Striping	Lane km	$155.00
401.17	401-05.00	Sample of Compacted Plant Mix Bituminous Pavement	Each	$75.00

Sec	Item #	Item of Work	Unit	Fixed Price
403.24.2	403-05.00	Sample of Compacted Asphaltic Concrete Pavement	Each	$75.00
407.6.1	407-05.00	Sanding Aggregate for Tack Coat	Ton	$8.00
	407-05.01	Sanding Aggregate for Tack Coat	Mg	$8.80
611.15.1.2	611-10.10	Furnishing Rock Fill	Cu Yd	$15.00
	611-10.15	Furnishing Rock Fill	Cu m	$19.60
703.5.2	Concrete Fill > 2 Cu Yd (2 Cu m)			
	703-20.02	Class B Concrete (Misc)	Cu Yd	$200.00
	703-20.13	Class B Concrete (Misc)	Cu m	$250.00
	Concrete Fill < 2 Cu Yd (2 Cu m)			
	703-20.02	Class B Concrete (Misc)	Cu Yd	$500.00
	703-20.13	Class B Concrete (Misc)	Cu m	$650.00
729.4.1	729-00.12	Placing 12" State-owned Pipe	LF	$5.00
	729-00.15	Placing 15" State-owned Pipe	LF	$6.00
	729-00.18	Placing 18" State-owned Pipe	LF	$7.00
	729-00.21	Placing 21" State-owned Pipe	LF	$8.00
	729-00.24	Placing 24" State-owned Pipe	LF	$9.00
	729-00.27	Placing 27" State-owned Pipe	LF	$10.00
	729-00.30	Placing 30" State-owned Pipe	LF	$11.00
	729-00.33	Placing 33" State-owned Pipe	LF	$12.00
	729-00.36	Placing 36" State-owned Pipe	LF	$13.00
	729-00.42	Placing 42" State-owned Pipe	LF	$15.00
	729-00.48	Placing 48" State-owned Pipe	LF	$17.00
	729.00.54	Placing 54” State-owned Pipe	LF	$19.00
	729-00.60	Placing 60" State-owned Pipe	LF	$21.00
	729-00.66	Placing 66" State-owned Pipe	LF	$23.00
	729-00.72	Placing 72" State-owned Pipe	LF	$25.00
	729-00.78	Placing 78" State-owned Pipe	LF	$27.00
	729-00.84	Placing 84" State-owned Pipe	LF	$29.00
	729-00.90	Placing 90" State-owned Pipe	LF	$31.00
	729-00.96	Placing 96" State-owned Pipe	LF	$33.00
	729-01.02	Placing 102" State-owned Pipe	LF	$35.00
	729-01.08	Placing 108" State-owned Pipe	LF	$37.00
729.4.1	729-01.12	Placing 300 mm State-owned Pipe	m	$16.40
	729-01.15	Placing 375 mm State-owned Pipe	m	$19.70
	729-01.18	Placing 450 mm State-owned Pipe	m	$23.00
	729-01.21	Placing 525 mm State-owned Pipe	m	$26.30
	729-01.24	Placing 600 mm State-owned Pipe	m	$29.60
	729-01.27	Placing 675 mm State-owned Pipe	m	$32.90
	729-01.30	Placing 750 mm State-owned Pipe	m	$36.20
	729-01.33	Placing 825 mm State-owned Pipe	m	$39.50
	729-01.36	Placing 900 mm State-owned Pipe	m	$42.80
	729-01.42	Placing 1050 mm State-owned Pipe	m	$49.40
	729-01.48	Placing 1200 mm State-owned Pipe	m	$56.00
	729-01.54	Placing 1350 mm State-owned Pipe	m	$62.60
	729-01.60	Placing 1500 mm State-owned Pipe	m	$69.20
	729-01.66	Placing 1650 mm State-owned Pipe	m	$75.80
	729-01.72	Placing 1800 mm State-owned Pipe	m	$82.40
	729-01.78	Placing 1950 mm State-owned Pipe	m	$89.00
	729-01.84	Placing 2100 mm State-owned Pipe	m	$95.60
	729-01.90	Placing 2250 mm State-owned Pipe	m	$102.20

Sec	Item #	Item of Work	Unit	Fixed Price
	729-01.96	Placing 2400 mm State-owned Pipe	m	$108.80
	729-02.02	Placing 2550 mm State-owned Pipe	m	$115.40
	729-02.08	Placing 2700 mm State-owned Pipe	m	$122.00

SECTION 201 – CLEARING AND GRUBBING

Delete Sec 201 and substitute the following: ***10/01; 04/02***

SECTION 201

CLEARING AND GRUBBING

201.1 Description. This work shall consist of clearing, grubbing, removing and disposing of items, debris and other objectionable matter from within the limits of right of way and easement areas, except vegetation designated to remain or to be selectively treated.

201.2 Construction Requirements.

201.2.1 General. The engineer will be responsible for establishing right of way lines and construction limits and designating all trees, shrubs, plants and other objects that are 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.

201.2.2 Clearing and Grubbing. Unless otherwise specified in the contract documents, the entire length of the project shall be cleared and grubbed to the limits and requirements specified. Clearing and grubbing shall include removal of all trees, stumps, roots and any objectionable matter resting on or protruding through the surface of the original ground, except for those items designated to remain.

201.2.2.1 Clearing. The area for clearing shall be within the following limits:

(a) Highway construction areas on the right of way or its easements, including structures, frontage roads, streets, ramps, approaches, ditches, channels and all other access roads, connections and incidental items that are to be constructed. These areas shall extend 10 feet (3 m) outside of construction lines or to the right of way limits if less than 10 feet (3 m).

(b) Material sites within the right of way or its easements.

(c) Areas enclosed by interchange loops and ramps.

(d) Site distance areas for intersecting routes.

201.2.2.2 Limits of Grubbing. Within the limits of the cut areas, grubbing shall be performed to a minimum depth of 18 inches (450 mm) below the finished earth grade of roadways, ditches, channels, borrows and structures. The areas below the natural ground surface, except in embankment areas where the finished earth subgrade elevation is 4 feet (1.2 m) or more above the natural ground, 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 (150 mm) above the ground line may remain, provided they are a minimum of 4 feet (1.2 m) 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.

201.2.2.3 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 (75 mm) above the ground. Low hanging, unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed by the engineer.

201.2.2.4 Tree Clearing Time Restriction. In counties north of the Missouri River, the contractor shall not clear trees which are considered suitable roosts for Indiana bats between April 1 and September 30, except as approved by the engineer. When clearing operations must be conducted during this restricted time period, the contractor shall notify the engineer at least 14 days prior to conducting the clearing so arrangements can be made to inspect each suitable tree to ensure Indiana bats are not present. Standing dead trees with loose or peeling bark and living shagbark hickories are considered suitable roosts when the trees are greater than 9 inches (225 mm) in diameter at 4 feet (1.2 m) above the ground.

201.2.3 Scalping. The contractor shall scalp all areas where excavation or embankment is to be performed, except mowed or burned over sod may remain where the embankment to be constructed is at least 4 feet (1.2 m) above natural ground. Scalping shall include the removal of surface material such as sod, grass, residue of agricultural crops, sawdust and any other vegetative matter without removing more earth than is necessary.

201.2.4 National Forest Land. Before beginning work on a highway to be constructed over national forest land, the contractor shall obtain information from the forest ranger in charge as to the rules and regulations covering construction procedures. The contractor shall cut all merchantable timber into standard log lengths of 12 feet (3.7 m) or more, clean it of all twigs, limbs and tops, and pile the logs as directed by the engineer. Merchantable timber will be considered any timber from which saw logs, pulpwood, posts, poles, ties or cordwood can be made. A burning permit shall be secured from the forest ranger in charge and the ranger shall be notified by the contractor before any fires are set. A zone extending 100 feet (30 m) each side from the centerline of the highway is considered to be a scenic zone and no area beyond construction limits shall be marred or defaced by the contractor's equipment or construction procedures.

201.2.5 Removal and Disposal of Material. The contractor shall dispose of all trees, stumps, brush, roots and all other objectionable matter removed in the clearing and grubbing process. Removal and disposal of all material shall be done in accordance with applicable laws, ordinances, rules and regulations.

201.2.5.1 Open burning in incorporated areas will be allowed only under a permit or waiver from MDNR. Open burning of tree trunks, tree limbs, and natural vegetation from clearing operations is allowable in outstate areas as defined in MDNR regulations. 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 107.1. A person 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 fire fighting methods may be allowable after coordination with MDNR or local fire departments, and shall be in strict accordance with National Fire Protection Association (NFPA) standards.

201.2.5.2 Burial of stumps and debris will not be permitted on the right of way. Products of clearing and grubbing may be removed from the right of way and disposed out of sight from the roadway provided there is no discrepancy with governing regulations for the wasted material. An acceptable written agreement with the property owner shall be submitted by the contractor prior to the disposal of material on that property.

201.2.5.3 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 neatly and uniformly deposited on the right of way in a manner that no drainage will be blocked.

201.2.5.4 Except in national forest areas, all timber that has not been removed from the right of way prior to construction and is not designated to remain shall become the property of the contractor.

201.2.6 The contractor shall scalp all areas where excavation or embankment is to be made, except that mowed or burned over sod need not be removed where the embankment to be constructed is 4 feet (1.2 m) high or more. Scalping shall include the removal of material such as sod, grass, residue of agricultural crops, sawdust and decayed vegetative 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 neatly and uniformly deposited on the right of way in such manner that no drainage will be blocked.

201.2.7 Tree Clearing Time Restriction. In counties north of the Missouri River, the contractor shall not clear trees which are considered suitable roosts for Indiana bats between April 1 and September 30, except as approved by the engineer. When clearing operations must be conducted during this restricted time period, the contractor shall notify the engineer at least 14 days prior to conducting the clearing so arrangements can be made to inspect each suitable tree to ensure Indiana bats are not present. Standing dead trees with loose or peeling bark and living shagbark hickories are considered suitable roosts when the trees are greater than 9 inches (225 mm) in diameter at 4 feet (1.2 m) above the ground.

201.3 Method of Measurement. The work provided herein will not be measured for payment, but will be considered a lump sum unit. 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 203.6.1, 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.

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 (0.05 hectare). An acre (hectare) will consist of 87.12 (160) units, each unit being a rectangular area 50 feet (12.5 m) long and 10 feet (5 m) wide.

201.3.2 The total area of the right of way, except that part secured for channel changes, inlet or outlet easements and borrow areas will be laid out in units beginning at the centerline of the highway with corners at whole or half stations and extending outward until all of the right of way has been included. The total area of the right of way secured for channel changes, inlet or outlet easements, or borrow areas will be laid out in units in the same manner from longitudinal base lines run or designated for these areas.

201.3.3 Clearing and grubbing will be considered as one item. If either clearing or grubbing is required for a unit, the entire unit will be counted for measurement. Areas of mowing or scalping, small trees or brush 5 feet (1.5 m) high or less, and all weeds, cornstalks and similar vegetation regardless of height, and the trimming of branches on trees and shrubs designated to remain, will not be measured and will be considered incidental to other required work. Only stumps 3 inches (75 mm) or more in diameter and 6 inches (150 mm) or more above the ground surface in areas where grubbing is required will be considered in the measurement of grubbing.

201.3.4 If any clearing or grubbing is performed within any unit, the entire area of that unit, except in the case of overlaps, will be included in the measurement. If individual trees or stumps cause the overlapping of units as laid out, only one unit of clearing and grubbing, as applicable, will be allowed. If a fractional unit occurs as a result of measurement or of overlap, the fractional unit will be counted as one unit. If the boundary line of any unit intersects a single tree or stump, counting of another applicable unit will not be made if there is any clearing and grubbing to be paid for in the adjacent unit.

201.4 Basis of Payment.

201.4.1 Clearing and grubbing will be paid for at the contract lump sum price and will be considered full compensation for all labor, material and equipment to perform the described work.

201.4.2 If a lump sum unit 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 shall be considered incidental to the contract and additional compensation will not be made.

201.4.3 If clearing and grubbing is required outside the initial contract work payment for that clearing and grubbing will be made per acre (hectare) at the fixed unit price specified in Sec 109.14.

SECTION 202 – REMOVALS

Delete Sec 202 and substitute the following: ***04/02***

SECTION 202

REMOVALS

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

202.2 Conformance Requirements. All work shall be performed in accordance with Sec 107.1 including the laws, regulations, and ordinances of the EPA, the Occupational Safety and Health Administration (OSHA), MDNR and local agencies.

202.3 Schedule. The contractor shall submit a plan and schedule for demolition and removal of any designated improvements, asbestos containing material (ACM), buildings, contaminated materials, and 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. The contractor shall complete all demolition, removal and disposal of residential buildings, other than ACM removal, within 7 days after starting work on the building.

202.4 General Requirements.

202.4.1 Disposal of Material. All improvements not designated to remain shall be removed or disposed of by the contractor as required. Regulated solid waste, including waste tires, shall be handled, transported and disposed of properly. Documentary proof of proper transport and disposal of this waste including scale tickets, cancelled checks or receipts shall be forwarded to MDNR and the engineer prior to acceptance of the work. Material designated for use elsewhere shall not be removed from the project. Open burning of material shall be conducted in accordance with Sec 201.2.5.1. Uncontaminated underground storage facilities not requiring removal shall be dewatered, filled with sand or grout to within one foot (300 mm) of the top of the facility, and crushed.

202.4.2 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, be repaired or replaced in a manner satisfactory to the engineer and in accordance with Sec 107.12.

202.4.3 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.

202.4.4 Salvage. All material designated in the contract to be salvaged for Commission use from existing structures or improvements shall be removed, without damage in sections that may be readily handled or transported and stored as approved by the engineer. Unless otherwise designated in the contract, coldmilled material and guardrail material shall remain the property of the Commission and stockpiled as specified in the contract or as directed by the engineer. All buildings, material and equipment of any description not designated for salvage by the Commission 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 be used by the contractor as a sales yard.

202.4.5 Removal Requirements. In removing pavement, curb, gutter, sidewalk and other similar improvements, and where a portion of such improvements are to be left in place, they shall be removed to an existing joint or to a joint sawed to a minimum depth of one inch (25 mm) 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 limits shown on the plans.

202.4.5.1 Removal and disposal of abandoned fences and mailboxes will be considered as included in final clean up of the right of way or parcel, and no direct payment will be made for such work.

202.4.5.2 Removal of concrete or bituminous material will consist of breaking up and disposal of the material in areas furnished at the contractor's expense, within a basement excavation where approved backfill material over 24 inches (600 mm) deep is to be placed over such broken material, or within embankments where new embankment over 24 inches (600 mm) 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 (0.4 m^2). At locations shown on the plans where piling is to be driven, existing pavements, 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 (300 mm) 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.

202.4.5.3 The contractor shall remove slabs on grade more than six inches (150 mm) higher than existing street or alley grades or surrounding low grades. All other above-ground 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 and floors, and any other incidental masonry construction prior to backfilling. All material from such removals shall be disposed of as directed by the engineer.

202.4.5.4 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.

202.4.5.5 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 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 (2:1) or flatter, sloping downward from the top of the wall or structure.

202.4.6 Sewers and Drains. All sewers, drainage pipes and floor drains which have been or are to be abandoned shall be permanently sealed at the ends with a minimum 8-inch (200 mm) thick bulkhead constructed of Class B concrete, a commercial mix concrete meeting the requirements of Sec 501.14 or brick masonry. The use of salvaged brick will be permitted for constructing bulkheads provided the brick is clean and sound. No direct payment will be made for sealing abandoned sewers, drainage pipes or floor drains.

202.4.7 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, smooth and finish disturbed areas. Backfilling shall be performed in accordance with applicable portions of Sec 203 and compacted in accordance with Sec 203.4 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.

202.4.7.1 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 (1:2). Broken masonry resulting from demolition of buildings or other improvements on the parcel may be used for backfill, but in no case shall broken masonry extend closer than 12 inches (300 mm) to the finished surface. In the event there is insufficient material in the immediate vicinity, the contractor shall be responsible for providing material at the contractor's expense, from a source obtained by the contractor and approved by the engineer in accordance with Sec 106.

202.4.7.2 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.

202.4.8 Hazardous Materials. The contractor may encounter small quantities of hazardous materials as defined by MDNR and similar items during demolition and removal operations. Materials that may be encountered include, but are not limited to the following:

(a) Used motor oil
(b) Pesticides
(c) Cleaning supplies and solvents
(d) Painting supplies and solvents
(e) Chromated Copper Arsenate (CCA), creosote, or pentachlorophenol treated lumber
(f) Polychlorinated Biphenyl (PCB)-containing light ballast
(g) Mercury-containing fluorescent lights
(h) Mercury-containing thermostats

202.4.8.1 The contractor shall remove and dispose of small quantities of hazardous material and similar items properly. No direct payment will be made for removal and disposal of small quantities of hazardous material.

202.4.8.2 In the event the contractor encounters what is reasonably suspected to be some other hazardous material or large quantities of hazardous materials, 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. Any additional work required for hazardous material abatement shall be handled in accordance with the contract requirements.

SECTION 202.10 REMOVAL OF BRIDGES

202.11 Description. This work shall consist of the removal and disposal of existing bridge structures as shown on the plans.

202.12 Removal Requirements.

202.12.1 The entire structure, including all substructure units, shall be removed to an elevation 2 feet (600 mm) below the finished ground line or streambed.

202.12.2 Existing structures used for handling temporary traffic shall not be removed until the replacement structures are open to traffic.

202.12.3 Any portion of an existing structure below the ground line that interferes with the construction of new structures shall be removed and will be paid for as removal of bridges.

202.13 Basis of Payment. Removal and disposal of bridges will be paid for at the contract lump sum price.

SECTION 202.20 REMOVAL OF IMPROVEMENTS FOR ROADWAY CONTRACTS

202.21 Description. This work shall consist of the removal and disposal of all existing improvements for roadway contracts, except those items designated to remain or to be removed under other items of work, from the right of way and within the limits of any construction easement outside the right of way.

202.21.1 Removal of improvements shall include removing all drainage structures, pavements, surfacing and base courses, curb, gutter, sidewalks and house walks, steps, retaining walls, foundation walls, columns, footings, concrete floors, cisterns, catch basins, uncontaminated storage tanks, manholes, drainage and sewer pipes, water and gas main pipes, signs, fences, scattered or piled bricks, stones, broken masonry, rubbish, debris, etc., from existing improvements.

202.21.2 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 the extent of the work to be performed under this item.

202.22 Method of Measurement. This work will not be measured for payment, but will be considered a lump sum unit. The work will include the removal of all items, regardless of whether they are shown on the plans or encountered during construction, unless the improvement encountered is considered a differing site condition in accordance with Sec 104.2. No deductions will be made from the volumes measured for payment of excavation where existing improvements are removed from within the limits of the sections measured for determining pay volumes of excavation.

202.23 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.

SECTION 202.30 REMOVAL OF IMPROVEMENTS FOR DEMOLITION AND REMOVAL CONTRACTS

202.31 Description. This work shall consist of the removal and disposal of all existing improvements on each parcel in the demolition and removal contracts, except those items designated to remain in place or to be removed under other items of work, from the right of way and within the limits of any construction easement outside the right of way.

202.31.1 Removal of improvements shall include all elevated sidewalks, steps, retaining walls, basement and foundation walls, columns, footings, concrete floors, cisterns, catch basins, uncontaminated storage tanks, manholes, signs, fences, scattered or piled bricks, stones, broken masonry, rubbish, debris, etc.

202.31.2 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.

202.32 Method of Measurement. This work will not be measured for payment, but will be considered a lump sum unit per parcel.

202.33 Basis of Payment. Payment for removal of improvements will be made at the contract lump sum unit price per parcel and will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 202.40 REMOVAL OF ASBESTOS-CONTAINING MATERIAL (ACM)

202.41 Description. This work shall consist of removal, transportation and disposal of asbestos- containing material (ACM) in buildings scheduled for demolition or removal.

202.42 Removal Requirements.

202.42.1 General. Unless designated otherwise, the Commission will test all buildings or structures for ACM that obstruct the construction of the roadway or are within the limits of the right of way. If ACM is determined to exist in the building or structure, the ACM shall be removed and disposed of by the contractor accordance with the contract documents.

202.42.2 Asbestos Identification and Testing. All buildings scheduled for demolition or removal will be inspected for the presence of friable ACM, Category II nonfriable ACM and Category I nonfriable ACM. Suspect material will be sampled and tested. The results of the testing for friable and nonfriable ACM requiring removal will be made available to the contractor and included within the contract documents. For those buildings with unknown quantities at the time of award, results of testing for friable and nonfriable ACM requiring removal will be provided with the notice to remove.

202.42.3 Licensing and Permits. The contractor performing friable asbestos abatement as required by 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 required by local, state, or federal agencies.

202.42.4 Notification and Reporting. The contractor shall provide all information regarding the asbestos abatement project 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 authorizations 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 commencing work on the project.

202.42.5 On-Site Supervisor. The contractor shall provide a trained supervisor as required by EPA regulations. The contractor shall provide evidence of the supervisor's training to the engineer before any work commences. The supervisor shall remain on-site during all asbestos removal work.

202.42.6 Safety Rules. The contractor shall be responsible for enforcement of the safety rules for employees and any person(s) authorized for entry into the work area. The engineer and the engineer's representatives will have a right of entry to the work area and will comply with the contractor's safety rules.

202.42.7 Disconnection of Utility Service. In the event that utility service lines are disconnected, destroyed or otherwise impaired and needed for this work, the contractor, at the contractor's expense, shall provide adequate substitute utility service in place of those affected.

202.42.8 Scope of Work. The contractor shall remove, transfer and dispose of regulated asbestos containing material (RACM) and Category I nonfriable ACM (floor tile and sheeting on concrete) specified in the contract. RACM is defined as:

(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.

202.42.9 Unidentified Asbestos. If the contractor encounters suspect ACM not previously identified in the contract documents, the contractor shall immediately notify the engineer in accordance with the contract requirements. The engineer will have the suspect materials sampled and tested, and the contractor shall not remove the additional suspect ACM until directed by the engineer.

202.42.10 No Salvage Permitted. This work shall be limited to asbestos removal. No salvage will be permitted. Removal of pipes, ducts or other items as units will be permitted only if determined necessary for asbestos removal.

202.42.11 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 the 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) Completion of Asbestos Removal. 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 is less than or equal to 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 is less than or equal to required levels.

(b) Third Party Air Monitoring. 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 no interruption to any other party.

202.42.12 Removal and Disposal. All RACM and Category I nonfriable ACM shall be disposed of within 7 days of removal from the building or structure. All ACM shall be disposed of properly.

202.42.12.1 The contractor shall identify or mark hauling vehicles used to transport asbestos waste during loading, transporting and unloading as required by 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 which shall be completely covered with 2 layers of 6-mil (0.15 mm) thick plastic sheeting or equivalent covering while the waste is being transported.

202.42.12.2 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.

202.43 Method of Measurement. Final measurement of removal for ACM will be made to the nearest square foot (0.1 square meter) or linear foot (0.5 meter) based on the asbestos survey test report.

202.44 Basis of Payment. Payment for removal of ACM will be made for field-measured quantities as approved by the engineer at the contract unit price per square foot (0.10 square meter) or linear foot (0.5 meter). Payment will be considered full compensation for all labor, equipment and material to complete the described work. If additional suspect material tested positive for the presence of asbestos, payment will be made per the contact unit price.

SECTION 202.50 DEMOLITION AND REMOVAL OF BUILDINGS

202.51 Description. This work shall consist of demolition, removal and disposal of all existing buildings from the right of way or within the limits of any construction easement outside the right of way as indicated on the plans. Removal of buildings shall include all attached structures, existing rubbish, trash and junk in and adjacent to the building on each parcel.

202.52 Demolition and Removal Requirements.

202.52.1 General. No building or substantial portion thereof shall be removed intact by the contractor or assignees, except as provided under Sec 202.52.9. 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.

202.52.2 Backfilling. Backfilling operations for residential basements shall be completed within 4 days after residential buildings are removed. Backfilling operations for commercial basements shall be completed within 14 days after commercial buildings are removed, and in accordance with the demolition and removal work schedule required in Sec 202.3.

202.52.3 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.

202.52.4 Removal of Asbestos Containing Material. All buildings specified for demolition and removal have been or will be tested for ACM. All RACM as defined in Sec 202.42.8 shall be removed from the buildings prior to demolition. 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 the 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 no direct payment will be made.

202.52.5 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.

202.52.6 Rodent and Pest Extermination. Before beginning demolition for each parcel, the contractor shall exterminate rodents and pests. Extermination shall be performed by an experienced exterminator in accordance with Sec 202.2. In the absence of local regulations, extermination shall be performed as directed by the engineer.

202.52.7 Barricades. Before starting demolition for each parcel, the contractor shall provide adequate barricades or fences adjacent to buildings to be demolished to protect the public and workers from operating equipment, falling debris and to block access to any situation that constitutes a hazard to the public. Barricades shall be of uniform height and color and constructed of the same material at each site. Fences shall be 12.5-gauge (2.5 mm) wire field fencing with 6-inch (150 mm) stays on posts adequately embedded in the ground to keep the fence in place, or an equivalent acceptable to the engineer. Fences and barricades shall be at least 47 inches (1195 mm) high and shall be placed as approved by the engineer.

202.52.8 Salvage. All RACM and Category I nonfriable material on concrete shall be removed from the buildings prior to salvage. Testing of buildings will be limited to ACM. Buildings have not been tested for other substances; therefore, the Commission will not make any representation that the buildings are hazard-free.

202.52.9 Building Removal. Removal of buildings shall include all attached structures. 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 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 approval from the city or other authority having jurisdiction over the area involved in the total move by issuance of the proper permits. The engineer will not grant a moving permit for moving a building or portion thereof exceeding statutory dimensions on a state route.

(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 overdimension permit from the Commission. 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.

(e) The contractor shall remove all components of the building to the foundation level, including those components suspended from the main level sub-floor structure. The primary components of the building shall be removed intact as a whole structure. The contractor will not be paid for ACM removal unless required from the disturbance of the foundation or on the remaining foundation components after building removal, as determined by the engineer.

202.52.10 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.

202.52.10.1 Where joint or party walls exist between two buildings which are not being demolished at the same time, the part of wall or walls which serve both buildings shall be removed with the demolition of the last structure. Demolition of that part of the building that is to be demolished first, where it adjoins the joint or party wall, shall be done with extreme care such that no demolition work shall damage or weaken the wall or portion of wall which serves both buildings.

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

202.52.11 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.

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

202.52.13 Cooling Systems. Buildings to be demolished may have various cooling systems that contain freon or other refrigerants. The contractor shall verify the type of refrigerant present in each system and properly recover the refrigerant prior to salvage or demolition of the cooling systems. No direct payment will be made for recovering refrigerant.

202.53 Method of Measurement. Measurement for demolition and removal of buildings will be considered a lump sum unit per parcel.

202.54 Basis of Payment. Payment for demolition and removal of buildings will be made at the contract lump sum unit price per parcel and will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 202.60 REMOVAL OF CONTAMINATED MATERIAL AND STORAGE TANKS

202.61 Description. This work shall consist of the removal and disposal 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.

202.62 Removal Requirements.

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

202.62.2 Conformance Requirements. Work shall be performed in accordance with Sec 202.2, industry recommended practices, including the American Petroleum Institute (API) Recommended Practices, and MDNR Underground Storage Tanks Closure Guidance (Closure Guidance).

202.62.3 Groundwater Monitoring Wells. The contractor shall protect all existing groundwater monitoring wells located within the area of the underground storage tank(s) from damage and contamination, except for wells in an area of contaminated soil removal.

202.62.4 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% of the lower explosive limit, flammable vapors shall be removed in accordance with methods outlined by API Recommended Practices until the 20% 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.

202.62.5 Tank Dewatering and Removal. The contractor shall notify the engineer prior to the dewatering and removal of storage tanks.

202.62.6 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. The 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.

202.62.7 Tank Pit Surface Water. The 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.

202.62.8 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 as 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.

202.62.9 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.

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

202.62.11 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. No direct payment will be made for disposal of water removed from the excavated area.

202.62.12 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 to comply with the Closure Guidance.

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

202.62.13 Backfill. The contractor shall not begin backfill operations until directed by the engineer.

202.62.14 Closure Report. The contractor shall provide copies of all necessary documentation for tank cleaning and disposal, soil disposal, 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 be responsible for the preparation of the underground storage tank closure report meeting the requirements identified in the Closure Guidance.

202.63 Method of Measurement. Measurement of tank removal and disposal will be made per each; residual hazardous material removal and disposal, measured per gallon (liter); tank pit surface water removal and disposal, measured per 10 gallons (50 L); and hauling and disposal of contaminated soil, measured per ton (Megagram) based on landfill weight tickets. Measurement of excavation and backfill will be made to the nearest cubic yard (cubic

meter), 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.

202.64 Basis of Payment.

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

202.64.2 The accepted quantity of hazardous residual material will be paid for at the contract unit price per gallon (liter). Payment includes the 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.

202.64.3 The accepted quantity of tank pit surface water and groundwater removal and disposal will be paid for at the contract unit price per 10 gallons (50 L). Payment includes sampling and analysis, transportation, disposal fees, and processing of approvals.

202.64.4 The accepted quantity for excavation of contaminated soil will be paid for at the contract unit price per cubic yard (cubic meter).

202.64.5 The accepted quantity for hauling of contaminated soil will be paid for at the contract unit price per ton (Megagram) based on landfill weight tickets. Payment includes removal from the site and transportation for treatment or disposal.

202.64.6 The accepted quantity for disposal of contaminated soil will be paid for at the contract unit price per ton (Megagram) based on landfill weight tickets. Payment includes all landfill fees and processing of landfill approvals.

202.64.7 The accepted quantity for backfill will be paid for at the contract unit price per cubic yard (cubic meter), and includes material, transportation and compaction.

202.64.8 Payment made for each of the items in the contract will be considered as full compensation for all labor, equipment and material to complete the described work.

SECTION 202.70 PLUGGING AND CLOSURE OF WELLS

202.70.1 Description. This work shall consist of plugging and closure of wells as shown on the plans or as directed by the engineer.

202.70.2 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 installation. Abandonment procedure for wells shall be in accordance with requirements set forth in specific MDNR regulations for monitoring wells, heat pump wells, test holes or all other wells as applicable.

202.70.3 Method of Measurement. Measurement of well plugging and closure will be made per each.

202.70.4 Basis of Payment. The accepted quantity of plugged and closed wells will be paid for at the contract unit price per each. Payment includes all labor, equipment and material for plugging and closure and the costs and fees associated with closed well registration. A copy of the completed registration shall be furnished to the engineer.

SECTION 202.80 SEPTIC TANK PLUGGING AND DISPOSAL

202.80.1 Description. This work shall consist of plugging and disposing of septic tanks as shown in the plans or as directed by the engineer.

202.80.2 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. 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 clean fill, such as coarse gravel or rock, agricultural lime, or sand to a depth of 2 feet (600 mm) below the existing ground surface. The top 2 feet (600 mm) shall be backfilled with soil from the parcel and compacted in 6-inch (150 mm) layers to the approximate density of the adjacent soil. In the event there is insufficient material in the immediate vicinity, the contractor shall be responsible for providing material meeting the approval of the engineer at the contractor's expense. All material pumped from the septic tank shall be properly disposed of at a permitted sewage treatment facility or other location approved by the engineer.

202.80.3 Method of Measurement. Measurement of plugging and disposing of septic tanks will be made per each.

202.80.4 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 203 – ROADWAY AND DRAINAGE EXCAVATION, EMBANKMENT AND COMPACTION

Delete Secs 203.2.3 through 202.2.3.3 ***04/02***

Renumber Secs 203.2.4 - 203.2.18, including subsections, to Secs 203.2.3 - 203.2.17 ***04/02***

Delete Sec 203.2.5 and substitute the following: ***01/01***

203.2.5 Excavating in Rock. Excavating and undergrading in rock (i.e., material conforming to the description of Class C, Sandstone or Igneous Rock, 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 shall be removed to the limits of undergrading insofar as practicable and in such manner as to leave no undrained pockets in the surface. Care shall be taken to avoid overshooting when blasting. Any loose or shattered rock, overhanging ledges and boulders above the roadbed which might dislodge shall be removed. If 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.

Delete Sec 203.2.5.2 and substitute the following: ***01/00***

203.2.5.2 Undergrading. Regardless of whether the contract includes paving, the final surface of the backfilled undergraded areas shall be of a uniform texture and grade suitable to the engineer for paving. Areas of required undergrading shall be backfilled with one of the following materials with preference in the order given, dependent on availability:

(a) Rock fragments or spalls. The top approximately 2 inches (50 mm) of the rock backfill shall consist of either 2 inch (50 mm) maximum rock fragments or spalls or a 2 inch (50 mm) maximum size granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No. 4 (4.75 mm) sieve. There shall be no exposed rock exceeding the 2 inch (50 mm) size in the final surface that would interfere with the final preparation of the base for paving.

(b) A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No. 4 (4.75 mm) sieve.

(c) A material having a low plasticity index and designated by the engineer as suitable.

Delete Sec 203.2.8 and substitute the following: ***04/01***

203.2.8 If obliteration of existing roadways or temporary construction is designated in the contract to be performed on a roadway excavation basis, such obliteration shall include all operations necessary to fill the ditches and blend the old road with the natural ground to provide a pleasing appearance. Removal of concrete pavement and concrete base course will be paid for in accordance with Sec 202.20. The earthwork for obliteration, including bituminous surfacing, will be included as roadway excavation.

Delete Sec 203.7 and substitute the following: ***04/01***

203.7 Basis of Payment. Payment for roadway and drainage excavation will be made at the contract unit price per cubic yard (cubic meter) which price shall be full compensation for the excavating and hauling; placing and forming of embankments; preparation of subgrade; shouldering, rounding slopes, obliterating existing roadways or temporary construction, finishing of graded earth roadway, picking up and disposing of field stone and other rock; and any work noted on the plans to be included in the contract unit price for excavation. No payment will be made for any material used for purposes other than those designated, except as approved by the engineer.

Delete Secs 203.7.3 and 203.7.4 and substitute the following: ***07/00; 10/00***

203.7.3 If the contract contains a unit price for either Sandstone or Class C Excavation, but not both, it shall apply to the other if both are encountered. If the contract does not contain a unit price for Class C Excavation or Sandstone Excavation and such material is encountered during construction, unless the project is let on an unclassified excavation basis, payment will be made per cubic yard (cubic meter) at the fixed unit price specified in Sec 109.14.

203.7.4 If the contract does not contain a unit price for Igneous Rock Excavation and such material is encountered during construction, unless the project is let on an unclassified excavation basis, payment will be made per cubic yard (cubic meter) at the fixed unit price specified in Sec 109.14.

SECTION 206 – EXCAVATION FOR STRUCTURES

Delete Sec 206.5.2 and substitute the following: ***10/01***

206.5.2 Measurement of Class 3 Excavation will be made to the nearest cubic yard (cubic meter) for each structure of that volume of material actually removed from within the area bounded by vertical planes 18 inches (450 mm) outside of the outer walls of box culverts with bottom slabs or the sides of pipe culverts except as modified for vitrified clay pipe culverts in Sec 726.7.2 and except the volume of headwall and culvert concrete removals included in the contract for direct payment. The upper limits of the volume measured will be the existing ground line, or the lower limits of the roadway excavation, whichever is lower. Class 3 Excavation under embankments and in channel changes will be measured from the original ground surface unless otherwise designated on the plans. For box culverts without bottom slabs, measurement will be made as above except no material below plan flow line will be included which is outside of the area bounded by vertical planes 18 inches (450 mm) each side of and parallel with the neat lines of the walls or footings.

Delete Sec 206.6.2 and substitute the following: ***10/00***

206.6.2 Payment for drilling test holes for foundation tests will be made per foot (meter) of hole drilled at the fixed unit price specified in Sec 109.14 .

Delete Sec 206.6.3 and substitute the following: ***01/00***

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 excavation for structures. 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.

Delete Sec 206.6.3.1 and substitute the following: ***01/00; 10/00***

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 (cubic meter) at the fixed unit price specified in Sec 109.14.

Delete Secs 206.6.3.2 and 206.6.3.3 and substitute the following: ***10/00***

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 (cubic meter) at the fixed unit price specified in Sec 109.14.

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 in Rock is included in the contract, payment for that material will be made per cubic yard (cubic meter) at the fixed unit price specified in Sec 109.14.

SECTION 207 – LINEAR GRADING

Delete Sec 207.2.3 and substitute the following: ***04/01***

207.2.3 If obliteration of existing roadways or temporary construction is designated in the contract to be performed on a linear grading basis, such obliteration shall include all operations necessary to fill the ditches and blend the old road with the natural ground to provide a pleasing appearance. Removal of concrete pavement and concrete base course will be paid for in accordance with Sec 202.20. The earthwork for obliteration, including bituminous surfacing, will be included as linear grading.

Delete Sec 207.2.4 and substitute the following: ***10/00***

207.2.4 Any subgrade upon which a paved surface is to be placed shall be compacted in accordance with Sec 203.4.

Delete Sec 207.3.2 and substitute the following: ***07/00***

207.3.2 If material is encountered that may be classified as other than Class A Excavation as described in Sec 203.1, the limits of Linear Grading will not be underrun but the material classified as other than Class A Excavation will be measured and paid for on a yardage (cubic meter) basis in accordance with Sec 203.7. Where undergrading is necessary, backfilling of the undergraded area will be considered as a part of the linear grading operation.

SECTION 301 – PLANT MIX BITUMINOUS BASE COURSE

Delete Sec 301.5 and substitute the following: ***07/02***

301.5 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 40 F (5 C), (2) on any wet surface or frozen pavement, or (3) when weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method T20.

Delete Sec 301.9 and substitute the following: ***01/00; 01/01***

301.9 The base course, primed surface or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign matter prior to spreading the bituminous mixture. When delivered to the roadbed, the mixture shall be at a temperature which will permit proper placement and compaction. The mixture 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. When placing multiple layers with varying thicknesses, the thicker layer shall be placed first. The compacted thickness of a single layer shall be between 3 and 4 inches (75 and 100 mm), except as follows:

(a) For spot-leveling and leveling course work, the layer thickness may be less.

(b) For base widening, the material may be placed in two layers, provided no individual layer has a compacted thickness greater than 7 inches (175 mm).

Delete Sec 301.9.3 and substitute the following: ***01/01; 07/01***

301.9.3 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 and approved by the engineer. On base widening work, a succeeding layer of bituminous mixture may be placed the same day as the previous layer, if it can be shown that the desired results are being obtained. On small areas, and on areas which are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the engineer.

Amend Sec 301.9 to include the following: ***07/02***

301.9.4 For roadways constructed under traffic, no pavement edge differential shall be left in place for more than seven calendar days, unless approved by the engineer.

Delete Sec 301.15 and substitute the following: ***10/00***

301.15 Basis of Payment. The accepted quantities of plant mix bituminous base course will be paid for at the unit price for each of the pay items included in the contract. Payment for obtaining and delivering samples of compacted mixture from the base and replacement of the surface will be made per sample at the fixed unit price specified in Sec 109.14.

SECTION 303 – ROCK BASE

Delete Sec 303.3.2 and substitute the following: ***04/01***

303.3.2 Rock base shall be 24 inches (600 mm) thick and may be placed in one lift. Rock base material may be placed thicker, in maximum 24-inch (600 mm) lifts, provided a uniform drainage plane under the rock base is provided, however no additional pay will be made for the thicker rock base material. Class C Excavation in rock cuts shall be performed to allow placement of the full specified lift thickness.

Delete Sec 303.3.4 and substitute the following: ***10/00***

303.3.4 Regardless of whether the contract includes paving over the rock base, the final surface shall be of a uniform texture and grade suitable to the engineer for paving. The top approximately 2 inches (50 mm) of the rock base shall consist of either 2-inch (50 mm) maximum rock fragments or spalls, a 2-inch (50 mm) maximum size granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No. 4 (4.75 mm) sieve or a gradation meeting Type 4 or Type 5 aggregate as specified in Sec 1007. There shall be no exposed rock exceeding the 2-inch (50 mm) size in the final surface that would interfere with final preparation of the base for paving.

Delete Sec 303.5.1.2 and substitute the following: ***07/00***

303.5.1.2 If the plans provide for obtaining material from the right of way or other source furnished by the Commission, but all or part of the required quantity of acceptable material is not actually available, payment for such additional rock base material that the contractor is required to furnish and haul will be made per square yard (square meter) in place at the fixed unit price specified in Sec 109.14.

Delete Sec 303.5.2 and substitute the following: ***01/02***

303.5.2 If the plans do not provide for a source of material, the contractor shall provide the material. All costs of securing the source, quarrying, excavating, breaking, processing and hauling the material to the site will be paid for and completely covered by the contract unit price per square yard (square meter) for furnishing and placing rock base.

SECTION 306 – MODIFIED SUBGRADE

Delete Sec 306.5 and substitute the following: ***10/00***

306.5 Basis of Payment. Payment for modified subgrade will be made per square yard (square meter) of modified subgrade at the fixed unit price specified in Sec 109.14, regardless of depth.

SECTION 310 – AGGREGATE SURFACE

Delete Sec 310.5 and substitute the following: ***07/02***

310.5 Basis of Payment. The accepted quantities of aggregate surface will be paid for at the contract unit price. If Type 1 or Type 2 Aggregate for Base is used for this work, payment will be based on plan quantity and unit price for Gravel (A) or Crushed Stone (B) as provided in the contract.

SECTION 401 – PLANT MIX BITUMINUOUS PAVEMENT

Delete Sec 401.3.5.2 and substitute the following: ***07/00***

401.3.5.2 The minimum voids in the mineral aggregate (VMA) shall be as listed below. The engineer may make adjustments in the job-mix formula submitted by the contractor in order that 60 to 80 percent of the VMA are filled with asphalt binder. Approved mixtures, when compacted and tested in the laboratory in accordance with AASHTO T 167 or AASHTO T 245, shall have an air void content within the range listed below, when calculated from a voidless mixture composed of the same material in like proportions.

Delete Sec 401.5 and substitute the following: ***07/02***

401.5 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 50 F (10 C), (2) on any wet surface or frozen pavement, or (3) when weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method T20.

Amend Sec 401.9 to include the following: ***07/02***

401.9.3 For roadways constructed under traffic, no pavement edge differential shall be left in place for more than seven calendar days, unless approved by the engineer.

Delete Sec 401.15 and substitute the following: ***10/00; 07/02***

401.15 Pavement Marking. If the contractor's work has obliterated existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced in accordance with Sec 620.

Delete Sec 401.17 and substitute the following: ***10/00***

401.17 Basis of Payment. The accepted quantities of plant mix bituminous pavement will be paid for at the unit price for each of the pay items included in the contract. Payment for obtaining and delivering samples of compacted mixture from the pavement and replacing the surface will be made per sample at the fixed unit price specified in Sec 109.14.

SECTION 402 – PLANT MIX BITUMINOUS SURFACE LEVELING

Delete Sec 402.5 and substitute the following: ***07/02***

402.5 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 50 F (10 C), (2) on any wet surface or frozen pavement, or (3) when weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method T20.

Amend Sec 402.9 to include the following: ***07/02***

402.9.2 No pavement edge differential shall be left in place for more than seven calendar days, unless approved by the engineer.

SECTION 403 – ASPHALTIC CONCRETE PAVEMENT

Delete Sec 403.13.1 and substitute the following: ***07/02***

403.13.1 Weather Limitations. Asphaltic concrete 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 50 F (10 C) for the surface course or below 40 F (5 C) for subsurface courses, (2) on any wet surface or frozen pavement, or (3) when weather conditions prevent the proper handling or finishing of the mixture. In addition, SMA mixture shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 60 F (15 C). Temperatures shall be obtained in accordance with MoDOT Test Method T20.

Delete Sec 403.15.2 and substitute the following: ***07/02***

403.15.2 The following shall apply for roadways constructed under traffic. For pavements having a width of 16 to 24 feet (5 to 7 m), inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement and the full width completed as soon as practicable. Unless otherwise permitted, a single lane of any course shall not be constructed to a length which cannot be completed to full width of the pavement the succeeding operating day. For pavements greater than 24 feet (7.3 m) wide, single lane width construction shall be limited to one day's production and completion to full width shall be accomplished as soon as practicable. No pavement edge differential shall be left in place for more than seven calendar days, unless approved by the engineer.

Delete Secs 403.20 – 403.20.6.5 and substitute the following: ***10/00; 10/01***

403.20 Surface Test. The surface of each layer shall be substantially free from waves or irregularities. The pavement surface shall be thoroughly tested for smoothness by profilographing or straightedging as indicated. Testing applicable to this specification, except straightedging, shall be performed by the contractor in the presence of the engineer. Profilographing shall be performed on the surface course on all resurfacing work containing leveling course, coldmilling or multiple course construction as an operation to improve the original riding surface prior to placing the new surface and on the surface course of all new construction.

403.20.1 Straightedging. As soon as practical, the engineer will straightedge all segments of the paved surface not profilographed, except medians and similar areas, shoulders adjacent to rigid pavement or resurfaced rigid pavement and temporary bypasses. Any variations exceeding 1/8 inch in 10 feet (3 mm in 3 m) will be marked. Areas more than 1/8 inch (3 mm) high shall be removed as specified in Sec 403.20.6.2. At transverse construction joints, the surface of all other layers shall not vary from the 10-foot (3 m) straightedge by more than 1/4 inch (6 mm).

403.20.2 Profilographing. Profilographing is applicable to the surface of all mainline paving, auxiliary lanes, turning lanes and ramps for projects with a sufficient amount of continuous bituminous pavement. A sufficient amount of continuous bituminous pavement will be such that a project, or combination of projects, consists of more than 0.5 mile (one km) of total profilographable pavement. Profilographing may be waived by the engineer, if staging of the overall project affects the normal paving operation, such as multiple entrance lane gaps, lane staging, etc., or if multiple profilograph exceptions continuously exist eliminating smoothness requirements on a large portion of the same roadway. Upon waiver, all smoothness requirements will revert to Sec 403.20.1.

403.20.2.1 All wheels of the profilograph shall be placed on the new pavement, with stationing based on the center wheel.

403.20.2.2 Profilographing will not be required for the following:

(a) Bridge decks, bridge approach slabs and concrete approach pavements.

(b) Pavement on horizontal curves with centerline radius of curve less than 1000 feet (300 m) and pavement within the superelevation transition of such curves.

(c) Pavement on vertical curves having a "K" value of less than 90 and a length less than 500 feet (150 m).

(d) Pavement in width transitions.

(e) Fifty feet (15 m) in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

(f) Fifty feet (15 m) in direction of travel on each side of intersecting routes with special grade transitions.

(g) Bituminous shoulders.

(h) Any lane which abuts an existing lane not constructed under the same contract.

(i) Interruptions designated by the engineer which provide independently placed sections shorter than 50 feet (15 m). See Sec 403.20.5.12 for interruptions designated by the contractor's operations.

(j) The last 15 feet (5 m) of any section where the prime contractor is not responsible for the adjoining surface.

(k) The first or last 12.5 feet (4 m) of a pavement section adjoining any above exception area.

403.20.3 Equipment. The profilograph shall be a California-type as approved by the engineer. The equipment furnished shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump at the same time. The pavement profile is recorded from the vertical movement of a sensing wheel attached to the frame at mid-point and is in reference to the mean elevation of the 12 points of contact with the road surface established by the support wheels. The profilogram is recorded with a scale of one inch (1 mm) equals one inch (1 mm) vertically and one inch (1 mm) equals 25 feet (300 mm) longitudinally. The profilogram line drawn by the profilograph will be referred to as the profile trace in these specifications.

403.20.4 Calibration. All profilographs used shall be calibrated at least annually on a test section established by MoDOT. The contractor's calibration profile index shall not vary more than 2.0 inches per mile (30 mm/km) from a standard profile index produced by a MoDOT profilograph.

403.20.4.1 Longitudinal calibration consists of pushing the profilograph over a pre-measured test distance and determining the scale factor by dividing the pre-measured test distance by the length of the paper in inches (millimeters). This factor shall be 25, one inch equals 25 feet (300, 25 mm equals 7.622 m). If not, the machine shall be adjusted until the scale factor is 25 (300) plus or minus 0.2 percent.

403.20.4.2 Vertical calibration consists of sliding a pre-measured calibration block, measured to the nearest 0.01 inch (0.25 mm), under the sensing wheel while the profilograph is stationary. The measurement of the vertical trace line from the base line to the peak and return shall be the same as the calibration block. The trace line must return to the base line. No tolerance will be allowed.

403.20.4.3 A profilograph equipped with automatic profile trace reduction capabilities shall be checked by comparing the machine's results with the results obtained by the engineer. This shall be done for the profile trace obtained on MoDOT's test section. The results and the profilogram shall be submitted to the engineer. The results of the comparison may not differ by more than 2.0 inches per mile (30 mm/km).

403.20.4.4 The contractor shall furnish certification that the 25 foot (7.622 m) profilograph test and evaluation was conducted by an operator trained in the use of profilograph equipment and with sufficient experience to demonstrate the operator's competence.

403.20.5 Test Procedures and Reporting. Smoothness shall be tested immediately behind the finish roller by measurement with a profilograph.

403.20.5.1 A profilogram shall be made for each continuous pavement section of 50 feet (15 m) or greater completed during each day's placement. A section is defined where paving begins and terminates at a day's work joint. Interruptions designated by the engineer which cause placement to cease and begin at a new location will be considered as a separate section for that day's operation if the separate section is greater than 250 feet (75 m).

403.20.5.2 The contractor shall furnish the profilogram and its evaluation to the engineer. The testing shall be done by a certified operator in the presence of the engineer. The testing procedure and the evaluation of the

profilogram shall be done in accordance with this specification and MoDOT TEST Method T59. The profilogram and evaluation shall be furnished to the engineer no later than the end of the next working day following placement of the pavement and within two days after corrective grinding. The evaluation shall be reported on an approved form for each day's placement. Separate sections in a day's placement shall be appropriately separated on the day's report for MoDOT use. Standard forms for reporting results may be obtained from MoDOT.

403.20.5.3 The engineer may test the surface or re-evaluate the profilogram for comparison and assurance purposes. If these tests or re-evaluations indicate the contractor-furnished profilograms are not accurate within 3.0 inches per mile (45 mm/km), the engineer may test the entire project length. If the entire project length is tested, the contractor will be charged for this work at the rate of $500.00 per lane mile ($310.00 per lane kilometer). Furnishing inaccurate test results may result in decertification of the operator.

403.20.5.4 All objects and foreign material on the pavement surface shall be removed by the contractor prior to testing.

403.20.5.5 The sensing wheel shall be lifted, rotated to take slack out of the linkage, and lowered to the starting point prior to testing.

403.20.5.6 The profilograph shall be propelled at walking speed in the paths indicated in Sec 403.20.5.10 for each section of pavement. Propulsion may be provided by personnel pushing manually or by a suitable propulsion unit. Speed of the profilograph shall be decreased if excessive spikes are encountered on the trace.

403.20.5.7 A location indicator for lateral placement shall be used. The back end of the profilograph shall be kept in the required path on horizontal curves except where profilographing is not required in accordance with Sec 403.20.2.2(b).

403.20.5.8 The actual stations shall be shown on the profilogram at least every 200 feet (50 m) for the necessary bump referencing. The stations may be marked on the trace by manual placement of a vertical mark when the sensing wheel reaches the station. The corresponding station shall be written at the mark. This vertical mark will reference the upward direction of the trace.

403.20.5.9 Both ends of the profilogram shall be labeled with the station, lane designation, position or track on the pavement, the direction the pavement was placed and the date placed.

403.20.5.10 Pavement profile shall be taken 3 feet (1 m) from and parallel to either edge of the traveled way or along the centerline of the lane being placed as directed by the engineer.

403.20.5.11 Sections will be divided into segments of 0.1 mile (0.1 km) with the exception of the last segment. If the last segment is greater than 250 feet (75 m) and less than 0.1 mile (0.1 km), then the segment shall be considered as a 0.1 mile (0.1 km) segment. If the last segment is 250 feet (75 m) or less in length, the profilogram for that segment shall be included in the evaluation of the adjacent segment in that section.

403.20.5.12 If an independently placed section required by the plans or the engineer is between 50 feet and 250 feet (15 m and 75 m), or an independently placed section caused by the contractor's operation is less than 50 feet (15 m), a profilogram shall be made for that section and included in the evaluation of the most recently placed adjoining segment of another day's placement.

403.20.5.13 The last 12.5 feet (0.4 m) of a pavement section and the construction header shall be included in the profilogram of the next day's placement.

403.20.5.14 A profile index shall be calculated from the profilogram for each segment of all profile trace lines and for the overall section. A report for each day's placement shall be completed. A day's report may consist of more than one section index if a bridge or a designated interruption is encountered in a day's placement. The profile index shall be calculated by summing the vertical deviations of the profile trace above or below the reference line. The units of this measure shall be inches per mile (mm/km).

403.20.6 Surface Corrections. Bump correction or smoothness correction or both may be required after the initial smoothness report is performed to achieve a final status. If the initial report has no corrections in accordance with Secs 403.20.6.3 and 403.20.6.5, it will serve as the final report.

403.20.6.1 If an average profile index of 45.0 inches per mile (711 mm/km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 65.0 inches per mile (1026 mm/km) for pavements having a final posted speed of 45 mph (70 km/h) or less, is exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action approved by the engineer is taken by the contractor.

403.20.6.2 Corrective action to improve the average profile index shall be accomplished by diamond grinding or by use of an approved device designed for that purpose. Satisfactory longitudinal grinding will be acceptable as the final surface of the corrected pavements. All corrective work shall be completed prior to determination of pavement thickness.

403.20.6.3 High points on the profile trace that correspond to high points or bumps on the pavement surface shall be separately identified. All bumps greater than 0.40 inch (10 mm) in height over a 25-foot (7.622 m) span, as indicated on the profile trace, shall be corrected. The corrected bumps will be considered satisfactory when measurements by the profilograph show that the bumps are 0.40 inch (10 mm) or less in height over a 25-foot (7.622 m) span. Station referencing or additional profiles may be used to accurately locate deviations greater than 0.40 inch (10 mm).

403.20.6.4 After removing all individual deviations greater than 0.40 inch (10 mm) in height, an intermediate profilogram report for the appropriate section shall be provided. The report shall provide segment indexes for the entire day's section after initial bump correction. The intermediate report will serve as the final report if all average profiled segment indexes are below the limits of Sec 403.20.6.3.

403.20.6.5 Correction above the individual deviations of 0.40 inch (10 mm) shall be performed if necessary to reduce the average profile index to 30.0 inches (474 mm) or less per mile (km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 45.0 inches (711 mm) or less per mile (km) for pavements having a final posted speed of 45 mph (70 km/h) or less. On pavement segments where corrections are necessary, additional profiles shall be made to verify corrections have produced an average profile segment index within the limits noted above. Upon correction, a final report will be performed.

Delete Sec 403.24 (including subsections) and substitute the following: ***10/00; 10/01***

403.24 Basis of Payment.

403.24.1 Due to possible variations in the specific gravity of the aggregates, the tonnage (quantity) used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

403.24.2 Payment for obtaining and delivering samples of compacted mixture from the pavement and replacing the surface will be made per sample at the fixed price specified in Sec 109.14.

403.24.3 Payment for Pavement Repairs (Blow-ups). Payment for removing and disposing of the broken concrete and for preparing subgrade will be made as provided in Sec 104.3. Payment for furnishing, placing and compacting the asphaltic concrete replacement material will be at the contract unit price for the mixture used.

403.24.4 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 either Table I or Table II. Table I will be used for pavements having a final posted speed greater than 45 mph (70 km/h). Table II shall be used for pavements having a final posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be considered as mainline pavements.

403.24.4.1 Smoothness incentive will be paid per section based on the profile index before any bump correction. Within a section qualifying for incentive pay, any segment having a profile index requiring a reduction in contract price will not be included in incentive payment for that section.

403.24.4.2 Deductions for rough pavement shall be based on Table I for pavements having a final posted speed greater than 45 mph (70 km/h) and Table II for pavements having a final posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be

considered as mainline pavements. Deductions will be applied to pavements based on the average segment index after initial 0.4 bump correction.

Final Profile Index, Inches Per Mile (mm/km)		Percent of Contract Price
Table I	Table II	
10.0 (158) or less		107
10.1 - 15.0 (159 - 237)	15.0 (237) or less	105
15.1 - 18.0 (238 - 284)	15.1 - 25.0 (238 - 395)	103
18.1 - 25.0 (285 - 395)	25.1 - 45.0 (396 - 711)	100
25.1 - 35.0 (396 - 553)	45.1 - 55.0 (712 - 869)	97*
45.1 (712) or greater 35.1 - 45.0 (555 - 711)	55.1 - 65.0 (870 - 1026)	95*
45.1 (712) or greater	65.1 (1027) or greater	93*

*Correction required.

403.24.4.3 After initial bump correction, segments with an average profile index of 25.1 (396) or greater (Table I), or 45.1 (712) or greater (Table II), shall be corrected as specified in Sec 403.20.6 until the profile index is 25.0 (395) or less (Table I) or 45.0 (711) or less (Table II). At the contractor's option, these segments may be removed and replaced to obtain 100% payment and eliminate grinding if retests verify that new segment indexes meet above requirements. Any correction results will not be applied to the initial section index for increasing bonus payment.

403.24.4.4 On sections where corrections are made, the pavement shall be tested by the contractor to verify that corrections have produced a profile index of 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II).

403.24.4.5 The contractor will not be allowed to make corrective grinding to increase the percent of pay when the final profile index is 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II).

403.24.4.6 The contract unit prices for asphaltic concrete pavement will be considered as full compensation for all material entering into the construction of the pavement and for the cost of the smoothness testing.

403.24.4.7 When paving widths are greater than the travel lane widths, payment for profiling will apply to the traffic lane design driving width only, normally 12 feet (3.6 m).

403.24.5 Random lane coring for thickness or required lane replacement will include the full paved lane width to the longitudinal joints or edge of shoulder, whichever is first.

403.24.6 Payment for test strips including all equipment, labor and any other work necessary to complete this item will be considered as completely covered by the contract unit price. Accepted test strips meeting density and all other specification requirements will be paid for at the contract unit price per test strip. No payment will be made for test strips required as a result of a change in the job mix formula, compaction method or equipment when initiated by the contractor or when unacceptable results occur as determined by the engineer. Test strips meeting density requirements, but fail to meet other specification requirements, may be left in place and the material paid for as determined by the engineer.

SECTION 407 – TACK COAT

Delete Sec 407.6.1 and substitute the following: ***10/00***

407.6.1 Aggregate used for sanding tack coat, if directed by the engineer, will be paid per ton (Mg) at the fixed unit price specified in Sec 109.14.

SECTION 501 – CONCRETE

Delete Sec 501.5.4 and substitute the following: ***07/01***

501.5.4 Central mixed concrete shall be mixed in a stationary mixer in accordance with the requirements specified herein. Except as otherwise permitted in Sec 501.5.11, it shall be transported to the point of delivery in a truck

mixer operating at agitating speed, or in an agitator truck. The mixing time shall be in accordance with the requirements of Sec 501.4.1 and as necessary to produce concrete which meets uniformity criteria when tested as specified in Section 10.3 of ASTM C 94 with the following additions and exceptions:

Delete Sec 501.5.4(e) and substitute the following: ***07/01***

(e) The contractor may designate the mixing time for which uniformity tests are to be performed. The mixing time shall not be less than 60 seconds or more than the time determined in accordance with requirements of Sec 501.4.1. 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. However, the engineer may allow the use of the test concrete for appropriate incidental construction. Labor, sampling, sampling equipment and material required for uniformity tests of the concrete mixture shall be furnished by the contractor. The engineer will furnish required testing equipment including scales, cubic measure and air meter. The tests will be performed by the engineer, or by the contractor with approval by the engineer. No direct payment will be made for the labor, equipment, material or testing. After operational procedures of batching and mixing are thus established, no changes in procedure will be permitted without re-establishing procedures by uniformity tests.

Delete Sec 501.10 and substitute the following: ***07/01; 07/02***

501.10 Water-Reducing Admixtures. At the option of the contractor, 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 content up to 0.25 sack per cubic yard (15 kg/m^3) will be permitted. The Type A water reducer shall be in accordance with AASHTO M 194. 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 allowed by specifications shall be based on the reduced cement content. High range water-reducing admixtures may be used when specified or as approved by the engineer.

Delete Sec 501.13.1.3 ***07/02***

SECTION 502 – PORTLAND CEMENT CONCRETE PAVEMENT

Delete Sec 502.3.6 and substitute the following: ***07/02***

502.3.6 Concrete Saw. Equipment may be a wet-cut diamond 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".

Delete Sec 502.4.1 and substitute the following: ***07/02***

502.4.1 Protection. All concrete shall be effectively protected from freezing until a minimum compressive strength of 3500 pounds per square inch (24 MPa) has been attained. Regardless of precautions taken, the contractor shall assume the risks of frozen concrete which shall be replaced at the contractor's expense.

Delete Sec 502.11.3 and substitute the following: ***04/00; 07/02***

502.11.3 Sawing. Unless otherwise provided, all transverse contraction joints and all Type L longitudinal joints in the pavement shall be sawed in a single cutting operation with the joint groove cut to the dimensions shown on the plans except as herein specified. If an early-entry concrete saw is used, the dimensions of the transverse contraction joint groove shall be a minimum of 3/8-inch (9.5 mm) wide and one eighth of the pavement thickness deep. The dimensions of the longitudinal joint groove to be sawed with an early-entry saw shall be a minimum of 1/8-inch (3 mm) wide and one eighth of the pavement thickness deep. 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 practical 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. If an early-entry concrete saw is used, all joint grooves shall be established within 12 hours of finishing. 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 engineer 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.

Delete Sec 502.14 (including subsections) and substitute the following: ***10/00; 10/01***

502.14 Surface Test. The pavement surface shall be thoroughly tested for smoothness by profilographing or straightedging as indicated. Testing applicable to this specification, except straightedging, shall be performed by the contractor in the presence of the engineer.

502.14.1 Straightedging. As soon as practical, the engineer will straightedge all segments of the paved surface not profilographed, including shoulder areas between rumble strips. Any variations exceeding 1/8 inch in 10 feet (3 mm in 3 m) will be marked. Areas more than 1/8 inch (3 mm) high shall be removed as specified in Sec 502.14.6.2. If areas more than 1/8 inch (3 mm) low exist, appropriate correction shall be required for suitable smoothness.

502.14.2 Profilographing. Profilographing is applicable to the surface of all mainline paving, auxiliary lanes, turning lanes and ramps for projects with a sufficient amount of continuous concrete pavement. A sufficient amount of continuous concrete pavement will be such that a project, or combination of projects, consists of more than 0.5 mile (1 km) of total profilographable pavement. Profilographing may be waived by the engineer if staging of the overall project affects the normal paving operation, such as multiple entrance lane gaps, lane staging, etc., or if multiple profilograph exceptions continuously exist eliminating smoothness requirements on a large portion of the same roadway. Upon waiver, all smoothness requirements will revert to Sec 502.14.1.

502.14.2.1 All wheels of the profilograph shall be placed on the new pavement, with stationing based on the center wheel.

502.14.2.2 Profilographing will not be required for the following:

(a) Bridge decks, bridge approach slabs and concrete approach pavements.

(b) Pavement on horizontal curves with centerline radius of curve less than 1000 feet (300 m) and pavement within the superelevation transition of such curves.

(c) Pavement on vertical curves having a "K" value less than 90 and a length less than 500 feet (150 m).

(d) Pavement in width transitions.

(e) Fifty feet (15 m) in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

(f) Fifty feet (15 m) in direction of travel on each side of intersecting routes with special grade transition.

(g) Portland cement concrete shoulders.

(h) Any lane which abuts an existing lane not constructed under the same contract.

(i) Interruptions designated by the engineer which provide independently placed sections shorter than 50 feet (15 m). See Sec 502.14.5.12 for interruptions designated by the contractor's operations.

(j) The last 15 feet (5 m) of any section where the prime contractor is not responsible for the adjoining surface.

(k) The first or last 12.5 feet (4 m) of a pavement section adjoining any above exception area.

502.14.3 Equipment. The profilograph shall be a California type as approved by the engineer. The equipment furnished shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump at the same time. The pavement profile is recorded from the vertical movement of a sensing wheel attached to the frame at midpoint and is in reference to the mean

elevation of the 12 points of contact with the road surface established by the support wheels. The profilogram is recorded with a scale of one inch equals one inch (1 mm equals 1 mm) vertically and one inch equals 25 feet (1 mm equals 300 mm) longitudinally. The profilogram line drawn by the profilograph will be referred to as the profile trace in these specifications.

502.14.4 Calibration. All profilographs used shall be calibrated at least annually on a test section established by MoDOT. The contractor's calibration profile index shall not vary more than 2.0 inches per mile (30 mm/km) from a standard profile index produced by a MoDOT profilograph.

502.14.4.1 Longitudinal calibration consists of pushing the profilograph over a pre-measured test distance and determining the scale factor by dividing the premeasured test distance by the length of the paper in inches (millimeters). This factor shall be 25 (300), one inch equals 25 feet (25 mm equals 7.622 m). If not, the machine shall be adjusted until the scale factor is 25 (300) plus or minus 0.2 percent.

502.14.4.2 Vertical calibration consists of sliding a pre-measured calibration block, measured to the nearest 0.01 inch (0.25 mm), under the sensing wheel while the profilograph is stationary. The measurement of the vertical trace line from the base line to the peak and return shall be the same as the calibration block. The trace line must return to the base line. No tolerance will be allowed.

502.14.4.3 A profilograph equipped with automatic profile trace reduction capabilities shall be checked by comparing the machine's results with the results obtained by the engineer. This shall be done for the profile trace obtained on the MoDOT test section. The results and the profilogram shall be submitted to the engineer. The results of the comparison may not differ by more than 2.0 inches per mile (30 mm/km).

502.14.4.4 The contractor shall furnish certification that the 25-foot (7.622-meter) profilograph test and evaluation was conducted by an operator trained in the use of profilograph equipment and with sufficient experience to demonstrate the operator's competence.

502.14.5 Test Procedures and Reporting.

502.14.5.1 A profilogram shall be made for each continuous pavement section of 50 feet (15 m) or greater completed during each day's placement. A section is defined where paving begins and terminates at a day's work joint. Interruptions designated by the engineer which cause placement to cease and begin at a new location will be considered as a separate section for that day's operation if the separate section is greater than 250 feet (75 m).

502.14.5.2 The contractor shall furnish the profilogram and its evaluation to the engineer. The testing shall be done by a certified operator in the presence of the engineer. The testing procedure and the evaluation of the profilogram shall be done in accordance with this specification and MoDOT Test Method T59. The profilogram and evaluation shall be furnished to the engineer no later than the end of the next working day following placement of the pavement and within two days after corrective grinding. The evaluation shall be reported on an approved form for each day's placement. Separate sections in a day's placement shall be appropriately separated on the day's report for MoDOT use. Standard forms for reporting results may be obtained from MoDOT.

502.14.5.3 The engineer may test the surface or re-evaluate the profilogram for comparison and assurance purposes. If these tests or re-evaluations indicate the contractor-furnished profilograms are not accurate within 3.0 inches per mile (45 mm/km), the engineer may test the entire project length. If the entire project length is tested, the contractor will be charged for this work at the rate of $500.00 per lane mile ($310.00 per lane kilometer). Furnishing inaccurate test results may result in decertification of the operator.

502.14.5.4 All objects and foreign material on the pavement surface, including protective covers, if used, shall be removed by the contractor prior to testing and, if appropriate, protective covers shall be properly replaced by the contractor after testing.

502.14.5.5 The sensing wheel shall be lifted, rotated to take slack out of the linkage, and lowered to the pavement surface at the starting point prior to testing.

502.14.5.6 The profilograph shall be propelled at walking speed in the paths indicated in Sec 502.14.5.10 for each section of pavement. Propulsion may be provided by personnel pushing manually or by a suitable propulsion unit. Speed of the profilograph shall be decreased if excessive spikes are encountered on the trace. The actual stationing

shall be noted on the profilogram at least every 200 feet (50 m). Station referencing is used to accurately locate deviations greater than 0.40 inch (10 mm).

502.14.5.7 A location indicator for lateral placement shall be used. The back end of the profilograph shall be kept in the required path on horizontal curves except where profilographing is not required in accordance with Sec 502.14.2.2(b).

502.14.5.8 The actual stations shall be shown on the profilogram at least every 200 feet (50 m) for necessary bump referencing. The stations may be marked on the trace by manual placement of a vertical mark when the sensing wheel reaches the station. The corresponding station shall be written at the mark. This vertical mark will reference the upward direction of the trace.

502.14.5.9 Both ends of the profilogram shall be labeled with the stationing, lane designation, position or track on the pavement, the direction the pavement was placed and the date placed.

502.14.5.10 Pavement profiles shall be taken 3 feet (1 m) from and parallel to each travelway edge and as directed by the engineer. Each profile line will be incorporated into the section report as separate tracks.

502.14.5.11 Sections shall be divided into segments of 0.1 mile (0.1 km) with the exception of the last segment. If the last segment is greater than 250 feet (75 m) and less than 0.1 mile (0.1 km), then the segment shall be considered as a 0.1 mile (0.1 km) segment. If the last segment is 250 feet (75 m) or less in length, the profilogram for that segment shall be included in the evaluation for the adjacent segment in that section.

502.14.5.12 If an independently placed section required by the plans or the engineer is between 50 feet and 250 feet (15 m and 75 m), or an independently placed section caused by the contractor's operation is less than 50 feet (15 m), a profilogram shall be made for that section and included in the evaluation of the most recently placed adjoining segment of another day's placement.

502.14.5.13 The last 12.5 feet (0.4 m) of a pavement section and the construction header shall be included in the profilogram of the next day's placement.

502.14.5.14 A profile index shall be calculated from the profilogram for each segment of all profile trace lines and for the overall section. A report for each day's placement shall be completed. A day's report may consist of more than one section index if a bridge or a designated interruption is encountered in a day's placement. The profile index shall be calculated by summing the vertical deviations of the profile trace above or below the reference line. The units of this measure shall be inches per mile (mm/km).

502.14.6 Surface Corrections. Bump correction or smoothness correction or both may be required after the initial smoothness report is performed to achieve a final report. If the initial report has no corrections in accordance with Secs 502.14.6.3 and 502.14.6.5, it will serve as the final report.

502.14.6.1 If an average profile index of 45.0 inches per mile (711 mm/km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 65.0 inches per mile (1026 mm/km) for pavements having a final posted speed of 45 mph (70 km/h) or less, is exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action approved by the engineer is taken by the contractor.

502.14.6.2 Corrective action to improve the average profile index shall be accomplished by diamond grinding or by use of an approved device designed for that purpose. The use of a bush hammer or other impact device will not be permitted. The final surface of the corrected concrete pavement shall be such that the texture is comparable to adjacent sections that do not require correcting. 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.

502.14.6.3 High points on the profile trace that correspond to high points or bumps on the pavement surface shall be separately identified. All bumps greater than 0.40 inch (10 mm) in height over a 25-foot (7.622 m) span, as indicated on the profile trace, shall be corrected. The corrected bumps will be considered satisfactory when measurements by the profilograph show that the bumps are 0.40 inch (10 mm) or less in height over a 25-foot (7.622 m) span. Station referencing or additional profiles may be used to accurately locate deviations greater than 0.40 inch (10 mm).

502.14.6.4 After removing all individual deviations greater than 0.40 inch (10 mm) in height, an intermediate profilogram report for the appropriate section shall be provided. The report shall provide segment indexes for the entire day's section after initial bump correction. The intermediate report will serve as the final report if all average profile segment indexes are below the limits of Sec 502.14.6.5.

502.14.6.5 Correction above the individual deviations of 0.40 inch (10 mm) shall be performed if necessary to reduce any average profile segment index to 30.0 inches (474 mm) or less per mile (km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 45.0 inches (711 mm) or less per mile (km) for pavements having a final posted speed of 45 mph (70 km/h) or less. On pavement segments where corrections are necessary, additional profiles shall be made to verify corrections have produced an average profile segment index within the limits noted above. Upon correction, a final report will be performed.

502.14.6.6 The final surface of the corrected concrete pavement shall be such that the texture is comparable to adjacent sections that do not require correcting. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements.

Delete Sec 502.19.5 (including subsections) and substitute the following: ***10/01***

502.19.5 Payment for smoothness shall be based on either Table I or Table II. Table I shall be used for pavements having a final posted speed greater than 45 mph (70 km/h). Table II shall be used for pavements having a final posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be considered as mainline pavements.

502.19.5.1 Smoothness incentive will be paid per section based on the profile index before any bump correction. Within a section qualifying for incentive pay, any segment having a profile index requiring a reduction in contract price will not be included in incentive payment for that section.

502.19.5.2 Deductions for rough pavement shall be based on Table I for pavements having a final posted speed greater than 45 mph (70 km/h) and Table II for pavements having a final posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be considered as mainline pavements. Deductions will be applied to pavements based on the average segment index after initial 0.4 bump correction.

Segment Profile Index, Inches Per Mile (mm/km)		**Percent of Contract Price**
Table I	**Table II**	
10.0 (158) or less		107
10.1 - 15.0 (159 - 237)	15.0 (237) or less	105
15.1 - 18.0 (238 - 284)	15.1 - 25.0 (238 - 395)	103
18.1 - 25.0 (285 - 395)	25.1 - 45.0 (396 - 711)	100
25.1 - 35.0 (396 - 553)	45.1 - 55.0 (712 - 869)	97*
35.1 - 45.0 (555 - 711)	55.1 - 65.0 (870 - 1026)	95*
45.1 (712) or greater	65.1 (1027) or greater	93*

*Correction required.

502.19.5.3 After initial bump correction, segments with an average profile index of 25.1 (396) or greater (Table I), or 45.1 (712) or greater (Table II), shall be corrected as specified in Sec 502.14.6 until the profile index is 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II). At the contractor's option, these segments may be removed and replaced to obtain 100% payment and eliminate grinding if retests verify that new segment indexes meet above requirements. Any correction results will not be applied to the initial section index for increasing bonus payment.

502.19.5.4 On sections where corrections are made, the pavement shall be tested by the contractor to verify that corrections have produced a profile index of 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II).

502.19.5.5 The contractor will not be allowed to make corrective grinding to increase the percent of pay when the final profile index is 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II).

SECTION 504 – CONCRETE APPROACH PAVEMENT

Delete Sec 504 and substitute the following: ***10/01***

SECTION 504

CONCRETE APPROACH PAVEMENT

504.1 Description. This work shall consist of placement and preparation of base material and construction of reinforced concrete approach pavement 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.

504.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Aggregate for Base	1007.5
Reinforcing Steel for Concrete Structures	1036.2
Concrete Curing Material	1055
Material for Joints	1057.1

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.

504.3 Construction Requirements. Base placement shall be in accordance with applicable requirements of Sec 304. Concrete approach pavement and tied shoulders shall be constructed in accordance with the applicable requirements of Sec 502. Reinforcement shall be supported and held securely in place by approved metal or plastic bar supports.

504.4 Method of Measurement. Concrete approach pavement areas including tied shoulders will be computed to the nearest 1/10 square yard (0.1 m^2). 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. 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 all labor, equipment and material to complete the described work.

SECTION 505 – BRIDGE DECK CONCRETE WEARING SURFACE

Delete Sec 505.10.4.6 and substitute the following: ***04/00***

505.10.4.6 When concrete density is specified, in-place density of plastic concrete will be determined in accordance with MoDOT Test Method T36. In-place density will be determined at a minimum passing test rate of 1 per 100 square yards (85 m^2) or 3 per continuous pour, whichever is greater. A nuclear gauge correction factor will be determined at least once for each day of concrete production. Work bridges spanning the plastic concrete shall be provided by the contractor to permit making nuclear density tests.

Delete Sec 505.30.2.4 and substitute the following: ***01/02***

505.30.2.4 Silica fume shall be approved prior to use and meet ASTM C 1240 except as noted herein. If in 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 they are included by the manufacturer of the silica fume admixture.

505.30.2.4.1 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 included in the silica fume admixture.

505.30.2.4.2 The manufacturer's certification shall also contain results of recent tests made 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 conforms to this specification.

505.30.2.4.3 For approval prior to use, the supplier shall furnish the same information to MoDOT, Project Operations - Materials, P. O. Box 270, Jefferson City, MO 65102 along with any requested samples for testing.

SECTION 601 – FIELD LABORATORIES

Delete Sec 601.6 and substitute the following: ***10/00***

601.6 Basis of Payment. Unless otherwise specified, no direct payment will be made for Type 1, Type 3 or Type 4 Field Laboratories. Authorized Type 2 Field Laboratories complete in place will be paid for at the contract unit price. Payment will be considered full compensation for all furnishings, maintenance, all utilities, heating and cooling facilities including operation and fuel, and final removal and disposal of the laboratory. Relocation of Type 2 or Special Field Laboratories will be paid for at the contract unit price per each move authorized by the engineer.

SECTION 602 – MARKERS

Delete Sec 602 and substitute the following: ***07/02***

602.1 Description. This work shall consist of constructing markers as specified in the contract documents, at the locations shown on the plans or as directed by the engineer. Markers will be drain markers or steel right of way markers.

602.2 Material.

602.2.1 All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Steel Post for Markers	1044

602.2.2 Right of way and drain marker plaques and fasteners will be furnished at the job site at no cost to the contractor.

602.3 Construction Requirements. Steel markers shall be set with the legend facing the centerline of the highway. Posts shall be driven, in accordance with Sec 903.3.1.2. Posts having battered or mushroomed tops will not be accepted. Posts shall be set vertically at locations shown on the plans or as designated by the engineer, and the plaques firmly attached.

602.4 Basis of Payment. The accepted quantity of markers will be paid for at the contract unit price.

SECTION 603 – WATER LINE INSTALLATION

Delete Sec 603.4.2 and substitute the following: ***04/01***

603.4.2 Rock encountered in trenching and classified as Class 3 Excavation in Rock in accordance with Sec 203 will be measured to the nearest cubic yard (cubic meter). Measurement of the volume to be paid for as Class 3 Excavation in Rock will be a width 18 inches (450 mm) greater than the inside diameter of the pipe and a depth from the surface of the rock as determined by the engineer to a plane 6 inches (150 mm) below the outside bottom of the pipe or to the bottom of the rock, whichever is higher. Any Class 3 Excavation in Rock performed prior to the establishment of the lines of demarcation and notification to the engineer will not be measured or paid for.

Delete Sec 603.5 and substitute the following: ***04/01***

603.5 Basis of Payment. Accepted water line 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. No direct payment will be made for excavation or backfill except

in accordance with Sec 206.6.3.3 and Sec 603.4.2. In relocating service connections, 2 inches (50 mm) inside diameter or less, no direct payment will be made for the pipe or fittings.

SECTION 604 – MISCELLANEOUS DRAINAGE

Delete Sec 604.12 and substitute the following: ***07/00***

604.12 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Precast Drainage Units	1033
Reinforcing Steel for Concrete	1036

All concrete, except that portion placed monolithic with paved surfaces, shall be Class B. Concrete for inverts shall be either Class B, or concrete of a commercial mixture meeting the requirements of Sec 501.14. Material, 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.

SECTION 606 – GUARDRAIL, END TERMINALS, CRASH CUSHIONS, ONE-STRAND CABLE – ACCESS RESTRAINT AND GUARD CABLE

Delete Sec 606 and substitute the following: ***04/02***

SECTION 606

GUARDRAIL, END TERMINALS, CRASH CUSHIONS, ONE-STRAND CABLE - ACCESS RESTRAINT AND GUARD CABLE

606.1 Description. This work shall consist of furnishing and installing guardrail, end terminals, crash cushions, one-strand cable - access restraint or guard cable as shown on the plans or as directed by the engineer.

606.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Concrete	501
Guardrail, End Terminals, Crash Cushions, One-Strand Cable - Access Restraint and Guard Cable	1040

606.2.1 Concrete shall be placed, finished and cured in accordance with applicable provisions of Sec 703. During cold weather, the limitations and protection requirements of Secs 502.4 and 502.4.1 shall apply to this work.

606.3 Construction Requirements.

606.3.1 Scheduling. Where guardrail or guard cable removal and replacement is required and the adjacent travel or auxiliary lane is open to traffic during non-working hours, the contractor shall:

(a) Remove no more guardrail or guard cable than can be replaced in the same day.

(b) 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.

(c) Ensure end sections or terminals exposed to traffic meet the current standards. Guardrail or guard cable must be maintained to within 3 inches (75 mm) of the nominal barrier height shown on the plans.

606.3.1.1 As an alternative, the contractor may choose to provide a concrete traffic barrier with an acceptable end treatment between the adjacent lane and unattached, installed posts or barriers which are not within the allowable height. Should the contractor choose this option, the contractor shall submit a traffic control plan to the engineer for approval. The contractor will not be compensated for any additional traffic control items required to perform this work. In all cases, the contractor shall ensure that the guardrail or guard cable installation is fully anchored before opening the adjacent lane to traffic.

606.3.1.2 The shoulders and slopes shall meet all standards shown on the plans or be as directed by the engineer before the installation of any guardrail, guard cable or end treatments.

606.3.2 Traffic Control. The contractor shall install applicable traffic control equipment as shown on the plans or as approved by the engineer before commencing work.

606.3.3 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 by the zinc alloy stick method in accordance with Sec 712.

606.3.4 Posts for Guardrail and One-Strand Cable - Access Restraint.

606.3.4.1 Posts may be wood or steel. 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.

606.3.4.2 Wood posts for end anchors shall be installed according to the plans.

606.3.4.3 Unless otherwise specified, wood posts shall be set vertically in dug or bored holes, true to line and grade. Holes shall be of a size sufficient to permit thorough compacting of the backfill around the posts. The backfill material shall be dry sand, placed in layers not exceeding 12 inches (300 mm) thick to a height 12 inches (300 mm) below the finished grade. After installing and adjusting the rail to true line and grade, the contractor shall compact the sand backfill by flooding. The final 12 inches (300 mm) of backfill, consisting of suitable earth material, shall then be compacted in no more than 6-inch (150 mm) lifts.

606.3.4.4 Steel posts may be set by the method described in Sec 606.3.4.3 or may be driven by a power hammer. Any mushrooming on the top of the post shall be removed, and damaged spelter coating on galvanized posts shall be field repaired in accordance with Sec 712.

606.10 GUARDRAIL

606.10.1 Description. This work shall consist of furnishing and installing guardrail in accordance with the lines and grades 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 25-foot (7.62 m) sections of beam rails (and channels, if required) will be permitted for bridge anchor sections, and any place 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.

606.10.3 Method of Measurement. Measurement of guardrail will be made to the nearest 1/2 linear foot (0.5 m) for each increment along a line passing through the centerline of each post, and totaled to the nearest linear foot (0.5 m) for the sum of the increments on the project. The length will be measured separately for each type from the center of the end post to the center of end post, excluding bridge anchor sections and end anchors.

606.10.4 Basis of Payment. The accepted quantities of guardrail, end anchors and bridge anchors, complete in place, will be paid for at the unit price for each of the pay items included in the contract. Payment for these items

will be considered full compensation for all labor, equipment and material to complete the described work. The cost of furnishing, fabricating and installing transition sections, complete in place, will be paid for at the contract unit price per each. No direct payment will be made for beam end sections or guardrail turned down terminal ends.

SECTION 606.20 BLANK.

SECTION 606.30 END TERMINALS AND CRASH CUSHIONS

606.30.1 Description. This work shall consist of furnishing and installing crashworthy end terminals or crash cushions as shown on the plans or directed by the engineer.

606.30.2 Material. Equipment and material shall be of new stock unless the contract provides for relocation of existing units or units to be furnished by others. New equipment and material shall be the product of reputable manufacturers, meet all applicable requirements of NCHRP 350, Test Level 3, and meet approval by Project Operations. A list of crashworthy end terminals and barrier systems meeting NCHRP 350, Test Level 3 criteria and FHWA acceptance is available through Project Operations or MoDOT's web site.

606.30.2.1 The assembled unit shall be capable of developing full tensile strength of the standard rail system and have redirectional and end-on capabilities as per criteria identified in NCHRP 350, Test Level 3, and supplements thereto. The assembled unit shall contain or permit controlled penetration of the vehicle into the system in an acceptable manner for vehicles in the 1800 pound (820 kg) to 4400 pound (2000 kg) classes. After installation, the end terminal shall redirect traffic face-side vehicle impacts to within the prescribed performance crash test criteria ranges in accordance with NCHRP 350, Test Level 3.

606.30.2.2 Type A end terminal installations shall be a minimum of 50 feet (15 m) in length. Additional Type A guardrail shall be provided by the contractor, at the contractor's expense, to extend the Type A end terminal to 50 feet (15 m) long if the unit is less.

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 details 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 placed as shown on the plans. No substitutions will be permitted without prior approval by 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 end terminals or crash cushions where Type B units are specified or shown on the plans.

606.30.3.5 Crashworthy end terminals located 12 feet (3.6 m) or less from the edge of the traveled way shall be furnished with a modified Type III 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 or crash cushions will be made by each unit assembled, installed and complete in place. 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.

606.30.5 Basis of Payment. The accepted quantities of Type A, B and C crashworthy end terminals or crash cushions, complete in place, will be paid for at the contract unit price. This will be considered full compensation for complete installation including any transition sections, backup assemblies or other items necessary for proper installation of the end terminal or crash cushion as required.

SECTION 606.40 ONE-STRAND CABLE - ACCESS RESTRAINT

606.40.1 Description. This work shall consist of furnishing and installing one-strand cable - access restraint in accordance with the lines and grades 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 cable - access restraint will be made to the nearest 1/2 linear foot (0.5 meter) for each increment, from center of end post to center of end post, and totaled to the nearest linear foot (0.5 meter) for the sum of the increments on the project.

606.40.4 Basis of Payment. The accepted quantities of one-strand cable - access restraint, end anchors, posts and hardware, complete in place, will be paid for at the unit price for each of the pay items included in the contract. Payment for these items will be considered full compensation for all labor, equipment and material to complete the described work.

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 and appurtenances, 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. The driving shall be accomplished with approved equipment and methods that will leave the posts in their final position, free from any distortion, burring or other damage. All posts shall be aligned to a tolerance of 1/4 inch (6 mm) 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 (125 mm) in diameter. Following placement of the post, the hole shall be backfilled with a cohesive soil or sand meeting the requirements of Sec 1005.2.4 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 (300 mm) 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. Three 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.

606.50.3 Method of Measurement. 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 (0.5 meter). Measurement of anchor assemblies will be made per each.

606.50.4 Basis of Payment. The accepted quantities of three-strand guard cable, end anchors, posts and hardware 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.

606.60 USE OF SALVAGED GUARDRAIL AND GUARDRAIL REHABILITATION

606.60.1 Description. Guardrail rehabilitation shall consist of removal of substandard guardrail as determined by height, length-of-need or structural deficiency and furnishing and installing guardrail in accordance with the lines and grades shown on the plans or as directed by the engineer.

606.60.2 Construction Requirements. The engineer will determine the suitability of any removed guardrail for reuse. If specified in the contract and sufficient quantities of guardrail are available, the contractor may use salvaged guardrail from the project. If sufficient quantities of suitable guardrail are not available, the contractor shall use new material for this work. All construction shall be performed in accordance with Sec 606.10 with the following modifications.

606.60.2.1 The removal of existing guardrail shall be in accordance with Sec 202, and the engineer will determine the location of the disposed material as provided in the contract.

606.60.2.2 Old post holes shall be backfilled with suitable material and compacted to the satisfaction of the engineer.

606.60.2.3 Any posts removed and reset shall be cleaned before resetting.

606.60.2.4 Any reused or new galvanized material on which the galvanizing has been damaged shall be repaired, with approval of the engineer, by the zinc alloy stick method in accordance with Sec 712. This item of work shall be performed regardless of whether the damage was done during construction or prior to award of the contract.

606.60.2.5 Additional holes necessary for the reuse of existing posts may be flame-cut or drilled. All flame-cut holes shall be plane-chipped or ground to provide a smooth surface and shall be provided with a 1 1/4-inch (30 mm) diameter clipped washer.

606.60.3 Method of Measurement. Measurement will be in accordance with Sec 606.10.

606.60.4 Basis of Payment. The basis of payment will be in accordance with Sec 606.10 regardless of whether the item was new or salvaged.

SECTION 608 – CONCRETE MEDIAN, MEDIAN STRIP, SIDEWALK, STEPS AND PAVED APPROACHES

Delete Sec 608.3.4.1 and substitute the following: ***01/02***

608.3.4.1 Transverse joints for concrete median shall be sawed joints of the same dimensions as required for concrete pavement and 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 or median and adjacent concrete pavement shall be constructed of either non-extruding preformed joint material, or one layer of commercially available 55-pound (2666 g/m^2) roll roofing. Sawed joints shall be sealed in accordance with Sec 502.11.4.

SECTION 611 – EMBANKMENT PROTECTION

Delete Sec 611.15.1.2 and substitute the following: ***10/00***

611.15.1.2 If the plans provide for obtaining material from the right of way or other source furnished by the Commission, but all or part of the required quantity of acceptable material is not actually available, payment will be

made per cubic yard (cubic meter) at the fixed unit price specified in Sec 109.14 for such additional rock fill material that the contractor is required to furnish and haul.

SECTION 613 – PAVEMENT REPAIR

Delete Sec 613.1.1 and substitute the following: ***01/01***

613.1.1 Full depth pavement repair shall consist of removing specified areas of existing variable thickness Portland cement concrete pavement and replacing the pavement with reinforced Portland cement concrete as shown on the plans.

Delete Sec 613.2.1 and substitute the following: ***04/00***

613.2.1 Approximate locations and areas of pavement sections to be removed will be shown on the plans. Specific locations, areas and type of pavement repair shall be as shown on the plans or designated by the engineer. All pavement repair subsequent to sawing of pavement shall be accomplished in the same day.

Delete Sec 613.2.3 and substitute the following: ***04/00; 01/01; 07/01***

613.2.3 Areas of full depth repair shall be filled with reinforced Portland cement concrete as specified in the plans. All pavement repairs exceeding 10 feet (3.0 m) 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 shall be 1 1/4 by 18 inches (32 x 450 mm) and epoxy coated. Tie bars shall be No. 6 bars, 18 inches (450 mm) long and 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 epoxy or polyester bonding agent meeting the requirements of Sec 1039.3 to fill the void around the bar. If the bonding agent is either in bulk or cartridge form, it shall be thoroughly mixed in the proper ratio by an automatic mixing unit prior to injection into the holes. The automatic mixing unit shall be an integral part of the injection device. 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. Prior to inserting the bar into the hole, a thin plastic disk, manufactured to slip tightly over the bar, shall be placed over the bar at approximately midpoint 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 1/4 inch (6 mm) in alignment. Bars shall be firmly seated prior to placing concrete. Welded wire fabric shall be used and placed 3 inches (75 mm) plus or minus 1/2 inch (13 mm) below the surface of the concrete patch.

Delete Sec 613.2.7.1 and substitute the following: ***01/00; 04/02***

613.2.7.1 When the repair is to be made and opened to traffic the same day, the concrete shall contain Type III cement and calcium chloride or an approved accelerator. The aggregates or water or both shall be heated during the season when the ambient temperature may drop below 60 F (15 C). Aggregates shall not be heated higher than 150 F (65 C). The temperature of the water and aggregates combined shall not be higher than 110 F (45 C) when the cement is added. The temperature of the concrete at the time of placement shall not be lower than 80 F (25 C). Insulating curing mats, approved by the engineer, shall be used throughout the curing period. At the option of the contractor, in lieu of Type III cement, an approved mix containing a minimum of 8 1/2 sacks per cubic yard (475 kg/m^3) of Type I cement may be used with an accelerator and/or other admixtures approved by the engineer. The contractor shall provide a trial mix to determine the approximate cure time needed to achieve a required compressive strength of 3500 pounds per square inch (24 MPa). Compressive specimens shall be prepared in accordance with current MoDOT methods and cured to simulate actual field conditions. Testing of compressive specimens shall be performed by methods and at facilities acceptable to the engineer. The repaired pavement shall not be opened to traffic until the cure time has elapsed. If Type II cement is selected by the contractor, a minimum of 4 hours of curing time shall be required prior to opening to traffic. A new trial mix may be required if the engineer determines the field conditions vary substantially from trial mix conditions.

Delete Sec 613.3.2 and substitute the following: ***01/01***

613.3.2 Measurement for drilling dowel or tie bar holes and furnishing and installing dowels or tie bars will be made per dowel or tie bar.

Delete Sec 613.4 and substitute the following: ***01/01***

613.4 Basis of Payment. The accepted quantities for full depth pavement repair will be paid for at the contract unit price for each of the pay items included in the contract. The accepted quantities for partial depth pavement repair will be paid for at the contract unit price of area repaired. In addition, subgrade compaction and aggregate base will be paid for as follows.

SECTION 614 – DRAINAGE FITTINGS

Delete Sec 614.12 and substitute the following: ***01/02***

614.12 Material. Grates and bearing plates shall be constructed of structural steel meeting the requirements of ASTM A 36.

SECTION 616 – TRAFFIC CONTROL PLAN

Amend Sec 616 to include the following: ***10/01; 01/02***

616.2.2 Safety Requirements for Traffic Control Devices.

616.2.2.1 All traffic control devices shall conform to the criteria and standards of effectiveness as set forth in NCHRP 350. Category II and III devices shall meet Test Level 3 criteria.

616.2.2.2 The contractor shall furnish a manufacturer's certification that each type of traffic control device supplied complies with crash test requirements of NCHRP 350, Test Level 3 (TL-3) and has received FHWA acceptance. However, regardless if the unit meets NCHRP 350 criteria, the engineer reserves the right of final approval. Installation of a unit prior to the engineer's approval shall be at the contractor's risk.

Amend Sec 616.3 to include the following: ***04/02***

616.3.1.2 During any period of two hours or more that no person is present in the work zone to perform duties related to the work zone, all “Work Zone Fine” signs shall be covered such that they are not visible to the traveling public.

SECTION 617 – CONCRETE TRAFFIC BARRIER

Delete Sec 617 and substitute the following: ***07/02***

SECTION 617

CONCRETE TRAFFIC BARRIER

617.1 Description. This work shall consist of constructing concrete traffic barrier as shown on the plans. For temporary traffic barrier, this work shall consist of providing, hauling, installing and relocating as required, precast Type F concrete traffic barrier as shown on the plans or directed by the engineer.

617.2 Material.

617.2.1 Material Requirements for Types A, B, C and D Concrete Traffic Barrier. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section/Specification
Reinforcing Steel for Concrete	1036
Concrete Curing Material	1055
Prestressing Strands	AASHTO M 203

Concrete traffic barriers shall be constructed of Class B or B-1 concrete. Material, proportioning, air-entraining, mixing, slump and transporting shall be in accordance with Sec 501. Concrete shall be placed and finished in accordance with the applicable provisions of Sec 703.

617.2.2 Material Requirements for Type F Concrete Traffic Barrier. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Specification
Barrier Reinforcing Steel	AASHTO M 31, Gr 60 (420)
Loop Steel	AASHTO M 31, Gr 60 (420)
Connector Pin Steel	AASHTO M 183
Connector Pin Keeper Bolt and Nut	AASHTO M 164
Wire Mesh	AASHTO M 221

617.2.2.1 The size and dimensions for steel shall be as shown on the plans.

617.2.2.2 Except as noted herein, all barrier reinforcing steel shall be deformed bar in accordance with Sec 1036.

617.2.2.3 The loop steel shall be plain round bar, except it may be bent to the radius shown on the plans. The steel shall otherwise be in accordance with Sec 1036.

617.2.2.4 All units shall be physically marked in accordance with Sec 617.5.2 and properly identified for inspection. Acceptance will be based on identification, physical measurement and certification. Additional sampling may be performed at the option of the engineer.

617.2.2.5 Wire mesh shall be deformed bar.

617.2.2.6 The concrete shall be Class A-1 or B-1 in accordance with Sec 501, placed and finished in accordance with applicable provisions of Sec 703. The air content shall be 6.0 plus or minus 1.5 percent. Approved concrete additives or high range water reducers may be used. When high range water reducer is used, the slump prior to introduction of the admixture shall not exceed 3 inches (75 mm), and the final slump shall not exceed 8 inches (200 mm).

617.3 Certification Requirements for Type F Concrete Barrier. The contractor shall provide to the engineer a barrier manufacturer's certification that the barrier furnished is identical in materials and design to that specified in the plans, or as approved for an alternate connection system. The specific connection system (Type F pin/loop or other) shall be listed in the certification. If approved alternate connections are supplied, the maximum deflection distance, as determined by the required testing, shall be listed.

617.4 Alternate Connection for Type F Concrete Traffic Barrier. Alternate connections for the Type F barrier may be used, if approved. Connector approval shall be requested in writing by the connector manufacturer from Project Operations. In the request, information shall be provided documenting the following requirements.

617.4.1 The barrier itself shall be of the same shape and dimensions as shown on the plans. Shop drawings indicating the actual barrier construction and detailing the alternate connector embedment shall be provided.

617.4.2 The alternate connection shall be capable of developing the full tensile strength of the standard barrier system and shall have redirectional and end-on capabilities as per criteria identified in NCHRP 350 when used with the specified barrier. The assembled barrier shall contain or permit controlled penetration of a vehicle into the system in an acceptable manner for vehicles in the 1800 pounds (820 kg) to 4400 pounds (2000 kg) classes.

617.4.3 The manufacturer of the connector shall provide in their certification the maximum deflection recorded when crash tested for evaluation per criteria identified in NCHRP 350, or the manufacturer's engineering estimate of the maximum deflection expected based on NCHRP 350 criteria. All information shall be based on the connector use with the Type F concrete barrier.

617.4.4 Submittals shall be accompanied by a letter of acceptance from FHWA documenting their acceptance of the alternate connector system when used in conjunction with the specified Type F barrier.

617.5 Construction Requirements. Forms shall be mortar tight and sufficiently rigid such that a smooth, non-deformed surface meeting the specified tolerances is provided.

617.5.1 Construction Requirements for Types A, B, C and D Concrete Traffic Barrier.

617.5.1.1 Permanent concrete traffic barriers shall be constructed using an extrusion machine or other equipment specifically designed for constructing cast-in-place reinforced concrete barriers, provided the finished barrier is true to line and grade and the exposed surfaces are in accordance with Sec 617.3.5.

617.5.1.2 Precast units shall not be removed from forms and casting beds until a compressive strength of not less than 1400 psi (9.5 MPa) is attained. Compressive strength will be determined by tests in accordance with MoDOT methods.

617.5.1.3 Permanent traffic barrier shall be cured in accordance with Sec 502.12.

617.5.1.4 For permanent traffic barrier, surface shall be of smooth and even texture, true to line and grade. Surfaces which do not exhibit a smooth, even texture shall be sanded with power sanders or other approved abrasive means until the required texture is attained.

617.5.1.5 When cast-in-place or extruded construction is used, contraction joints shall be constructed as shown on the plans. Insertion of joint filler will not be required.

617.5.1.6 When concrete traffic barriers are required to be marked with a 13 inch (325 mm) stripe, the material shall be in accordance with Sec 620.50.

617.5.2 Construction Requirements for Type F Concrete Traffic Barrier.

617.5.2.1 Welding of loop steel shall be limited to the minimum surface welding necessary to maintain the position required for placement. Surface welds will be inspected by the engineer prior to placement of concrete. Any indications of welding beyond the surface of the bar will be cause for rejection of that bar.

617.5.2.2 Concrete barrier units shall not be removed from the forms until a minimum of 1750 psi (12 MPa) is attained and shall be continuously cured until 5000 psi (35 MPa) is attained. Exposed concrete immediately after casting shall be protected from water loss by use of plastic sheeting or damp burlap. After form removal, all units shall immediately be wetted and continuously cured in accordance with Sec 1026.16 except that Type 2, white pigmented, curing compound shall not be used. During all curing, the units shall be kept damp or well coated with curing compound at all times.

617.5.2.3 Concrete barrier units shall be straight and square on the ends and shall meet the following tolerances:

Dimension	Tolerance
Length	+3/4 inch (19 mm)
Width	+1/4 inch (6 mm)
Height	+1/4 inch (6 mm)

617.5.2.4 Concrete barrier units shall be substantially free of honeycomb, surface spalling, and surface defects. Corner breaks and spalls on new units shall not exceed one square foot (0.1 m^2) of surface, including the base, at the time of shipment from the manufacturer. Corner breaks and spalls for units placed on the project location shall not exceed 5 square feet (0.5 m^2) of surface including the base, at the time of placement. Units damaged in a crash after

placement shall be replaced immediately if the connector is damaged, if the barrier is broken or if the concrete is spalled to the extent that a colliding automobile moving in the direction of the adjacent traffic could be snagged. Units moved to another location shall be re-examined for excessive breaks and spalls and replaced if directed by the engineer.

617.5.2.5 Barrier sections damaged beyond reuse shall be removed and replaced at the contractor's expense. Damaged sections shall be removed from the right of way.

617.5.2.6 All barrier sections shall remain the property of the contractor unless specified otherwise in the contract.

617.5.2.7 All units shall have the name and location of the manufacturer and the year of manufacture clearly and permanently marked on the top or the end, by indentation, plates or other suitable methods, where it is identifiable after installation. Paint or other liquid marking will not be permitted. The day and month of production will be required for tracking prior to initial use, and may be permanently marked, or applied using permanent ink in the same location. Units which cannot be clearly identified shall not be used.

617.5.2.8 Connecting loops shall be true to dimensions and not deformed. Concrete barrier units with visual cracks in the steel forming the connecting loops will be rejected.

617.5.2.9 The gap between units shall not exceed the dimensions shown on the plans.

617.5.2.10 The connection method for the barrier units shall be of the same design in any continuous run of barrier.

617.5.2.11 The contractor shall keep any equipment or material at least 3 feet, 8 inches (1.1 m) away from the barrier to allow the barrier to perform as designed when impacted, except as approved by the engineer. In the case of an alternate connection to that shown on the plans, a distance equivalent to the deflection distance provided in the manufacturer's certification shall govern.

617.5.2.12 Delineators shall be provided by the contractor at the contractor's expense and installed on the barrier as shown on the plans.

617.6 Method of Measurement.

617.6.1 For the purpose of measurement and payment, Type A Concrete Traffic Barrier will be considered that which is cast or formed with two traffic faces regardless of the width of the barrier. Type B Concrete Traffic Barrier will be considered that which is cast or formed with one traffic face.

617.6.2 Measurement of concrete traffic barrier will be made to the nearest 1/2 linear foot (0.1 m) for each continuous length and totaled to the nearest linear foot (0.5 m) for the sum of the lengths. The length will be measured separately for each type. 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.

617.7 Basis of Payment. Accepted concrete traffic barriers will be paid for at the contract unit prices. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 620 – PAVEMENT MARKING

Delete Sec 620 and substitute the following: ***07/02***

SECTION 620

PAVEMENT MARKING

620.1 Description. This work shall consist of furnishing, installing and removing temporary and permanent pavement marking.

620.2 Construction Requirements.

620.2.1 General.

620.2.1.1 All pavement marking shall be in accordance with the latest edition of the MUTCD.

620.2.1.2 All pavement marking shall be installed as shown on the plans unless otherwise directed by the engineer.

620.2.1.3 All pavement marking shall be uniform in appearance.

620.2.1.4 Longitudinal pavement marking shall not be placed on longitudinal joints.

620.2.1.5 Damage to pavement marking caused by the contractor's operations, including resurfacing of shoulders, shall be repaired or replaced at the contractor's expense.

620.2.2 Permanent Pavement Marking.

620.2.2.1 Permanent pavement marking, except edge lines, shall be in place no later than five days after final paving operations. If edge lines are specified, edge lines shall be in place no later than 15 days after final paving operations.

620.2.2.2 On roadways open to traffic, any pavement marking obliterated by milling, grinding or resurfacing operations, except edge lines, shall be replaced with permanent pavement marking material specified in the contract or temporary pavement marking in accordance with Sec 620.2.3, no later than the end of the same day. If edge lines are specified, edge lines shall be the type of pavement marking material specified in the contract and placed no later than 15 days after final paving operations for each construction season. 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.

620.2.2.3 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.

620.2.2.4 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 as approved by the engineer.

620.2.3 Temporary Pavement Marking.

620.2.3.1 In lieu of installing the permanent pavement marking material specified in the contract, the contractor may, at the contractor's expense, provide and maintain temporary pavement marking. The temporary pavement marking shall be removed immediately prior to the installation of the permanent pavement marking material specified in the contract. Should the contractor choose this option, no more than one mile (1.6 km) of roadway behind the operation shall remain unmarked. At the end of each day, the temporary pavement marking shall be installed so, when combined with existing pavement marking, the entire project is marked.

620.2.3.2 On multiple lane roadways, temporary pavement marking shall be installed as shown on the plans.

620.2.3.3 On multiple lane roadways with two way traffic and "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 620.70. Sign WO8-12, "No Center Stripe", shall be installed throughout the section where the striping has been obliterated at one-half mile (1 km) intervals and 150 feet (45 m) from side roads or as shown on the plans. These signs shall be displayed only where the striping has been obliterated and shall be removed or covered where final striping is complete.

620.2.3.4 On resurfacing projects, when the adjacent layer of resurfacing has not been placed and the existing centerline or lane line 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 placed shall be replaced by the contractor at the contractor's expense.

620.2.4 Inspection and Acceptance.

620.2.4.1 Initial Inspection. Permanent pavement marking will be inspected following installation. The engineer will measure the initial retroreflectivity a minimum of seven days after, and within 14 days of application. If traffic control is required as determined by the engineer, the contractor shall provide approved traffic control at the contractor's expense.

620.2.4.1.1 If the initial performance inspection discloses any permanent pavement marking, in whole or in part, which does not meet the acceptance requirements, the contractor shall at the contractor's expense, repair or replace such work to the satisfaction of the engineer within 30 days. If more than 50 percent of any lane line, centerline or edge line is required to be replaced, the pavement marking shall be replaced in accordance with this specification.

620.2.4.1.2 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.

620.2.4.2 Acceptance.

620.2.4.2.1 Retroreflectivity inspection will be performed by the engineer using a Mirolux 30 or approved 30 meter geometry retroreflectometer. The engineer will take a minimum of five individual readings at two locations evenly spaced per one mile (1.6 km) section of each line. The engineer will average all readings for each color line to determine the retroreflectivity. Retroreflectivity acceptance requirements will be as follows:

Type of Material	**Color**	**Millicandelas/ft^2/footcandle Millicandelas/m^2/lux (Minimum Initial)**
Extruded Thermoplastic	White	300
	Yellow	225
Hot Spray Thermoplastic	White	300
	Yellow	225
Epoxy	White	300
	Yellow	225
Preformed Marking Tape	White	Per Manufacturer's Specifications
	Yellow	Per Manufacturer's Specifications
Paint	White	300
	Yellow	225

620.2.4.2.2 Initial visual inspection requirements shall be as follows:

(a) Lane lines shall be 90 percent by area of each individual dashed line segment.

(b) Crosswalks, stop lines, arrows and words shall be 90 percent by area of each individual line, symbol or letter.

(c) Centerlines, edge lines, gore markings and channelizing lines shall be 90 percent by area measured over any 10-foot (3 m) length of any individual line regardless of width.

(d) The project shall be measured in its entirety according to (a), (b) and (c) above, and the entire project shall be 95 percent intact.

620.3 Method of Measurement.

620.3.1 Measurement of pavement marking will be made as described in the following sections.

620.3.2 Measurement of "No Center Stripe" signs will be made to the nearest square foot (0.1 square meter).

620.4 Basis of Payment.

620.4.1 The accepted quantity of pavement marking 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 to complete the described work.

620.4.2 Payment for installing, maintaining, covering and removing "No Center Stripe" signs will be made at the contract unit price.

SECTION 620.10 PREFORMED PAVEMENT MARKING TAPE

620.10.1 Description. This work shall consist of furnishing and placing Type 1 preformed pavement marking tape at locations shown on the plans or as directed by the engineer. On bituminous surfaces, the contractor may use thermoplastic pavement marking material in lieu of Type 1 preformed marking tape at the Type 1 preformed marking tape contract unit price.

620.10.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Type 1 Preformed Marking Tape	1048.2

620.10.3 Construction Requirements.

620.10.3.1 Type 1 preformed pavement marking tape shall be installed as shown on the plans, or as directed by the engineer. Type 1 preformed pavement marking tape shall be installed according to the manufacturer's specifications.

620.10.3.1.1 Arrows, words and symbols shall be white and may be formed from one piece or multiple pieces of Type 1 preformed pavement marking tape material.

620.10.3.1.2 On bituminous surfaces, Type 1 tape shall be embedded or inlaid by the final roller or other roller as approved by the tape manufacturer. All rolling shall be completed prior to the surface temperature decreasing to 120 F (50 C).

620.10.3.2 Method of Measurement.

620.10.3.2.1 Measurement of 4-inch (100 mm), 6-inch (150 mm), 8-inch (200 mm) and 24-inch (600 mm) preformed marking tape will be made to the nearest linear foot (0.5 m). Where intermittent lines are specified, deductions will be made for the gaps in pavement marking.

620.10.3.2.2 Measurement of preformed marking tape arrows, words and symbols will be made per each.

620.10.3.2.3 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.

620.10.3.3 Basis of Payment. The accepted quantity of preformed pavement marking tape 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 to complete the described work.

SECTION 620.20 EXTRUDED THERMOPLASTIC PAVEMENT MARKING

620.20.1 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.

620.20.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Extruded Thermoplastic Marking Material	1048.3
Drop-On Glass Beads	1048.6

620.20.3 Construction Requirements.

620.20.3.1 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.

620.20.3.1.1 Melting Kettle. The melting kettle shall be capable of heating the thermoplastic material to its recommended application temperature without scorching and shall be capable of maintaining the application temperature. The heating 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.

620.20.3.1.2 Extruded Thermoplastic Dispensing Devices. Extrusion dispensing devices shall be capable of applying molten thermoplastic material in lines from 4 inches to 12 inches (100 mm to 300 mm) wide and 125 mils (3 mm) thick at the temperature recommended by the manufacturer of the thermoplastic material. Dispensing devices shall be of the extrusion type. The extrusion device shall have a visible temperature gauge to allow monitoring of the temperature of the thermoplastic material near the point of application.

620.20.3.1.3 Glass Bead Dispenser. All thermoplastic dispensers shall be equipped with a drop-on type glass bead dispenser. The glass bead dispenser shall be located so as to drop the glass beads immediately after the molten thermoplastic material is applied. 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.

620.20.3.2 Surface Preparation. The pavement surface on which the thermoplastic material is to be placed shall be clean and dry. Even if the pavement is visibly dry, subsurface moisture may be present in amounts sufficient to affect bonding. 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 mechanical bond between the thermoplastic and the pavement shall be removed by methods approved by the engineer.

620.20.3.3 Weather Limitations. The pavement surface where the thermoplastic material is to be placed shall have a minimum temperature of 60 F (15 C). The air temperature shall be at least 55 F (13 C) and rising during marking operations. The wind chill temperature shall be at least 45 F (7 C) 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. Temperatures shall be obtained in accordance with MoDOT Test Method T20.

620.20.3.4 Primer Application. Primer will not be required on new bituminous surfaces unless recommended by the manufacturer of the thermoplastic material. 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.

620.20.3.5 Thermoplastic Application. The thermoplastic marking material shall be extruded onto the pavement surface.

620.20.3.5.1 Thermoplastic marking material for use on new bituminous surfaces shall be alkyd thermoplastic. Material for use on other bituminous surfaces may be alkyd or hydrocarbon thermoplastic.

620.20.3.5.2 The temperature of the thermoplastic at the time of application shall be 400 to 425 F (204 to 218 C) for alkyd or hydrocarbon material. 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.

620.20.3.5.3 Alkyd or hydrocarbon thermoplastic material shall not be heated above 450 F (232 C). 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 two times. Material subjected to these conditions will be rejected.

620.20.3.5.4 Finished marking shall have well-defined edges, and lateral deviation shall not exceed one inch in 100 feet (25 mm in 30 m). The thickness of long line thermoplastic markings shall be 100 ± 10 mils (2.5 ± 0.3 mm). The thickness of thermoplastic pavement marking arrows, words, symbols and other intersection markings, excluding lines, shall be a minimum of 125 mils (3 mm) and a maximum of 188 mils (5 mm). To determine acceptance, the thickness of the marking will be measured above the pavement surface at random points as selected by the engineer.

(a) If the thickness at a given location is less than 90 mils (2.2 mm), 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 average thickness of the unacceptable portion is less than 90 mils (2.2 mm) but more than 60 mils (1.5 mm), an adjusted unit price of 50 percent of the contract unit price will be used in computing payment for the unacceptable area.

(b) If the measurements show the average thickness to be less than 60 mils (1.5 mm), the contractor shall grind the surface of the unacceptable portions of the markings to reduce the average thickness to approximately 50 mils (1.25 mm) or less. The contractor shall then apply additional thermoplastic material and beads to bring the thickness of the markings to a minimum of 90 mils (2.2 mm) and the retroreflectivity to the minimum required values. Corrections will be at the contractor's expense.

620.20.3.6 Glass Bead Application. The drop-on glass beads shall be mechanically deposited on the molten thermoplastic line immediately after placement of the thermoplastic at the rate of at least 12 pounds per 100 square feet (0.6 kg/m^2) of line. The glass beads shall not be dropped at the point of application of the thermoplastic or ahead of that point. Beads shall adhere to the cured thermoplastic or all marking operations shall cease until corrections are made.

620.20.3.7 Quality of Work. The applied thermoplastic marking shall be inspected continually for overall quality. Markings shall have clean cut edges and the finished yellow color shall be defined by Federal Test Standard 595 - Color Chip Number 13538 using Federal Test Standard 141 (Method 4252). Glass beads shall appear uniform on the entire marking surface. Adhesion to the pavement surface shall be checked with a stiff putty knife or similar instrument. The marking shall not be removable from a concrete surface. If the marking can be removed from the bituminous surface, residue of the bituminous substrate shall adhere to the marking material. If the thermoplastic marking does not provide initial nighttime reflectivity or have the required color, the contractor shall, grind the surface and apply additional thermoplastic material and beads in accordance with Sec 620.3.5.4(b).

620.20.3.8 Method of Measurement. Measurement of 4-inch (100 mm), 6-inch (150 mm), 8-inch (200 mm) and 24-inch (600 mm) extruded thermoplastic pavement marking will be made in accordance with Sec 620.10.3.2.

620.20.3.9 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. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

620.30 PREFORMED REMOVABLE PAVEMENT MARKING TAPE

620.30.1 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.

620.30.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Preformed Removable Pavement Marking Tape	1048.4

620.30.3 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 specifications.

620.30.4 Method of Measurement. Measurement of 4-inch (100 mm), 6-inch (150 mm), 8-inch (200 mm) and 24-inch (600 mm) preformed removable pavement marking tape will be made in accordance with Sec 620.10.3.2.

620.30.5 Basis of Payment. 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. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 620.40 PREFORMED SHORT TERM PAVEMENT MARKING TAPE

620.40.1 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. At the option of the contractor, pavement marking paint may be used in lieu of preformed short term pavement marking tape at the contractor's expense.

620.40.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Preformed Short Term Pavement Marking Tape	1048.5

620.40.3 Construction Requirements.

620.40.3.1 Preformed short term marking tape shall be installed according to the manufacturer's specifications.

620.40.3.2 The centerline marking shall be yellow for a two-lane road with opposing traffic and the lane lines shall be white for a two-lane road with one way traffic. Preformed short term pavement marking tape shall be applied in increments 4 feet (1.2 m) long parallel to the direction of traffic flow at approximately 40-foot (12 m) intervals.

620.40.3.3 The centerline marking of pavement of sufficient width to accommodate four or more undivided lanes carrying opposing traffic shall be marked with two parallel yellow lines separated by a 4-inch (100 mm) space. Lane lines for these pavements shall be white in increments 4 feet (1.2 m) long at approximately 40-foot (12 m) intervals.

620.40.4 Method of Measurement. Measurement of preformed short term pavement marking tape will be made in accordance with Sec 620.10.3.2.

620.40.5 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. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 620.50 PAINT FOR PAVEMENT MARKING

620.50.1 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 waterborne 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.

620.50.2 Material. Traffic paint shall be used as specified on the plans or as approved by the engineer. Glass beads shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Drop-On Glass Beads	1048.6

620.50.3 Construction Requirements.

620.50.3.1 Equipment. All equipment for application of pavement marking paint shall be of such design and maintained in such condition to properly and evenly apply marking paint and drop-on glass beads.

620.50.3.2 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.

620.50.3.3 Temperature 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 in accordance with MoDOT Test Method T20.

620.50.3.3.1 For waterborne applications the pavement surface temperature and ambient air temperatures shall be above 50 F (10 C). Waterborne paint shall not be applied if the forecast conditions for the 8 hours immediately following final application include precipitation or temperatures below 50 F (10 C).

620.50.3.3.2 For acrylic copolymer applications, the pavement surface temperature and ambient air temperature shall be above 35 F (2 C).

620.50.3.4 Paint Application.

620.50.3.4.1 Paint shall be machine applied using spray guns designed and adjusted to apply paint at 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.

620.50.3.4.2 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. Pre-cut templates to the dimensions shown on the plans shall be used for arrows, words and symbols.

620.50.3.4.3 Paint shall be applied to a minimum thickness of 15 mils (0.4 mm). At the request of the engineer, the wet film thickness of the applied paint shall be tested with a paint thickness gauge.

620.50.3.4.4 If necessary, paint may be heated to a maximum temperature of 150 F (65 C) for waterborne and 125 F (52 C) for acrylic copolymer before application.

620.50.3.4.5 Finished markings shall have well-defined edges and lateral deviation shall not exceed one inch in 100 feet (25 mm in 30 m).

620.50.3.5 Glass Bead Application. Drop-on glass beads shall be mechanically applied to the wet paint directly behind the paint spray guns. Glass beads shall be applied evenly at a minimum rate of 8 pounds per gallon (0.95 kg/L) of paint. For stop lines, arrows, words and symbols, glass beads may be applied by hand. Glass beads shall be applied evenly and completely cover the painted area. If beads do not embed properly in the paint, all marking operations shall cease until corrections are made.

620.50.3.6 Quality of Work. The applied marking paint shall be inspected continually for overall quality. 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 be defined by Federal Test Standard 595 - Color Chip Number 33538. 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 reflectivity or if the marking does not have the required minimum thickness or required color, the contractor shall, at the contractor's expense, re-apply the marking paint to the required thickness and shall meet all requirements as described above.

620.50.4 Method of Measurement. Measurement of 4-inch (100 mm), 6-inch (150 mm), 8-inch (200 mm) and 24-inch (600 mm) pavement marking paint will be made in accordance with Sec 620.10.3.2.

620.50.5 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. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 620.60 PAVEMENT MARKING REMOVAL

620.60.1 Description. This work shall consist of all necessary operations for removal of existing pavement markings, including the removal of painted lines, thermoplastic pavement marking, epoxy pavement marking, preformed pavement marking tape or preformed removable pavement marking tape when no longer required.

620.60.2 Construction Requirements. Removal of all pavement markings within the project limits shall be as shown on the plans or as directed by the engineer. Pavement markings shall be completely removed to the satisfaction of the engineer with minimal damage to the pavement. No more than five percent of the existing line shall remain. The pavement surface shall not be left scarred with an image which might mislead traffic. Any excess damage or scarring of the pavement shall be repaired at the contractor's expense.

620.60.3 Method of Measurement.

620.60.3.1 Measurement for the removal of pavement markings will be made to the nearest linear foot (0.5 m). 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.

620.60.3.2 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.

620.60.4 Basis of Payment. The accepted quantity of pavement marking removal 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 to complete the described work.

SECTION 620.70 TEMPORARY RAISED PAVEMENT MARKERS

620.70.1 Description. This work shall consist of installing and maintaining 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.

620.70.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Temporary Raised Pavement Markers	1048.7

620.70.3 Construction Requirements.

620.70.3.1 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 specifications.

620.70.3.1.1 Type 1 Temporary RPM's shall be used for surface treatment projects when temporary RPM's are specified.

620.70.3.1.2 Type 2 Temporary RPM's shall be used on all projects other than surface treatment projects when temporary RPM's are specified.

620.70.3.2 Temporary RPM's shall be placed at approximately 40-foot (12 m) intervals.

620.70.3.3 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. No direct payment will be made for the removal of temporary RPM's.

620.70.4 Method of Measurement.

620.70.4.1 Measurement of temporary raised pavement markers will be made per each.

620.70.4.2 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.

620.70.5 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. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

620.80 HOT SPRAY THERMOPLASTIC PAVEMENT MARKING

620.80.1 Description. This work shall consist of furnishing and placing thermoplastic pavement marking material formulated with alkyd resin and intermix beads, and applied by the hot spray process at a 45-mil (1.15 mm) or 60-mil (1.50 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.

620.80.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Hot Spray Thermoplastic Marking Material	1048.8
Drop-On Glass Beads	1048.6

620.80.3 Construction Requirements. Construction requirements shall be in accordance with Sec 620.20.3, except as follows.

620.80.3.1 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 (100 mm) to 12 inches (300 mm) wide at the specified thickness. Dispensing devices shall be of the spray type.

620.80.3.2 Thermoplastic Application. The thermoplastic marking material shall be sprayed onto the pavement surface.

620.80.3.2.1 The temperature of the thermoplastic material at the time of application shall be a minimum of 350 F (177 C) and a maximum of 425 F (218 C). 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.

620.80.3.2.2 Discoloration of material will be cause for rejection.

620.80.3.2.3 Alkyd thermoplastic material shall not be heated above 450 F (232 C). 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 two times. Material subjected to these conditions will be rejected.

620.80.3.2.4 Finished markings shall have well-defined edges and lateral deviation shall not exceed one inch in 100 feet (25 mm in 30 m). The thickness of the thermoplastic marking shall be within ± 5 mils (± 120 μm) 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.

(a) 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 average thickness of the unacceptable portion is less than the contract mil (mm) thickness, but no more than 15 mils (0.375 mm) less than the contract mil (mm) thickness, an adjusted unit price of 50 percent of the contract unit price will be used in computing payment for the unacceptable area.

(b) If the measurements show the average thickness to be more than 15 mils (0.375 mm) less than the contract mil (mm) thickness, the contractor shall grind the surface of the unacceptable portions of the markings to reduce the average thickness to approximately 20 mils (0.50 mm) less than the contract mil (mm) 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 (mm) thickness and the retroreflectivity to the minimum required values. Corrections will be at the contractor's expense.

620.80.4 Method of Measurement. Measurement of hot spray thermoplastic pavement marking will be made in accordance with Sec 620.10.3.2.

620.80.5 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. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

SECTION 622 – PAVEMENT SURFACE TEXTURING AND REMOVAL

Delete Sec 622.30.3.6 and substitute the following: ***01/02***

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.

SECTION 702 – BEARING PILE

Delete Sec 702 and substitute the following: ***01/00; 10/00; 01/02; 04/02***

SECTION 702

BEARING PILE

702.1 Description. This work shall consist of furnishing and driving concrete and steel piles to the bearing and penetration required, at the location shown on the plans.

702.2 Material.

702.2.1 All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section/ Specification
Reinforcing Steel for Concrete	1036
Steel Strand	AASHTO M 203
Cast-In-Place Pile Shells (Thick Shell Type) Welded or Seamless Steel Pipe	ASTM A 252
Closure Plates	ASTM A 36
Fluted Pipe	SAE-1010 or SAE-1015
Forged Steel Tips or Noses	SAE-1020
Structural Steel Pile	ASTM A 36
Pile Point Reinforcement	ASTM A 27 Grade 65-35 (450-240) or ASTM A 148 Grade 90-60 (620-415)

702.2.2 Precast Concrete Piles. Precast concrete piles shall be manufactured of Class A-1 concrete to the shape and size 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. Precast piles shall be straight, with a centerline variation of not more than 1/2 inch per 25-foot (1.6 mm/m) length of pile. Precast concrete piles shall be lifted and handled by a suitable bridle attached to the pile at points shown on the plans. Unless the concrete is steam cured in accordance with Sec 703.3.17, removal of precast concrete from casting beds shall not begin for at least 48 hours after casting and not then until a compressive strength of 1500 pounds per square inch (10 MPa) has been attained. If the concrete is steam cured, removal shall not begin until a compressive strength of 1500 pounds per square inch (10 MPa) has been attained. Curing shall be continued for at least 24 hours after a compressive strength of 2400 pounds per square inch (17 MPa) has been attained. Precast piles shall not be transported or driven until at least 7 days after casting and then only if the compressive strength of 2400 pounds per square inch (17 MPa) has been attained. Compressive strength of concrete shall be determined by tests of standard cylinders made of concrete from the same batches and cured in the same manner as the piles.

702.2.3 Precast-Prestressed Concrete Piles. Precast-prestressed concrete piles may be furnished in lieu of precast concrete piles. They shall be manufactured in accordance with Sec 705 using Class A-1 concrete. End anchors shall not be released until the concrete has attained a compressive strength of 4000 pounds per square inch (28 MPa) as determined by tests of standard cylinders made of concrete from the same batches and cured in the same manner as the piles.

702.2.4 Cast-In-Place Concrete Piles. Cast-in-place concrete piles shall consist of Class B-1 concrete cast in pre-driven metal shells. The metal shells shall conform to 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. Metal shells driven with or without a core or mandrel shall be of sufficient thickness or shall be reinforced so that they will hold their original form without distortion after being driven. Metal pile shells shall be free from water, soil and other deleterious matter when concrete is cast in them. The contractor shall maintain on the job at all times prior to and during the filling of the shells, a light suitable for use in their inspection.

702.2.5 Structural Steel Piles. Structural steel piles shall be of the series rolled as H-bearing piles. They 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 (10.4 mm) multiplied by the length of pile in feet (meters) divided by five. Steel piles shall be stored on platforms, skids or other supports at the site of the work and shall be supported at not more than 15-foot (4.5 m) intervals.

702.2.6 Pile Point Reinforcement. Pile point reinforcement shall be furnished and installed on structural steel piles at locations as shown on the plans and in accordance with Sec 712 except as modified herein.

702.2.7 Pile Length. The pile lengths shown on the plans are approximate. The contractor shall be fully responsible for the lengths the contractor furnishes for driving to obtain the specified bearing and penetration. Sub-surface investigations made by the Commission are for design purposes only.

702.2.8 Test Piles. Test piles shall be the same material and size as the permanent piles. Test piles of precast concrete shall, in general, be driven in permanent position. Test piles shall be of such length as to permit driving the tips to an elevation 10 feet (3 m) below that indicated by plan lengths unless otherwise specified.

702.2.9 Certifications. For structural steel piles and thick 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 Concrete Testing Equipment. Equipment for field determination of compressive strength of concrete shall be furnished by the contractor at the location of manufacture of precast and precast-prestressed piles. The testing machine may be of any mechanical or hydraulic type capable of applying and measuring the required load and shall comply with the accuracy tolerances and corrections specified in AASHTO T 67, Section 16.1 and Section 17. Approximately the last one-half of the load shall be applied at a rate of between 1200 and 3000 pounds per square inch (8 and 21 MPa) per minute. The contractor shall furnish a sufficient number of 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.

702.3.2 Driving Equipment. The contractor shall furnish pile driving equipment adequate for handling the length of pile to be placed in the leads and for driving the total length of pile to the tip penetration and bearing required. Piles shall be driven with power-driven hammers, or by a combination of power-driven hammer and water jets. Power-driven hammers are 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, 75 percent of the manufacturer's energy rating for the hammer will apply. 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 no additional cost to the Commission, and the checked rating of the diesel powered hammer will be used in determination of pile bearing values at that site. Diesel hammers which 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.

702.3.3 Leads. Pile driver leads shall be constructed in such manner as to afford freedom of movement of the hammer, and they 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.

702.3.4 Followers. Followers may be used in the driving of 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 bearing value of the group.

702.3.5 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 the piles shall be driven to secure a final penetration of not less than 2 feet (600 mm) if the nature of the soil permits.

702.3.6 Hammer Energy. The minimum energy developed by hammer per blow shall not be less than shown in Table I.

TABLE I **Hammer Energy**	
ENGLISH	
Type of Pile	Minimum Hammer Energy Required per blow, foot-pound (ft-lb)
Precast Concrete	1.0 ft-lb/lb times the total pile weight in pounds but not less than 8000 ft-lb.
Steel Shells for Cast-In-Place	3.0 ft-lb/lb times the total pile weight in pounds, including mandrel if used, but not less than 8000 ft-lb.
Structural Steel	The largest of the following: (1) 3.0 ft-lb/lb times the total pile weight in pounds. (2) 225 ft-lb/ton times the pile bearing value in tons. (3) 7000 ft-lb.

METRIC	
Type of Pile	Minimum Hammer Energy Required per blow, Newton-meter (N-m)
Precast Concrete	3.0 N-m/kg (mass) times the total pile mass in kilograms but not less than 11,000 N-m.
Steel Shells for Cast-In-Place	9.0 N-m/kg (mass) times the total pile mass in kilograms, including mandrel if used, but not less than 11,000 N-m.
Structural Steel	The largest of the following: (1) 9.0 N-m/kg (mass) times the total pile mass in kilograms. (2) 35.0 N-m/kN times the pile bearing value in kN. (3) 9500 N-m.

702.4 Construction Requirements.

702.4.1 The contractor shall furnish and drive test piles at locations specified. Where required, test piles shall be driven full length, or to refusal, or to a capacity 50 percent greater than that shown on the plans. In all cases the test

piles shall be driven to not less than the minimum tip elevation shown on the plans for permanent piles. Test piles shall be driven with the same type of equipment as will be used for driving the permanent piles. Before driving test piles, the excavation shall be completed to an elevation not more than 2 feet (600 mm) above the proposed grade at the point where a test pile is to be driven. Test piles not driven in a permanent location shall be cut off, or pulled and backfilled, as approved by the engineer.

702.4.2 Foundation 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 them to excessive and undue abuse. Any pile broken or damaged by reason of internal defects or by improper driving, or driven out of its proper location shall be removed and replaced, or a second pile may be driven adjacent thereto if this can be done without detriment to the structure as determined by the engineer.

702.4.3 Where piles are to be driven through more than 5 feet (1.5 m) of compacted embankment, which has been in place for less than five years, prebored holes will be required 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 be of a diameter not less than that of the pile. The space remaining around any type pile after it is driven shall be completely filled with sand or other approved material.

702.4.3.1 Other locations where preboring for piles is 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 not 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. 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. The pile shall then be driven in accordance with the requirements of Sec 702.4.11.

702.4.4 Final position of piles shall be not more than 1/4 inch per foot (20 mm/m) 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 not more than 2 inches (50 mm), except that piles in footings entirely below the finished ground line may not vary more than 6 inches (150 mm). All piles pushed up by the driving of adjacent piles, or by any other cause, shall be redriven to required bearing and penetration. Improperly driven, broken or otherwise defective shells shall be removed and replaced, or otherwise corrected to the satisfaction of the engineer.

702.4.5 Pile Point Reinforcement. Each point shall be made in one piece of cast steel with the minimum web and flange thickness equal to that portion of the pile being attached thereto multiplied by the factor (t) shown below.

Material	**(t)**
ASTM A27 Grade 65-35 (450-240)	2.0
ASTM A148 Grade 90-60 (620-415)	1.6

702.4.5.1 The point shall extend onto the pile a minimum of 1/2 inch (13 mm) 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 transitioning to a protrusion of not less than its 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, whether it be totally by point extension or combination of point extension and attached backing plate.

702.4.5.4 The point extension onto the web of the pile may be omitted if alternating 1 1/2 inch (39 mm) by 1/4 inch (7 mm) 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 welder certified by MoDOT. Properly dried low hydrogen electrodes of the E70XX series shall be used with adequate protection from the elements in accordance with Sec 712.8. The contractor shall be fully responsible for the adequacy of welds during driving.

702.4.6 Splices. Extending and splicing of piles is not desirable and full length piles shall be driven wherever possible and practicable. The number of splices used shall be held to a minimum. If extensions and splices are permitted or required by the engineer, they shall be made as follows:

702.4.6.1 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 712.3.3.7 and performed by a MoDOT certified field welder using properly dried low-hydrogen E7018 electrodes that have been protected from the elements to maintain the dry condition. The contractor shall be fully responsible for the adequacy of welds during driving. 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 will be permitted to furnish lengths of cast-in-place pile shells which incorporate not more than one splice per pile or structural steel piles which incorporate not more than one splice per pile for lengths up to and including 40 feet (12 m). Not more than two splices will be permitted in each structural steel pile furnished for lengths exceeding 40 feet (12 m). In preparation of piles prior to driving, the use of individual sections less than 8 feet (2.5 m) long will not be permitted. Additional field splices necessary to extend structural steel piles or cast-in-place pile shells to reach adequate bearing material shall be limited to one per pile, unless authorized by the engineer.

702.4.6.2 Precast and precast-prestressed concrete piles driven below plan elevations shall be extended by build-up construction. The forms for extensions of concrete piles shall remain in place at least 24 hours. The extension shall be cured in accordance with Sec 703.3.17 and the exposed surfaces shall be finished in accordance with Sec 703.3.15.

702.4.7 Cut-Offs. Tops of all piles shall be cut off square at cut-off elevations.

702.4.8 Protective Coatings. Before the coatings are applied, the steel shall be thoroughly cleaned. Steel shells and structural steel piles in end bents shall be coated with a heavy coating of an approved bituminous paint applied for a length of 3 feet (1 m) below the bottom of the concrete cap. All exposed steel piles shall be coated with bituminous paint 3 feet (1 m) below and one foot (300 mm) above the finished ground line. All other exposed surfaces of steel shells and structural steel piles, including bracing, shall be painted in accordance with Sec 712.12 using System G, if there is no pay item for paint included in the contract; and the specified system if the contract contains a pay item for paint. Protective coatings below the normal low water line will not be required.

702.4.9 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 (6 m) of concrete that has taken initial set and has not attained a compressive strength of at least 1500 pounds per square inch (10 MPa). Compressive strength will be determined by tests made in accordance with MoDOT methods.

702.4.10 Static Load Tests. The bearing value of piles shall be determined by actual load tests if specified or ordered by the engineer. The test shall consist of the application of a load placed upon a suitable platform supported by the pile, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. Hydraulic jacks with suitable yokes and pressure gauges may be used in lieu of the loaded platform. The test load shall be applied to exert a uniform pressure over the pile being tested. Prior to the driving of the pile to be loaded, the contractor shall submit to the engineer plans for applying the test load. Sketches showing arrangement of apparatus for obtaining settlements and recovery measurements of the test shall also be furnished to the engineer. Two gauges shall be used to measure settlement and recovery of the pile loaded, and at least one gauge shall be used on each hold-down pile to measure uplift if the hold-down system of load application is used. All test loads shall be applied concentrically and shall be kept uniform by constant attention to load gauge readings and jacking applications. The driven pile shall not be disturbed for at least 24 hours prior to the application of any portion of the test load. The load shall be applied in 25 percent increments of the total load, allowing rest periods of six, twelve and six hours respectively between the increment of loading. The safe allowable load per pile shall be considered as 50 percent of that load which, after remaining in place for 48 hours, produces a permanent settlement not greater than 1/4 inch (6 mm), measured at the top of the pile. All test loads shall be removed at 30 minute intervals in the same increments specified for placing, and readings for recovery shall be taken just prior to the removal of each increment. If results of the load tests are not satisfactory, the engineer will make arrangements for such corrective changes as deemed necessary which may include redesign of the foundations. No compensation will be allowed for any delay or inconvenience caused by corrective changes or redesign.

702.4.11 Dynamic Bearing Formulas. The following formulas will be used as a guide to determine the safe bearing value of piles if static load tests are not required.

ENGLISH					
P	=	$\frac{2WH}{(S+0.1)}$	.	$\frac{2W}{(W+w)}$	*for single acting hammers.
P	=	$\frac{2E}{(S+0.1)}$	.	$\frac{2W}{(W+w)}$	*for double acting hammers and diesel powered hammers with enclosed rams and bounce pressure gauges.
P	=	$\frac{2(0.75E)}{(S+0.1)}$	.	$\frac{2W}{(W+w)}$	*for all other diesel powered hammers unless tested as specified in Sec 702.3.2.

METRIC					
P	=	$\frac{1636WH}{(S+2.54)}$	.	$\frac{2W}{(W+w)}$	*for single acting hammers.
P	=	$\frac{167E}{(S+2.54)}$	.	$\frac{2W}{(W+w)}$	*for double acting hammers and diesel powered hammers with enclosed rams and bounce pressure gauges.
P	=	$\frac{167(0.75E)}{(S+2.54)}$	.	$\frac{2W}{(W+w)}$	*for all other diesel powered hammers unless tested as specified in Sec 702.3.2.

*The value of $\frac{2W}{(W+w)}$ shall be considered unity if it exceeds one.

P = safe allowable bearing value in pounds (newtons).
W = weight (mass) of striking part of hammer in pounds (kilograms).
w = weight (mass) of pile and mandrel in pounds (kilograms).
H = height of fall in feet (meters).
E = manufacturer's rated energy in foot-pounds (joules) per blow at manufacturer's rated speed, or in case of a diesel hammer equipped with a bounce pressure gauge the actual energy shown by the gauge chart.
S = average penetration in inches (mm) per blow for 10 to 20 consecutive blows.

702.4.11.1 The above formulas are applicable only if:

(a) The piles are driven in a vertical position.

(b) The hammer has an unrestricted fall.

(c) The pile head is not broomed, crushed or splintered.

(d) There is no appreciable bounce of the hammer after striking the pile.

(e) The penetration is at a uniform or uniformly decreasing rate.

702.4.11.2 For piles driven to a batter, the safe bearing value of the pile shall be taken as follows:

$$P_B = \frac{0.1\,(10-m)}{(1+m^2)} \times P$$

P_B = safe allowable bearing value in pounds (newtons) for batter pile.
m = the tangent of the angle of batter.
P = safe allowable bearing value in pounds (newtons) for vertical pile.

702.4.12 Piles shall be driven to the minimum penetration indicated on the plans. If no minimum penetration is shown on the plans, piles shall have a tip elevation at least 10 feet (3 m) below the bottom of the supported footing or 10 feet (3 m) below the natural ground line, whichever is lower, unless specifically authorized otherwise by the

engineer. Piles other than structural steel piles shall be driven to attain a bearing value not less than that shown on the plans, determined in accordance with Sec 702.4.10. Structural steel piles shall in general be driven to practical refusal which is defined as a pile bearing value of 1.9 times the design bearing value. In general, concrete piles shall not be driven to a bearing value in excess of 10 tons (90 kN) over the design bearing value.

702.5 Method of Measurement.

702.5.1 Piles in place shall be the actual length of all piles, except test piles, measured to the nearest foot (0.5 m) for that portion of each pile that remains permanently in the structure.

702.5.2 Test piles will be measured to the nearest linear foot (0.5 m) of pile authorized and driven.

702.5.3 Precast and precast-prestressed concrete piles with built-up extensions will be considered single piles for measurement. No measurement will be made for the length of pile destroyed when making the extension.

702.5.4 No measurement will be made for that excavation required to apply protective coatings. Measurement of prebored holes required under the provisions of Sec 702.4.3 will be made to the nearest linear foot (0.5 m) of each hole specified or directed by the engineer. 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.

702.5.5 Pile point reinforcement will be measured per each and shall include all material, equipment, labor and any other incidental work necessary to complete this work in accordance with Sec 702.4.5.

702.6 Basis of Payment.

702.6.1 The accepted quantity of bearing pile 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 incidental items necessary to complete the work unless specifically provided as a pay item in the contract. No direct payment will be made for painting exposed surfaces of steel shells, structural steel piles and bracing.

702.6.2 Test piles will be paid for at the contract unit price. Test piles if driven and used as permanent piles in place will be paid for as test piles and not as piles in place.

702.6.3 No payment will be made for any cut-offs.

702.6.4 Loading test will be paid for at the contract unit price. Piles tested will be paid for as accepted bearing pile.

702.6.5 Pile point reinforcement, where specified, will be paid for at the contract unit price per each.

702.6.6 Payment for preboring as specified in Sec 702.4.3 will be made at the contract unit price. No direct payment will be made for backfilling.

702.6.7 If a splice is authorized to extend a structural steel or steel shell pile to reach adequate bearing material, the only splices that will be paid for are those required to extend the pile after plan length plus 10 percent has been driven. Splices, if authorized, will be paid for as an additional 8 feet (2.5 m) of pile in place at the contract unit price.

SECTION 703 – CONCRETE MASONRY CONSTRUCTION

Delete Sec 703.3.17.3 and substitute the following: ***01/02***

703.3.17.3 Light material and equipment, weighing less than 1000 pounds (450 kg), may be carried onto the bridge deck only after the deck concrete has been in place at least 24 hours, providing curing is not interfered with and the surface texture is not damaged. Vehicles needed for construction activities and weighing between 1000 and 4000 pounds (450 and 1800 kg), and comparable material and equipment loads, shall not be moved onto any span until after the last placed deck concrete has attained a compressive strength of at least 3200 pounds per square inch (22 MPa). Loads in excess of the above shall not be moved onto the bridge deck until the deck concrete has reached the compressive strength specified in the contract.

Amend Sec 703.3.17 to include the following: ***01/02***

703.3.17.4 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 concrete has attained the compressive strength specified in the contract.

Delete Sec 703.5.2 and substitute the following: ***10/00***

703.5.2 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 (cubic meter) at the fixed price specified in Sec 109.14.

SECTION 705 – PRESTRESSED CONCRETE MEMBERS FOR BRIDGES

Delete Sec 705.2.1 and substitute the following: ***01/02***

705.2.1 All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	**Section**
Reinforcing Steel for Concrete Structures	1036.1
	Specification
Structural Steel	ASTM A 36
Structural Steel (for anchorage plates)	AASHTO M 223, Grade 50
Steel Strand	AASHTO M 203
Wire and Parallel-Lay Wire Cables	AASHTO M 204
High-Tensile Strength Alloy Bars	AASHTO M 275

SECTION 710 – EPOXY COATED REINFORCING STEEL

Delete Sec 710.3.2.1 and substitute the following: ***01/01***

710.3.2.1 Epoxy coated bars shall be placed on wire 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. Plastic bar supports shall meet or exceed the load carrying capacity of, and use the same spacing as, metal bar supports, and shall be molded in a configuration that does not restrict concrete flow and consolidation around and under the bar support. When placing epoxy coated bars, they shall be prevented from coming into contact with other steel items such as drains and shear connectors.

SECTION 712 – STRUCTURAL STEEL CONSTRUCTION

Delete Sec 712.2.1.1 and substitute the following: ***01/01***

712.2.1.1 Bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with the requirements of AASHTO M 232 (ASTM A 153), Class C or mechanically galvanized in accordance with the requirements of AASHTO M 298 (ASTM B 695), Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils (150 µm).

Delete Sec 712.2.1.2 and substitute the following: ***04/02***

712.2.1.2 Fasteners are not required to be galvanized when installed prior to the completion of shop blast cleaning.

Delete Sec 712.2.4 and substitute the following: ***04/02***

712.2.4 High Strength Fastener Assemblies. In addition to the requirements of 712.2.3, high strength bolts, nuts and washers shall meet the following requirements. The contractor shall furnish a manufacturer's certification showing results of tests performed in accordance with these requirements. 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.

712.2.4.1 Bolts. All bolts shall be in accordance with AASHTO M164 (ASTM A325) and the following requirements. If the contractor elects to use load indicator bolts, a button head will be permitted. The type of head used shall be consistent throughout the entire structure, unless otherwise permitted.

712.2.4.1.1 Hardness required by AASHTO M164 (ASTM A325) for bolt diameters 1/2 inch (12.7 mm) to 1 inch (25.4 mm) inclusive shall be modified as noted below:

	Hardness Number			
Bolts Size, In. (mm)	**Brinnel**		**Rockwell C**	
	Min.	Max.	Min.	Max.
1/2 to 1 inch (12.7 to 25.4 mm)	248	311	24	33

712.2.4.1.2 Proof load tests in accordance with ASTM F606 Method 1 shall be performed. Minimum frequency of tests shall be in accordance with AASHTO M164 (ASTM A325).

712.2.4.1.3 Wedge tests on full size bolts in accordance with ASTM F606, paragraph 3.5 shall be performed. If bolts are to be galvanized, tests shall be performed after galvanizing. Minimum frequency of tests shall be in accordance with AASHTO M164 (ASTM A325).

712.2.4.1.4 The thickness of the zinc coating of galvanized bolts shall be measured on the wrench flats or top of the bolt head.

712.2.4.2 Nuts. All nuts shall be in accordance with AASHTO M292 (ASTM A194) as applicable or AASHTO M291 (ASTM A563) except as follows.

712.2.4.2.1 Nuts to be hot dip or mechanically galvanized shall be heat treated grade 2H, DH or DH3.

712.2.4.2.2 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.

712.2.4.2.3 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 AASHTO M291 (ASTM A563) and the rotational-capacity test. The overtapping requirements of ASTM A563 shall apply except these limits shall be considered maximum values instead of the minimum, as it is currently shown.

712.2.4.2.4 All galvanized nuts including ASTM A194 nuts shall meet the supplementary requirements of ASTM A563. Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

712.2.4.2.5 Proof load tests in accordance with ASTM F606 shall be performed. Minimum frequency of tests shall be in accordance with AASHTO M291 (ASTM A563) or AASHTO M292 (ASTM A194). If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping and lubricating.

712.2.4.2.6 The thickness of the zinc coating on the galvanized nuts shall be measured on the wrench flats.

712.2.4.2.7 When Type 3 fasteners are specified for use with weathering steel, nuts shall be in accordance with AASHTO M291 (ASTM A563) and shall be grades C3 or DH3.

712.2.4.3 Washers. All washers shall be in accordance with AASHTO M293 (ASTM F436) and the following requirements.

712.2.4.3.1 Hardness testing shall be performed on galvanized washers. The coating shall be removed prior to taking hardness measurements.

712.2.4.3.2 The thickness of the zinc coating on galvanized washers shall be measured.

712.2.4.4 Rotational-Capacity Tests. Rotational-capacity tests shall be performed on all black or galvanized (after galvanizing) bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Washers shall be part of the test regardless if they are not required as part of the installation procedure.

712.2.4.4.1 Except as modified herein, the rotational-capacity test shall be performed in accordance with AASHTO M164 (ASTM A325).

712.2.4.4.2 Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, washers need not be included in the lot identification.

712.2.4.4.3 A rotational-capacity lot number shall be assigned to each combination of lots tested.

712.2.4.4.4 The minimum frequency of testing shall be two assemblies per rotational-capacity lot.

712.2.4.4.5 The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device.

712.2.4.4.6 The minimum rotation, from a snug tight condition (10% of the specified proof load), shall be as follows:

Bolt Length	**Rotation**
< 4 Diameters	240° (2/3 turn)
> 4 Diameters and < 8 Diameters	360° (1 turn)
> 8 Diameters	480° (1 1/3 turn)

712.2.4.4.7 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 A325 bolts shall be as follows:

Diameter (In.)	**1/2**	**5/8**	**3/4**	**7/8**	**1.00**	**1-1/8**	**1-1/4**	**1-3/8**	**1-1/2**
Req. Installation Tension (kips)	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	14	22	32	45	59	64	82	98	118

Diameter (mm)	**12.7**	**15.9**	**19.0**	**22.2**	**25.4**	**28.6**	**31.8**	**34.9**	**38.1**
Req. Installation Tension (kN)	53	85	125	173	227	249	316	378	458
Turn Test Tension (kN)	62	98	142	200	262	285	365	436	525

712.2.4.4.8 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:

$$\text{Torque} \leq 0.25\ PD$$

Where:

Torque = measured torque, foot-pounds (N-m)
P = measured bolt tension, pounds (N)
D = bolt diameter, feet (m)

712.2.4.4.9 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 712.2.4.4.7.

712.2.4.5 Reporting. The results of all tests, including zinc coating thickness, required herein and in the applicable AASHTO/ASTM specifications shall be recorded on the appropriate document. Location and date of tests performed shall be reported on the appropriate document.

712.2.4.6 Witnessing. The tests need not be witnessed by an inspection agency. The manufacturer or distributor performing the tests shall certify the results are accurate.

712.2.4.7 Documentation for High Strength Fastener Assemblies.

712.2.4.7.1 Mill Test Reports (MTR). An MTR shall be furnished for all mill steel used in the manufacture of the bolts, nuts or washers. The MTR shall indicate the place where the material was melted and manufactured.

712.2.4.7.2 Manufacturer Certified Test Reports (MCTR). The manufacturer of the bolts, nuts and washers shall furnish the MCTR for the item furnished. Each MCTR shall show the relevant information required in accordance with Sec 712.2.4.5. The manufacturer performing the rotational-capacity test shall include on the MCTR:

(a) The lot number of each of the items tested.

(b) The rotational-capacity lot number as required in Sec 712.2.4.4.3.

(c) The results of the tests required in Sec 712.2.4.5.

(d) The pertinent information required in Sec 712.2.4.4.2.

(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.

712.2.4.7.3 Distributor Certified Test Reports (DCTR). The 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 reported on the DCTR. The DCTR shall show the following:

(a) The results of the tests required in Sec 712.2.4.5.

(b) The pertinent information required in Sec 712.2.4.4.2.

(c) The rotational-capacity lot number as required in Sec 712.2.4.4.3.

(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 712.2.1.1

712.2.4.8 Shipping of High Strength Fastener Assemblies. Bolts, nuts and washers, where required, from each rotational-capacity lot shall be shipped together in proportionate quantities for use in the same containers. 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.

Delete Sec 712.3.1.1 and substitute the following: ***04/02***

712.3.1.1 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 (1600 km) of Jefferson City. 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 Project Operations. 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 (1600 km)

from Jefferson City, shall be borne by the contractor. In such cases, the contractor will be charged with transportation costs and expenses of QA inspectors for trips made from Jefferson City to locations to which they must travel for shop inspection work. These transportation costs and expenses of QA inspectors will be deducted by the Commission from monies due the contractor.

Amend Sec 712.10.2 to include the following: ***04/02***

712.10.2.7 A Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device shall 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.

712.10.2.8 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 they are not required as part of the installation procedure.

712.10.2.9 Weathered or rusted bolts or nuts not in accordance with Secs 712.10.2.7 and 712.10.2.8 shall be cleaned and relubricated prior to installation. Recleaned or relubricated bolt, nut and washer assemblies shall be retested in accordance with Sec 712.10.2.8 prior to installation.

712.10.2.10 Bolt, nut and washer (when required) combinations as installed shall be only from the established and tested rotational-capacity lot.

712.10.2.11 Calibrated wrench tightening shall 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 allowed in Sec 712.10.2.4 Table II.

SECTION 725 – METAL PIPE AND PIPE-ARCH CULVERTS

Delete Sec 725 and substitute the following: ***04/00; 04/01***

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 contract will specify either the type of pipe or the group of permissible types of pipe. If Group B pipe is specified, the contractor shall use any of the types listed as follows:

Reinforced Concrete Pipe
Corrugated Metallic-Coated Steel Pipe
Corrugated Aluminum Alloy Pipe
Corrugated Polyethylene Pipe

725.1.3 If the contract specifies corrugated metallic-coated steel pipe culverts of 60-inch (1500-mm) diameter or larger, the contractor may substitute structural plate pipe of like sizes, lengths and thicknesses of steel, constructed in accordance with the requirements of Sec 727 at no additional cost to the Commission.

725.1.4 If the contract specifies corrugated metallic-coated steel pipe or corrugated aluminum alloy pipe, or if the contract specifies pipe culverts by group and the contractor elects to furnish corrugated metallic-coated steel pipe or corrugated aluminum alloy pipe, the thickness of metal and size of corrugation for the respective pipe size shall be

as shown on the plans unless otherwise specified. 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.

725.1.5 If the contract specifies pipe culverts by group and the contractor elects to furnish vitrified clay or reinforced concrete pipe, the culvert shall be constructed in accordance with Sec 726. If the contractor elects to furnish corrugated polyethylene pipe, the culvert shall be constructed in accordance with Sec 730.

725.1.6 The thickness of metal, type of coating or size of corrugation shall not be changed throughout the length of any individual pipe culvert.

725.1.7 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:

Item	Section
Corrugated Metallic-Coated Steel Culvert Pipe, Pipe-Arches and End Sections	1020
Corrugated Aluminum Alloy Culvert Pipe	1024
Bituminous Coated Corrugated Metal Culvert Pipe, Pipe Arch and End Sections	1021

Construction Requirements

725.3 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 ½ in. (13 mm) 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.

725.4 Laying Pipe.

725.4.1 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.

725.4.2 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.

725.5 Bedding & Backfill Material.

725.5.1 Backfill material for metal culverts shall consist of gravel, sand or sandy silt soil as shown on the plans.

725.5.1.1 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 Al or A3.

725.5.1.2 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.

725.5.2 Bedding material shall have a maximum particle size of 1.5 inches (38 mm). Backfill shall be free of organic material or frozen clumps and shall not contain stones larger than 3 inches (75 mm).

725.6 Installation.

725.6.1 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.

725.6.2 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 725.6.1. 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.

725.6.3 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 (300 mm) 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 725.6.1.

725.6.4 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.

725.6.5 Backfilling. Backfilling shall be done as soon as practicable. 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 (200 mm) 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 (200-mm) 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 one foot (300 mm) 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 (0.6 m) 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.

725.6.6 Shop Elongation. Round corrugated steel pipe of 54 inches (1350 mm) or greater in diameter shall be shop elongated. Corrugated steel pipe 48 inches (1200 mm) 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.

725.6.7 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.

725.6.8 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.

725.7 Corrugated Metal Drop Inlets. The contractor shall install corrugated metal drop inlets of the proper size and length at the locations shown on the plans. The drop inlet shall be constructed of the same base metal and thickness of corrugated metal used in the culvert pipe and shall meet all applicable requirements of Sec 1020 or 1024.

725.8 Corrugated Metal Curtain Walls. The contractor shall install metal curtain walls of the proper size and shape at locations shown on the plans. Metal curtain walls shall be constructed of the same base metal used in the culvert pipe, shall be of the thickness of metal shown on the plans and shall meet all applicable requirements of Sec 1020 or 1024.

725.9 Method of Measurement.

725.9.1 Measurement of corrugated metal pipe or pipe-arch, complete in place, will be made to the nearest foot (0.5 m) 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.

725.9.2 Excavation for placing pipe, pipe-arches, corrugated metal drop inlets and metal curtain walls will be measured and paid for as Class 3 Excavation in accordance with Sec 206.

725.10 Basis of Payment.

725.10.1 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.

725.10.2 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.

725.10.3 The accepted quantities of corrugated metal drop inlets, and metal curtain walls, complete in place including coupling bands, toeplates, nuts and bolts will be paid for at the unit price for each pay item included in the contract.

SECTION 726 – RIGID PIPE CULVERTS, STORM DRAINS AND SEWERS

Delete Sec 726 and substitute the following: ***04/00; 10/01***

SECTION 726

RIGID PIPE CULVERTS, STORM DRAINS AND SEWERS

726.1 Description.

726.1.1 This work shall consist of concrete and vitrified clay pipe of the diameter or shape designated, laid upon a bed as specified on the plans and backfilled as specified.

726.1.2 The contract will specify either the type of pipe or the group of permissible types of pipe. If Group B pipe is specified, the contractor shall use any one of the types listed as follows:

Reinforced Concrete Pipe
Corrugated Metallic-Coated Steel Pipe
Corrugated Aluminum Alloy Pipe
Corrugated Polyethylene Pipe

726.1.3 If the contract specifies reinforced concrete pipe, or if the contract specifies pipe culverts by group and the contractor elects to furnish reinforced concrete pipe, 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.

726.1.4 If the contract specifies vitrified clay pipe, or if the contract specifies pipe culverts by group and the contractor elects to furnish vitrified clay pipe, such pipe shall be placed in a trench conforming to the requirements as shown on the plans for the applicable allowable overfill height.

726.1.5 If the contract specifies pipe culverts by group and the contractor elects to furnish metal pipe, the culvert shall be constructed in accordance with Sec 725. If the contractor elects to furnish corrugated polyethylene pipe, the culvert shall be constructed in accordance with Sec 730.

726.1.6 If the contract specifies non-reinforced concrete pipe, the contractor may, at no additional cost to the Commission, furnish reinforced concrete pipe of like sizes meeting the requirements of these specifications.

726.1.7 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.

726.1.8 The class of pipe or type of installation shall not be changed throughout the length of any individual pipe culvert.

726.1.9 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.

726.1.10 If standard strength vitrified clay pipe is specified in the contract or elected for use by the contractor, extra strength vitrified clay pipe may be used but payment will be made for standard strength vitrified clay pipe. Only extra strength vitrified clay pipe shall be used under roadways. Standard strength vitrified clay pipe will be permitted only where vehicular traffic is not anticipated.

726.2 Material.

726.2.1 All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Reinforced Concrete Culvert, Storm Drain and Sewer Pipe	1026
Vitrified Clay Sewer and Culvert Pipe	1030
Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe	1034
Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe	1035
Plastic Joint Compound for Vitrified Clay and Concrete Pipe	1057.3
Tubular Joint Seal	1057.4
Mortar for Pipe Joints	1066

Construction Requirements

726.3 Laying.

726.3.1 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 re-laid 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. All joints, except for field or private entrance culverts, shall be sealed with an approved plastic compound, cement mortar or tubular joint seal. Rubber gasketed joints may be used at no additional cost to the Commission. Where permissible lift holes have been used, the holes shall be carefully filled with expansive mortar to provide a watertight section. The mortar shall be finished flush on the inside of the pipe and shall be properly cured on the outside. 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.

726.3.2 If rubber gasket type pipe or vitrified clay pipe is specified or used, the 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.

726.3.3 In sealing rigid pipe with mortar, the mortar contact areas of all pipe ends shall be damp when mortar is applied. After applying mortar to the entire interior surface of the bell or groove, the spigot or tongue end shall be forced into position. Any remaining void in the bell or groove shall be filled with a hub of mortar built up adjacent to the bell, or a bead of mortar built up around a groove-type joint. The interior joints of either type of pipe shall be finished flush with the surface of the pipe. Outside surface of mortar joints shall be cured with membrane curing compound.

726.3.4 In sealing rigid pipe with plastic joint compound, trowel grade compound shall be applied to the mating surfaces of both the tongue and groove, or to the entire interior surface of the bell and the upper portion of the spigot. Rope or tape type plastic compound shall be applied in accordance with the manufacturer's recommendations. The joints shall be forced together with excess compound extruding both inside and outside the joint. Excess compound shall be removed from the interior surface where accessible. Tubular joint seals shall be installed in a manner as recommended by the manufacturer. The joint between the bell and spigot shall be uniform for the full circumference and care shall be taken to prevent the bell from supporting the spigot.

726.4 Bedding.

726.4.1 Bedding for reinforced concrete pipe shall consist of Category 1, Category 2 or Category 3 soils as shown on the plans.

726.4.1.1 Category 1 soils consist generally of a well graded mixture of stone fragments, gravel and coarse sand as well as clean, fine sand. Specifically, these soils shall meet the requirements of AASHTO M 145, classification A1 or A3.

726.4.1.2 Category 2 soils consist generally of non-plastic or moderately plastic granular material with silt content higher than that of Category 1. Specifically, these soils shall meet the requirements of AASHTO M 145, classification A2 or A4.

726.4.1.3 Category 3 soils consist generally of silty clays. Specifically, these soils shall meet the requirements of AASHTO M 145, classification A5, A6 or A7.

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 the adjacent fill.

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 (600 mm) 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 (300 mm) 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 Vitrified clay pipe (extra strength) shall be laid in a trench with a width, on a plane level with the top of the pipe, not greater than that shown on the plans for the respective pipe diameter. The trench shall have a minimum

depth of one outside pipe diameter plus 16 inches (400 mm). If the original ground line is below an elevation one foot (300 mm) above the top of the proposed pipe, embankment shall be constructed to at least one foot (300 mm) above the proposed pipe prior to excavating the trench. The trench walls shall be as nearly vertical as practicable. Prior to laying the pipe, the bottom of the trench shall be covered with a 4-inch (100 mm) layer of sand. After laying the pipe, the trench shall be backfilled with sand around the pipe for at least 10 percent of the height of the pipe. The sand shall be thoroughly compacted by the use of tampers or by flooding. The remainder of the trench shall be backfilled in accordance with the requirements of Sec 726.5.5.

726.5.3 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 (150 mm). The width of the cushion excavation shall be 1.33 times the outside diameter of the pipe, but not less than 24 inches (600 mm) 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.

726.5.4 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. The 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.

726.5.5 Backfilling. Backfilling shall be done as soon as practicable. Suitable backfill and embankment material, free from large lumps, clods or rocks, shall be placed alongside the pipe in loose layers not exceeding 6 inches (150 mm) thick to provide a berm of compacted or undisturbed earth on each side of the pipe as shown on the plans. Each 6-inch (150 mm) 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.

726.6 Inspection. After the roadway has been completed, and before final acceptance of the project, all pipe culverts will be inspected. Any separation at joints sealed with either cement mortar or plastic joint compound shall be resealed with like material.

726.7 Method of Measurement.

726.7.1 Measurement of rigid pipe, complete in place, will be made to the nearest foot (0.5 m) 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. The length of structure may be increased by not more than 3 feet (1 m) as necessary to avoid cutting the pipe, but such increased length will not be included in the contract quantity for payment.

726.7.2 Excavation for placing rigid pipe culverts will be measured and paid for as Class 3 Excavation in accordance with Sec 206, except if vitrified clay pipe is specified in the contract or elected for use by the contractor, no direct payment will be made for additional excavation required to cut the trench in the embankment above the original ground line. Class 3 Excavation, below a level line one foot (300 mm) above the top of the pipe will be measured to the nearest cubic yard (cubic meter) of that volume actually removed within an area bounded by the vertical planes of the maximum permissible trench width shown on the plans, Sec 726, for the respective pipe diameter.

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. The accepted quantities of pipe by groups will be paid for in accordance with the item numbers, pay items and pay units listed in Sec 725.

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 729 – PLACING STATE-OWNED PIPE

Delete Sec 729.4.1 and substitute the following: ***10/00***

729.4.1 Payment for placing State-owned pipe will be made per linear foot (meter) at the fixed unit price specified in Sec 109.14. Payment for placing pipe-arch will be at the rate for circular pipe from which the arch was developed.

SECTION 730 - POLYETHYLENE PIPE CULVERTS

Delete Sec 730 and substitute the following: ***04/00; 04/01; 10/01***

SECTION 730

POLYETHYLENE PIPE CULVERTS

730.1 Description.

730.1.1 This work shall consist of providing polyethylene pipe of the diameter designated, laid upon a firm bed and backfilled as specified.

730.1.2 The contract will specify either the type of pipe or the group of permissible types of pipe. If Group B pipe is specified, the contractor shall use any of the types listed as follows:

Reinforced Concrete Pipe
Corrugated Metallic-Coated Steel Pipe
Corrugated Aluminum Alloy Pipe
Corrugated Polyethylene Pipe

730.1.3 If the contract specifies corrugated polyethylene pipe, or if the contract specifies pipe culverts by group and the contractor elects to furnish corrugated polyethylene pipe, the allowable overfill height shall be in accordance with the plans, unless otherwise specified. Minimum cover will be measured from the top of the pipe to the bottom of the pavement.

730.1.4 If the contract specifies pipe culverts by group and the contractor elects to furnish metal pipe, the culvert shall be constructed in accordance with Sec 725. If the contractor elects to furnish concrete or vitrified clay pipe, the pipe culvert shall be constructed in accordance with Sec 726.

730.1.5 The size and shape of the corrugation and thickness of wall shall not be changed throughout the length of any individual pipe culvert.

730.1.6 The type of pipe permitted in extending an existing pipe shall be the same type as used in place, except as otherwise specified in the contract, or unless prohibited by any of the requirements set out herein.

730.2 Material.

730.2.1 All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Metallic-Coated Steel End Sections	1020
Precast Concrete Flared End Sections	1032
Corrugated Polyethylene Pipe	1047

Construction Requirements

730.3 Handling. All pipe shall be unloaded and handled with reasonable care. The pipe shall not be dropped or dragged. Tie down straps or bands shall not be removed until the pipe has been secured to prevent rolling or dropping the pipe. Pipe shall be stockpiled on level ground, and if stacked, blocking shall be provided to prevent rolling. Stacked pipe shall be placed with bells alternated on successive layers, and the bells shall overhang the layer to prevent deforming the bell. The protective wrap on the gaskets of the spigot end shall be left on the pipe until it is ready for installation. Damaged pipe, unless repaired to the satisfaction of the engineer, will be rejected at the site and shall be replaced at the contractor's expense.

730.4 Laying.

730.4.1 Flexible pipe shall be carefully laid true to lines and grades shown on the plans, with bell ends upstream and with the spigot end entered the full length into the adjacent section of pipe. 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, camber shall be built into the pipe structure to allow for settlement from fill loads.

730.4.2 Joints shall be soiltight unless otherwise specified. Joints shall be installed so that the connection of pipe sections will form a continuous line free from appreciable irregularities in the flow line. Suitable field joints can be obtained with the following types of connections: corrugated bands, bell and spigot pipe ends with rubber o-ring gasket meeting ASTM F477 or double bell couplings.

730.5 Bedding & Backfill Material.

730.5.1 Backfill material for polyethylene pipe shall consist of gravel, sand, or sandy silt soil as shown on the plans.

730.5.1.1 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 Al or A3.

730.5.1.2 Sandy silt soil shall consist of non-plastic granular material with silt content higher than that of gravel or sand and shall meet the requirements of AASHTO M 145, classification A2-4 or A2-5.

730.5.2 Bedding material (material between the bottom of the trench and the bottom of the pipe) shall have a maximum particle size of 1.25 inches (30 mm). Backfill shall be free of organic material, stones larger than 1.5 inches (38 mm) in greatest dimension, or frozen clumps.

730.6 Installation.

730.6.1 The 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 (300 mm) above the top of pipe before a subtrench is excavated. 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 shall be compacted to the required density shown on the plans before placing the pipe. The pipe shall be installed to grade according to Sec 730.4. Special care shall be taken to properly compact the material under the haunches of the pipe.

730.6.2 Bedding in Unsuitable Material. If rock is encountered, the bedding depth shall be increased to 6 inches (150 mm) below the bottom of the pipe. If soft, spongy or unstable material is encountered, it shall be removed and excavated to a minimum depth of 6 inches (150 mm) below the bottom of the pipe and replaced with a 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 the removing and backfilling shall be at the contractor's expense.

730.6.3 Backfilling. Backfilling shall be completed as soon as possible. Suitable backfill material free from large lumps, clods or rocks, shall be placed alongside the pipe in loose layers not exceeding 8 inches (200 mm) thick.

Each 8-inch (200 mm) 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. The placement of the remainder of the backfill to at least 1 foot (300 mm) 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 (0.6 m) 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.

730.6.4 Construction Loading. 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 as shown on the plans. Any damage or displacement shall be repaired or corrected at the contractor's expense.

730.6.5 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. The 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.

730.7 Inspection. The internal diameter of the barrel shall not be reduced by more than 5% of its base inside diameter when measured not less than 30 days following completion of installation.

730.8 Method of Measurement.

730.8.1 Measurement of flexible pipe, complete in place, will be made to the nearest foot (0.5 m) 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.

730.8.2 Excavation for placing pipe, pipe-arches, corrugated metal drop inlets and metal curtain walls will be measured and paid for as Class 3 Excavation in accordance with Sec 206.

730.9 Basis of Payment.

730.9.1 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. The accepted quantities of pipe by groups will be paid for in accordance with the item numbers, pay items and pay units listed.

730.9.2 No direct payment will be made for material or work required for placing couplings on exposed ends of the pipe.

730.9.3 No direct payment will be made for any backfilling required except as specified in Sec 206.6.3.

730.9.4 No direct payment will be made for the construction of bedding or for bedding material.

SECTION 734 – JACKING PIPE

Delete Sec 734.3.1.2 and substitute the following: ***01/02***

734.3.1.2 On divided and undivided multi-lane roadways, 200 feet (60 m) of concrete traffic barrier shall be installed on the shoulder to protect the work area. The first 100 feet (30 m) of barrier shall be centered on the jacking pit, parallel to the centerline of the roadway and 4 feet (1.2 m) from the outside edge of the shoulder. The second 100 feet (30 m) of barrier shall be installed on a 25:1 taper away from the traveled way in the direction of on-coming traffic. An approved crashworthy end terminal shall be installed on the upstream end of the tapered section. Where work on the receiving side is limited to 8 hours or less, drum-like channelizers may be used in lieu of the barrier as approved by the engineer.

SECTION 735 – CULVERT PIPE LINER

Amend Div 700 to include the following: ***04/01; 10/01***

SECTION 735

CULVERT PIPE LINER

735.1 Description. This work shall consist of providing and installing pipe liner in existing culvert pipes.

735.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Pipe Liner	1046
Grout	1066

735.2.1 The pipe liner shall be capable of being joined into a continuous length by an approved interlocking method. The joints shall be soil-tight with no gaskets required.

735.2.2 Approval for interlocking methods may be obtained by submitting the proposed system to Project Operations - Materials.

735.3 Construction Requirements.

735.3.1 The dimensions of the pipe liner shall meet the requirements shown in Table 1.

735.3.2 Before any pipe liner construction is started, the culvert to be lined shall be thoroughly cleaned of all sediment and debris.

735.3.3 The pipe liner shall be joined into a continuous length by the approved interlocking method. The engineer will approve each joint before each section of pipe liner is inserted.

735.3.4 Existing culvert ends that are damaged or impede installation shall be straightened or removed at the engineer's direction.

735.3.5 The insertion may be made by pushing or pulling the assembled pipe liner from either end of the culvert. The insertion operation shall not cause the joints to separate. A temporary nose cone or plug may be required to guide the pipe liner past minor obstructions. The handling of pipe liner shall be in such a manner so that the pipe liner is not damaged. Pipe liner with deep scratches or gouges shall be removed and replaced.

735.3.6 After the pipe liner has been completely inserted and has been inspected in place by the engineer, it shall be cut off as directed by the engineer and grouted in place. Pipe liner shall be allowed to cool to the temperature of the existing culvert before it is cut off and grouted.

735.3.6.1 Only enough water to make a stiff, but workable, expansive grout shall be used.

735.3.6.2 The grout shall extend into the annular space between the existing culvert and pipe liner for a minimum distance of 6 inches (150 mm) from the face of the pipe to a flexible grout stop comprised of flexible foamed polyethylene, pavement joint backer rod or other material approved by the engineer.

735.3.6.3 Drainage of the annular space between the culvert and pipe liner shall be provided by drilling a circumferential line of weep holes in the lower half of the pipe liner approximately 2 inches (50 mm) from the downstream grout stop. The weep holes shall not be less than 3/8 inch (10 mm) nor more than 1/2 inch (15 mm) in diameter and shall be spaced circumferentially at 3-inch (75-mm) centers starting at the invert and extending upward to the spring line of the pipe liner.

735.3.7 The pipe liner shall be anchored to the existing culvert by a minimum of two 1/2-inch (12.7-mm) diameter bolts with washers. The pipe liner shall be centered in the existing pipe with anchor bolts installed at the upstream end, spaced equal distance, above the spring line.

735.4 Method Of Measurement. Measurement of pipe liner, complete in place, will be made to the nearest foot (0.3 meter) along the geometrical center of the pipe liner. 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. This item shall include all material, labor, equipment and excavation necessary to complete the work.

735.5 Basis Of Payment. The accepted quantities for the pipe liner complete in place will be paid for at the unit price for the pay items included in the contract.

TABLE I			
CULVERT PIPE LINER DIMENSIONS			
Existing Pipe	Liner		
	Clearance *		ID
Size (ID) in.(mm)	Minimum in. (mm)	Maximum in. (mm)	Minimum in. (mm)
12 (305)	0.5 (12)	2 (50)	9 (225)
15 (381)	0.5 (12)	3 (50)	11 (275)
18 (457)	0.5 (12)	3 (75)	13 (330)
21 (533)	0.5 (12)	3 (75)	15 (380)
24 (610)	0.5 (12)	4 (100)	17 (430)
27 (686)	1 (25)	4 (100)	20 (505)
30 (762)	1 (25)	4 (100)	22 (555)
33 (838)	1 (25)	4 (100)	24 (610)
36 (914)	1 (25)	4 (100)	26 (660)
42 (1067)	1 (25)	6 (150)	30 (760)
46 (1168)	2 (50)	6 (150)	33 (835)
48 (1219)	2 (50)	6 (150)	35 (885)
54 (1372)	2 (50)	8 (200)	39 (990)
60 (1524)	2 (50)	9 (225)	43 (1090)
72 (1829)	2 (50)	10 (250)	52 (1320)

* Clearance is the difference between the inside diameter (ID) of the existing pipe and the outside diameter (OD) of the pipe liner.

SECTION 802 – MULCHING

Delete Sec 802.2.3.2 and substitute the following: ***07/02***

802.2.3.2 Recycled slick paper mulch shall be produced from printers slick paper containing wood cellulose and kaolin clay. Recycled newsprint or cardboard will not be allowed. The material shall be free of other material or fillers and shall have a moisture content and pH in accordance with Sec 802.2.3.1.

SECTION 803 – SODDING

Delete Sec 803.3.2 and substitute the following: ***04/00***

803.3.2 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 and adjusted as necessary, beginning 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. Sod shall be pegged on 3:1 (1:3) slopes or steeper, and in ditches and on ditch slopes for the full depth of the ditch, to a maximum of 4 vertical feet (1.2 m),

with wood pegs approximately 1/2 inch x 12 inches (15 x 300 mm) driven into ground, leaving about 1/2 inch (15 mm) of the peg above the sod, and spaced not more than 2 feet (600 mm) 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.

SECTION 806 – EROSION AND SEDIMENT CONTROL

Delete Sec 806 and substitute the following: ***04/00; 01/0; 04/01***

SECTION 806

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 designated by the engineer.

806.1.1 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 control features specified in the contract to ensure economical, effective and continuous erosion and pollution control. This work shall also apply to work within easements designated by the Commission.

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 be started until the pollution and erosion control schedules and methods of operations have been accepted by the engineer.

806.3 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Fertilizer and Lime	801
Straw for Bales	802
Mulching	802
Seed	805
Geotextile Fabric	1011

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, slope drains, and use of temporary mulches, seeding or other control devices or methods as necessary to control erosion and pollution.

806.4.1 The contractor shall incorporate all permanent erosion and pollution control features into the project at the earliest practicable 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 that develops during normal construction practices, but are not associated with permanent control features on the project.

806.4.2 Clearing and grubbing operations shall be scheduled and performed so grading operations and erosion control features will follow immediately thereafter. The surface area of erodible earth material exposed at one time by clearing and grubbing, excavating fill or borrow shall not exceed 435,000 square feet (40,000 m^2) within any

individual drainage area without installation of erosion controls for that drainage area. The total erodible surface area exposed at one time for the entire project shall not exceed 750,000 square feet (70,000 m^2) without documented approval by the engineer.

806.4.3 The engineer will limit the additional amount of erodible surface areas exposed by clearing and grubbing, excavation, borrow and fill operations with the amount of fill area in which the finished grading, mulching, seeding and other such permanent erosion control measures are completed and properly maintained. Should seasonal limitations make such operations unrealistic, temporary erosion control measures shall be taken immediately.

806.4.4 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 which 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.

806.4.5 Frequent fording of streams or other bodies of water with construction equipment will not be permitted. Temporary bridges or other structures shall be used wherever an appreciable number of stream or other bodies of water crossings are 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 shall prevail.

806.4.6 The location of all local material pits, other than commercially operated sources, and all excess material sites shall be subject to the approval of the engineer. Erosion from construction operations and pollution control measures shall not cause water pollution.

806.4.7 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 shall apply.

806.4.8 Unless otherwise specified by the engineer, all temporary erosion control measures shall be removed by the contractor after permanent erosion control measures are established.

SECTION 806.10 TEMPORARY BERMS

806.10.1 Description. This work shall consist of constructing temporary berms of compacted soil at the top of fill slopes or transverse to the centerline of fills.

806.10.2 Material. Temporary berms shall consist of graded material from within the project limits, or any other suitable material approved by the engineer.

806.10.3 Construction Requirements. Temporary berms shall be constructed to the approximate dimensions as shown on the plans.

806.10.3.1 Type A Berms. Type A berms shall be machine compacted with a minimum of one pass over the entire width of the berm.

806.10.3.2 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 dispose any excess or unsuitable material to a location as directed by the engineer.

806.10.3.3 Type A and Type B Berms. Temporary berms shall drain to a compacted outlet at a 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 a minimal disruption.

806.10.3.4 Type C Berms. Type C berms shall be constructed of rock base material meeting the requirements of Sec 303.2 or other material as approved by the engineer. A straw layer or an equivalent erosion control blanket shall be placed on the upslope side of the Type C berm. The straw layer shall be placed in such a manner that the final compacted thickness is 2 inches (50mm). The material for the straw layer shall be Type 1 mulch meeting Sec 802. The straw layer or equivalent erosion control blanket shall be removed and replaced as determined by the engineer.

806.10.4 Method of Measurement.

806.10.4.1 Quantities for Type A berms will be included in Class A or Unclassified Excavation quantities listed in the contract. No direct measurement will be made for Type A berms.

806.10.4.2 Measurement of Type B and C berms will be made to the nearest linear foot (meter).

806.10.5 Basis of Payment.

806.10.5.1 Payment for Type A berms will be made at the contract unit price for Class A or Unclassified Excavation and will be full compensation for all labor, equipment and material to construct, maintain and remove Type A berms.

806.10.5.2 The accepted quantities of Type B and C berms will be paid for at the contract unit price and will be full compensation for installation, maintenance, removal and any other work noted on the plans. No additional payment will be made for any costs associated with the straw layer or equivalent erosion control blanket on the Type C berm.

806.10.5.3 Any hand work at slope drain inlets will be considered part of the contract unit price for slope drains.

SECTION 806.20 TEMPORARY SLOPE DRAINS

806.20.1 Description. This work shall consist of constructing temporary slope drains to carry water down slopes and 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 (150 m) intervals or as directed by the engineer. All temporary slope drains shall be adequately anchored to the slope to prevent disruption of flow. Inlet ends shall be properly 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. The contractor shall restore the site 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 (meter).

806.20.4 Basis of Payment. The accepted quantities of temporary slope drains will be paid for at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work.

SECTION 806.30 TEMPORARY DITCH CHECKS

806.30.1 Description. This work shall consist of constructing and maintaining temporary ditch checks, removing sediment deposits from these ditch checks and disposing of the sediment at a location approved by the engineer.

806.30.2 Construction Requirements.

806.30.2.1 Type I Ditch Checks. Type I ditch checks shall be constructed of straw bales, silt fence or an approved alternative erosion control measure as specified in the contract. Type I ditch checks shall not be used where drainage areas exceed 3 acres (1.2 ha) or ditch slopes exceed 10 percent. Type II ditch checks may be substituted for Type I ditch checks at no additional cost.

806.30.2.1.1 Straw Bale Ditch Checks. Straw bale ditch checks shall be constructed according to the plans and specifications.

806.30.2.1.2 Silt Fence Ditch Checks. Silt fence ditch checks shall be constructed according to the plans and specifications.

806.30.2.1.3 Alternative Ditch Checks. Approved alternative ditch checks shall be installed and maintained according to the manufacturer's recommendations.

806.30.2.2 Type II Ditch Checks. Type II ditch checks shall be constructed of rock, sand bags or approved alternate Type II ditch checks as specified in the contract. Type II ditch checks shall not be used where drainage areas exceed 50 acres (20.2 ha) or ditch slopes exceed 10 percent.

806.30.2.2.1 Rock Ditch Checks. Rock ditch checks shall be constructed according to the plans and specifications with clean rock. A minimum of 50% of the rock shall have a diameter of 6 inches (150 mm) or greater with a maximum size of 9 inches (225 mm). Silt fence or an equivalent filter fabric shall be placed beneath the rock ditch check as shown on the plans.

806.30.2.2.2 Sand Bag Ditch Checks. The sand bag ditch check shall be constructed as shown on the plans. Sand or rock for sand bags shall be a uniform granulation with a maximum aggregate size of 2 inches (50 mm), shall be clean to allow percolation of water through the sand bag and meet the approval of the engineer. Sand bags shall be of tightly woven burlap or other material that is sufficiently durable to remain intact for the time intended. Sand bags shall be filled approximately 3/4 full, shall weigh approximately 55 pounds (25 kg) and shall be securely closed. Sand bags shall be placed in the ditches at locations shown on the plans or as directed by the engineer. The sand bags shall be laid in horizontal courses, and successive courses shall break joints with preceding ones. The sacks shall be packed against each other and tamped to provide a uniform surface.

806.30.2.2.3 Alternate Ditch Checks. Approved alternative ditch checks shall be installed and maintained according to the manufacturer's recommendation.

806.30.2.3 If the engineer determines a Type I or II ditch check is not suitable due to site conditions, a combination of ditch checks and erosion control blankets or rock blankets shall be designed so as to effectively reduce flow velocities.

806.30.3 Maintenance. The contractor shall replace ditch checks at the request of the engineer. Periodic sediment removal shall include removal and disposal of sediment to a location where it will not erode into construction areas, steams or other bodies of water. The contractor shall inspect the ditch checks for sediment accumulation after each storm event and shall remove the sediment when deposits reach approximately one-half the original height of the ditch check.

806.30.4 Method of Measurement. Measurement of sediment removal will be made to the nearest cubic yard (cubic meter).

806.30.5 Basis of Payment.

806.30.5.1 The accepted quantities of temporary ditch checks will be paid for at the contract unit price per each pay item included in the contract and will be full compensation for all labor, equipment and material to complete the described work. This includes constructing, maintaining, repairing and removing and disposing of the ditch check after completion of the work. The contractor will be compensated if the engineer determines unusual conditions warrant a repair or replacement of a ditch check.

806.30.5.2 Payment for removal and disposal of sediment will be made at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work.

SECTION 806.40 SEDIMENT BASINS

806.40.1 Description. This work shall consist of constructing sediment basins as shown on the plans or as determined by the engineer to detain sediment. This work shall also include disposal of excavated material, sediment and basin removal and site restoration.

806.40.2 Construction Requirements. The area where a sediment basin is to be constructed shall be cleared of vegetation to enable sediment removal. The sediment basin shall be an excavated or dammed storage area with defined side slopes. Inlet and outlet areas shall be lined with rock riprap.

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. When the depth of sediment reaches 1/3 the original depth of the structure in any part of the pool, all accumulation shall be removed.

806.40.2.2 The contractor shall dispose of accumulated sediment and excavated material removed during the construction of the sediment basin in locations where it will not erode into the construction areas, streams or other bodies of water.

806.40.2.3 Sediment basins shall remain in service until all disturbed areas draining into the structure have been satisfactorily stabilized. When use of a temporary sediment basin is to be discontinued, the contractor shall remove any sediment, backfill, and properly compact all excavations and restore the existing ground to its natural or intended condition.

806.40.3 Method of Measurement.

806.40.3.1 Measurement of sediment basin excavation and sediment removal will be made to the nearest cubic yard (cubic meter).

806.40.3.2 Measurement of all seeding and mulching required after the sediment basin is built, after removal of the sediment basin and for site restoration will be made to the nearest 1/10 acre (0.05 ha).

806.40.4 Basis of Payment.

806.40.4.1 The accepted quantities for a sediment basin will be paid for at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work.

806.40.4.2 Payment for sediment removal will be made at the contract unit price.

806.40.4.3 Payment for all seeding and mulching required after the sediment basin is built, after removal of the sediment basin and for site restoration, will be made at the contract unit price for the applicable temporary or permanent seeding and mulching.

806.40.4.4 If additional clearing and grubbing is necessary for construction of a sediment basin, payment will be included in the contract unit price for sediment basin.

SECTION 806.50 TEMPORARY SEEDING AND MULCHING

806.50.1 Description. This work shall consist of furnishing and applying fertilizer, seed, Type 1 mulch or other acceptable cover authorized by the engineer. This work shall produce a quick ground cover to reduce erosion in disturbed areas expected to be redisturbed at a later date. Finish grading of areas will not be required. Hydraulic seeding and fertilizing in accordance with Sec 805 will be allowed.

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 eliminate erosion.

806.50.2.1 The contractor shall provide permanent seeding and mulching as shown on the plans following temporary seeding.

806.50.2.2 Temporary seeding mixtures of oats, cereal rye or wheat shall be applied at a rate of 100 pounds per acre (110 kg/ha). Temporary seeding mixtures of oats shall be applied only during the months of December through May.

806.50.2.3 Temporary mulch placed over temporary seed mixtures shall be applied in accordance with Sec 802.2.1.

806.50.2.4 Fertilizer shall be applied at a rate of 40 pounds (45 kg) nitrogen (N) per acre (hectare).

806.50.2.5 Lime will not be required for temporary seeding.

806.50.3 Method of Measurement. Measurement of all temporary seed mixtures and accompanying mulch will be made to the nearest 1/10 acre (0.05 ha).

806.50.4 Basis of Payment. The accepted quantities of all temporary seed mixtures and the accompanying mulch will be paid for at the contract unit price per acre (hectare).

SECTION 806.60 STRAW BALES

806.60.1 Description. This work shall consist of furnishing, installing, maintaining and disposing of bales of straw or other approved foliage used as a means of controlling sheet flow erosion, as shown on the plans or designated by the engineer.

806.60.2 Material. Bales shall be Type 1 mulch in accordance with Sec 802.

806.60.3 Construction Requirements.

806.60.3.1 The contractor shall place bales at the bottom of embankment slopes or on the lower side of cleared areas to divert runoff and to detain sediment from sheet flow. When used to divert runoff or detain sediment, the bales shall be adequately anchored to withstand the applied load.

806.60.4 Method of Measurement. Measurement of bales will be made to the nearest linear foot (0.5 m).

806.60.5 Basis of Payment. The accepted quantities of bales will be paid for at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work, including the removal and disposal of the bales when no longer required.

SECTION 806.70 TEMPORARY SILT FENCE

806.70.1 Description. This work shall consist of furnishing, installing, maintaining, removing and disposing a wire-supported or self-supported geotextile silt fence designed to remove suspended particles from sheet flow passing through the fence and prevent sediment from polluting nearby streams or other bodies of water. The quantities of temporary silt fence shown on the plans may be increased or decreased at the direction of the engineer. At the engineer's discretion, the location may be modified to fit field conditions.

806.70.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Geotextile, Type 2	1011

806.70.2.1 Posts. Wood, steel or synthetic posts may be used. Posts shall be of sufficient length, not less than 4 feet (1.2 m), to ensure adequate embedment while fully supporting the silt fence and shall have sufficient strength to resist damage during installation and support applied loads while in service.

806.70.2.2 Support Fence. All geotextile silt fence shall be supported either externally by wire or other approved mesh to a height of at least 24 inches (600 mm) or by a suitable designed-in support system capable of keeping the material erect. Either method shall be strong enough to withstand applied loads.

806.70.2.3 Prefabricated Fence. Prefabricated fence systems may be used provided they meet all of the above material requirements.

806.70.3 Construction Requirements.

806.70.3.1 The contractor shall install temporary 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 (150 mm) to prevent flow under the barrier. The trench shall be backfilled and the soil compacted over the fabric. Fabric splices with a minimum 6-inch (150 mm) 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. All geotextile construction shall be in accordance with Sec 624.

806.70.3.2 Post spacing shall not exceed 5 feet (1.5 m). Posts shall be driven a sufficient depth into the ground or placed on closer spacing as necessary to ensure adequate resistance to applied loads.

806.70.3.3 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 (50 mm).

806.70.3.4 The contractor shall maintain the integrity of silt fences as long as they are necessary to contain sediment runoff. The contractor shall inspect all silt fences immediately after each rainfall and at least daily during prolonged rainfalls. Any deficiencies shall be immediately corrected by the contractor. In addition, the contractor shall make a daily review of the silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as approved or directed by the engineer.

806.70.3.5 The contractor shall remove and dispose of sediment when accumulations reach approximately one-half the fence height, or sooner when directed by the engineer. If required by heavy sediment loading, a second silt fence shall be installed as directed by the engineer.

806.70.3.6 The silt fence shall remain in place until removal is directed by the engineer. Upon removal, the contractor shall remove and dispose of any excess silt accumulations, grade and dress the area to the satisfaction of the engineer, and establish vegetation on all bare areas in accordance with the contract requirements. The fence material shall remain the property of the contractor and may be used at other locations, provided the material continues to meet the requirements of this specification, is sound and not weakened by exposure to the elements.

806.70.4 Method of Measurement. Temporary silt fence will be measured to the nearest linear foot (meter) from end post to end post of each separate installation.

806.70.5 Basis of Payment. The accepted quantities of temporary silt fence will be paid for at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work.

SECTION 806.80 TEMPORARY PIPE

806.80.1 Description. This work shall consist of installing temporary pipe of any material acceptable to the engineer, 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 active streams or other bodies of water or intermittent streams created during heavy rainfalls.

806.80.2 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 (150 mm) lifts and mechanically compacted. Compaction tests will not be required.

806.80.3 Method of Measurement. Measurement of temporary pipe will be made to the nearest linear foot (0.5 m).

806.80.4 Basis of Payment. The accepted quantities of temporary pipe will be paid for at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work.

<u>SECTION 901 – HIGHWAY LIGHTING</u>

Delete Sec 901 and substitute the following: ***01/00; 01/01; 04/01; 01/02; 04/02; 07/02***

SECTION 901

HIGHWAY LIGHTING

901.1 Description. This work shall consist of furnishing and installing highway or street lighting equipment and material as shown on the plans. All work shall meet NEC, NESC and NEMA standards.

901.2 General. Existing highway or street lighting shall be maintained in effective operation by the contractor except for shutdowns approved by the engineer for alterations or final removal.

901.2.1 Temporary Lighting. 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 Commission 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 150 watt high pressure sodium with a Type III medium distribution semi-cutoff light distribution and mounted at 30 feet (9 m) above the pavement unless otherwise shown on the plans. Bracket arms shall be a minimum of 10 feet (3 m) and a maximum of 15 feet (4.5 m) long and oriented at right angles to traffic flow unless otherwise shown on the plans. 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 approved by 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 which shall remain the property of the contractor may be new or used. Contractor furnished equipment which shall become the property of the Commission shall be of new stock and meet all applicable specifications. Commission owned equipment shall remain the property of the Commission 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 no existing power supply, it is the responsibility of the contractor to 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 shall be considered a malfunction as specified in Sec 901.5.6.2. 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 installations shall be installed to meet the construction schedule. The contractor shall be responsible for maintaining the lighting in proper operating condition. Maintenance of temporary lighting shall be in accordance with Sec 901.5.6.2. Any damage to the lighting installation from any cause whatsoever shall be repaired by the contractor at their expense.

901.3 Material. All material shall conform to Division 1000, Material Details, and specifically as follows:

Item		**Section/Specification**
Concrete		501
Galvanized Coating of Steel Lighting Poles and Appurtenances		712
High-Strength Bolts, Nuts and Washers		712
Low-Carbon Steel Bolts, Nuts and Washers		712
Reinforcing Steel for Concrete		1036
Wood Poles for Power Supplies and Temporary Installation		1050
Electrical Conduit		1060
Electrical Conductors		1061
Pull and Junction Boxes		1062
High-Strength Anchor Bolts		ASTM A 449
Structural Low Alloy Steel for Base Plates		AASHTO M 270, Grade 50 (ASTM A 709, Grade 50)
Stainless Steel Bolts, Screws and Washers		ASTM A 193, Grades B5, B6, B7 or B16
Stainless Steel Nuts		ASTM A 194
Circular Steel Pile Foundation		ASTM A 252, Grade 2
Steel H-Pile Foundation		ASTM A 709, Grade 36

Item		Section/Specification
Screw Anchor Foundation		
Shaft		ASTM A 252, Grade 2
Helix		ASTM A 575, Grade M 1010 or AASHTO M 270, Grade 36 (ASTM A 709, Grade 36)
Helix Core		ASTM A 575, Grade M 1023 or AASHTO M 270, Grade 36 (ASTM A 709, Grade 36)
Connector Plates and Steel Closure Plates for Circular Pipes and Connector Plates for H-Pile and Screw Anchor Foundations		AASHTO M 270, Grade 36 (ASTM A 709, Grade 36)

901.3.1 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 (150 µm). For anchor bolts and nuts and for high strength bolts and nuts except those in accordance with AASHTO M 164, 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 AASHTO M 164, 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 that 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 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 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 the product of reputable manufacturers, conform to the requirements of ICEA, NEMA, NESC and the regulations of the National Board of Fire Underwriters, as applicable, and meet the approval of the engineer. A list of pre-approved equipment and material is available through Traffic or MoDOT's web site.

901.3.4 The configuration and installation of equipment mounted on substation and service poles shall meet the requirements of the utility company or municipality furnishing electrical power.

901.3.5 Three 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.

901.4 Equipment.

901.4.1 Lighting Pole Pre-Approval. Fabricators shall submit six copies of shop drawings and supporting calculations to Traffic. Submittals shall be approved by Traffic 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. Design details for all possible pole combinations as shown on the plans may be submitted. Shop drawings shall provide pole installation and hardware details. 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 also 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.

901.4.2 Lighting Poles. Lighting poles shall be steel or aluminum meeting the requirements of the contract and shall be of the same material and design throughout the project. The poles shall be Type AT, Type B or Type MB as shown on the plans. The contractor has the option to 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. The contractor shall furnish the length of pole and bracket rise shown on the plans. Clamps shall be provided for connecting bracket arms to poles to obtain the specified mounting height. The cable entrance at the bracket arm shall be a field drilled 1 1/4 inch (32 mm) 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. All poles shall have removable raintight metal pole caps held in place by screws. All handhole covers and pole caps shall be attached to the pole with a chain constructed of the same material as the pole. 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 identification tag shall be provided with all poles as shown on the plans. The tag shall be aluminum or stainless steel with embossed or engraved letters and numbers. The tag shall be attached to the pole 6 inches (150 mm) above the top of the handhole or 18 inches (450 mm) 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.

(a) Each Type AT pole shall be provided with a transformer base in accordance with Sec 901.4.2.3. A grounding conductor shall be attached to the ground lug in each transformer base as shown on the plans.

(b) Each Type B and MB pole shall have a wiring handhole with a suitable metal cover near the base using two screws for attachment and a grounding lug inside the pole convenient to the handhole. A grounding conductor shall be attached to the ground lug in each pole as shown on the plans.

901.4.2.1 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 (3.1 mm), as one continuous shaft or as individual segments not less than 10 feet (3 m) 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 pounds per square inch (330 MPa) 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.

(a) 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.

(b) For base plate-type poles, the base plate shall be not less than 13 inches (330 mm) square and no less than 1 1/4 inches (32 mm) thick.

901.4.2.2 Aluminum lighting poles shall be round shaft poles. Each shaft shall be manufactured 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 (6 mm) and a nominal wall thickness for the upper section of 0.188 inch (4.75 mm). The one piece shaft for 30-foot (9 m) mounting height shall have a nominal wall thickness of 0.188 inch (4.75 mm), except those with twin truss type arms shall have a nominal wall thickness of 0.250 inch (6 mm).

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 blow holes. 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 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 Section 5, Paragraph 1.5.3 of AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

901.4.2.2.1 At the contractor'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 (9 m) mounting height shall have a 9-inch (230 mm) diameter at the base and a nominal wall thickness of 0.135 inch (3.5 mm). Shafts for 35 to 55-foot (10 to 17 m) mounting heights shall have a 13.4-inch (340 mm) diameter at the base and a nominal wall thickness of 0.135 inch (3.5 m) 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 blow holes. 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 pounds per square inch (8 MPa) 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.

901.4.2.3 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. It 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 in accordance with the plans. 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.

901.4.2.4 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 not less than 1/4 inch (6 mm) nor more than 5/8 inch (16 mm) beyond the nut when properly tensioned. Flat and lock washers shall be used for attachment.

901.4.2.5 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 not less than 1/4 inch (6 mm) nor more than 5/8 inch (16 mm) beyond the nut when properly tensioned. Flat and lock washers shall be used for attachment.

901.4.2.6 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. Fabricator's shop drawings of the screw anchor foundations shall be provided to the engineer. The shop drawings shall indicate the maximum torque rating of the foundations. Bolts shall project not less than 1/4 inch (6 mm) nor more than 5/8 inch (16 mm) beyond the nut when properly tensioned. Flat and lock washers shall be used for attachment.

901.4.2.6.1 Fabricators for screw anchor foundations shall submit two copies of shop drawings to Traffic. Submittals shall be approved by Traffic in writing prior to fabrication. Shop drawings shall indicate complete design details required for fabrication, including material grades, dimensions, thicknesses and welding. Shop drawings shall provide installation procedures and torque ratings. Upon written approval, pre-approved drawings may be used on any project where the design conditions of the shop drawings are not exceeded.

901.4.3 Bracket Arms. Bracket arms shall be similar in design to those shown on the plans, arranged for 2-inch (50 mm) slipfitter luminaire mounting, and attached to the poles as shown on the plans. Bracket arms shall be of the same kind of material as the pole on which they are mounted. Bracket arm mounting plates shall match the shape of the pole on which they are mounted. A 1-inch (25 mm) 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. Attachment bolts and nuts shall be properly tensioned. Flat and lock washers shall be used for attachment.

901.4.4 Luminaires.

901.4.4.1 High Pressure Sodium. High pressure sodium luminaires for roadway lighting shall be of the enclosed type with lamps burning in a horizontal position and for the type of circuit specified. Type III medium distribution semi-cutoff light distribution shall be set in accordance with the manufacturer's instructions unless otherwise directed by the engineer or shown on the plans. Each luminaire shall have an aluminum housing with two 2-inch (50 mm) slipfitters or one 4-bolt slipfitter or one 2-inch (50 mm) slipfitter with a longitudinal leveling system and an internal ballast kit designed for that fixture. The housing shall have a natural aluminum or gray baked enamel finish. Reflectors shall have an alzak aluminum finish with reverse flange. The refractor shall consist of prismatic or flat heat-resistant glass in a cast aluminum holder. Plastic refractors shall not be used. The holder shall be secured to the luminaire by means of a hinge and an automatic latch. 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. Lamp size shall be as specified in the contract. Lamps shall have a rated life of not less than 20,000 hours for 400-watt, 15,000 hours for 250-watt and 12,000 hours for 150-watt lamps, based on ten hours per start. Wiring inside the luminaire housing shall be protected by suitable heat resistant insulating material. The reflector-refractor optical assembly and the ballast shall form a single unit. The optical system (reflector, bottom refractor, lamp socket and lamp) shall be a sealed chamber with provision for filtered ventilation accomplished by either a separate filter or a filtering gasket. Ventilation shall permit intake and exit of air into or from the chamber as a result of expansion or contraction of air in the chamber due to lamp heat. The ballast shall be pre-wired to the lamp socket and to a terminal board so that only the connection of the supply leads to the ballast primary terminals is necessary. A pipe stop shall be included in the assembly to locate the luminaire properly on the bracket arm. Ballasts shall be of the regulator type and shall operate satisfactorily throughout a voltage range of plus or minus ten percent of their nominal primary voltage rating. The change in lamp wattage over this range shall not exceed that recommended by the manufacturer. The ballast shall start and operate the lamp satisfactorily to a minimum temperature of -20 F (-28 C). The ballast shall have a power factor of not less than 90 percent.

901.4.4.2 Underpass. 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 instructions 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 non-ferrous metal or stainless steel hardware. Ballasts for underpass luminaires shall be in accordance with Sec 901.4.4.2. 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.

901.4.4.3 Navigation. The navigation lighting system shall consist of furnishing and installing all cable, conduit, controllers, lanterns, lamps, supports and all other equipment as shown on the plans. Bridge navigation lights shall be installed in accordance with Title 33, Code of Federal Regulations, Part 118, the manufacturer's recommendations and these specifications.

901.4.4.3.1 All lanterns shall be weatherproof and operate on a 120 volt system. Lanterns shall be of the fresnel lens-type and shall be fabricated from a corrosion-resistant material. Each lantern shall provide a light emitting diode (LED) or a standard service lamp with at least 4 standby lamps controlled by a lampchanger mechanism capable of illuminating the standby lamp after each lamp burnout. Lanterns mounted in an inverted position shall have a hole drilled in the tip of the lens to prevent water from collecting in the lantern. Lamps shall be properly installed and focused in the lenses.

901.4.4.3.2 Mounting brackets and all accessories shall be provided with each lantern. A swing arm and retrieval chain shall be provided for main channel lanterns to hold the fixture in proper operating position. The retrieval chain shall be capable of being locked in both the upright and inverted positions. Mounting brackets shall be fully galvanized or stainless steel. All hardware shall be stainless steel.

901.4.4.3.3 As part of the system, a photoelectric cell shall be provided in accordance with Sec 901.4.5.3. The photoelectric cell shall be mounted on the control station such that all lanterns operating within the system operate simultaneously and illuminate only during hours of darkness or low visibility.

901.4.4.3.4 Equipment used for general illumination of the bridge shall be designed such that the light distribution pattern will not permit high-intensity light to spill over and blind or interfere with marine navigation.

901.4.4.3.5 The contractor shall maintain navigational lighting on bridges during all construction and provide permanent navigation lighting on the bridge when it spans the river and falsework has been removed. Existing navigation lighting shall remain in use or temporary navigation lighting installed during the construction period as required. Upon the notice to proceed, the contractor shall maintain and operate the navigation lights until the permanent navigation lights are in operation and the test period completed. Temporary lights and reflectors shall be of the same color and characteristic and have a range of visibility equal to that prescribed for permanent navigation lights.

901.4.4.3.6 The contractor shall notify the engineer in writing the date the navigation lighting system will be ready for testing. Upon concurrence of the engineer, the contractor shall place the navigation lighting system in operation for a 15 consecutive day test period. The test period shall not be started until all lanterns in the system are ready to be tested. The system shall be tested as a unit. Any failure or malfunction of equipment during the test period shall be corrected at the contractor's expense and the navigation lighting system tested for an additional 15 consecutive day period. This procedure shall be repeated until the navigation lighting system has operated to the engineer's satisfaction for 15 consecutive days.

901.4.4.3.7 Acceptance. Before acceptance of the work, the contractor shall furnish the engineer with three copies of the manufacturer's instructions for maintenance and operation of all navigation lighting equipment including, but not limited to, lanterns, lamps and auxiliary equipment. At a minimum, the manufacturer's instructions shall include organized written instructions, wiring and component layout diagrams, and parts lists with part numbers. The contractor shall also furnish three copies of wiring diagrams of the installation or system.

901.4.5 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.

901.4.5.1 Control cabinets shall have a control panel constructed of the same material as the cabinet. All equipment such as circuit breakers, switches, contactors, fuses, photoelectric control and terminal blocks shall be installed on the panel as shown on the plans. Control cabinets shall be of sufficient size to house all equipment as shown on the plans. Cabinets shall be NEMA 4, dust-tight, watertight and constructed of 0.125-inch (3 mm) 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.

901.4.5.2 Lightning arrestors shall be of the rated voltage as shown on the plans.

901.4.5.3 Photoelectric controls shall be of the cadmium-sulfide type or solid-state type operating on 120 volts or 240 volts, as shown on the plans. They 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. They 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 (10 to 32 lux). A turn-on setting of 1.0 footcandle (10 lux) and a turn-off setting of 2.0 footcandles (22 lux) 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 photo controls shall face an open sky, and side mount photo controls shall face north. Each photo control unit shall include a lightning arrestor.

901.4.5.4 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 housed in the control cabinet as shown on the plans. At the option of the contractor, mercury load relays may be used in lieu of contactors. Mercury load relays shall be two-pole, normally-open, mercury contact, magnetic-type with load capacity as shown on the plans.

901.4.5.5 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.

901.4.5.6 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.

901.4.5.6.1 Type A Circuit Breakers. Type A breakers shall have a minimum of 18,000 amps AC interrupting rating at 240 volts AC and 14,000 amps AC interrupting rating at 480 volts AC. Breakers shall be full-size and designed to accept wire sizes up to 2/0 (12 mm). Terminals shall be provided for the wire sizes as shown on the plans.

901.4.5.6.2 Type B Circuit Breakers. Type B breakers shall have a minimum of 10,000 amps AC interrupting rating at 240 volts AC. Type B breakers shall have a nominal size no greater than 1 inch (25 mm) wide by 4 inches (100 mm) high by 3 inches (75 mm) 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.

901.4.6 Power Supply Assembly. The power supply assembly shall consist of all equipment mounted on a service pole or pedestal as shown on the plans. The assembly shall meet the approval of the utility company. All contractor provided meter boxes and disconnect boxes shall be constructed of aluminum or stainless steel. All hinges, catches and other hardware shall be non-ferrous metal or stainless steel.

901.4.6.1 Service poles shall consist of wood poles and crossarms, insulators, necessary pole line hardware, conduit, ground rods, guy wires and anchors and all other accessories and appurtenances mounted on the pole except those items furnished by the utility company or municipality, or specified separately in the contract.

901.4.6.2 Pedestals shall consist of two W6 x 9 (W150 x 14) or two W6 x 15 (W150 x 22) galvanized steel posts, a concrete footing and all other accessories and appurtenances mounted on the post except those items furnished by the utility company or municipality, or specified separately in the contract.

901.4.6.3 Main disconnect switches shall be separately housed on the power supply. The disconnect cabinet shall be NEMA 4, dust-tight, watertight and contain a Type A or Type B circuit breaker in accordance with Sec 901.4.5.6 of the rating shown on the plans. 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.

901.4.6.4 Circuit breaker cabinets and meters shall not be installed on the street or walk side of the pole or pedestal.

901.4.6.5 Meter boxes shall be NEMA 3R or NEMA 4. Meter sockets provided by the contractor shall be Underwriters Laboratories approved and conform to the requirements of the utility company or municipality providing power.

901.4.6.6 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. The assembly shall meet the safety requirements and approval of the utility company or municipality furnishing power for operation.

901.5 Construction Requirements. Prior to installation, manufacturer and drawing numbers shall be submitted by the contractor to the engineer for approval in writing. Four copies of applicable pre-approved drawings shall be supplied with the poles.

901.5.1 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 902.5.3.

901.5.2 Trenching and Backfilling.

901.5.2.1 The depth of trenching and backfilling for conduit and cable-conduit shall be no less than shown on the plans. No conduit or cable-conduit shall 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.

901.5.2.2 Type I, 24-inch (600 mm) trenching for cable-conduit is specified if the excavated material would be classified as Class A Excavation, as defined in Sec 203.1.1 and no material is in evidence which might cause mechanical damage to cable-conduit. The cable-conduit shall be laid on the bottom of the trench and the trench backfilled.

901.5.2.2.1 In lieu of Type I, 24-inch (600 mm) trenching, the cable-conduit may be installed by plowing. The cable-conduit shall be placed at a minimum depth of 18 inches (450 mm) and the soil over the installation shall be recompacted to the approximate original in-place density.

901.5.2.3 Type II, 24-inch (600 mm) trenching for cable-conduit is specified if the excavated material would be classified as Class A Excavation, as defined in Sec 203.1.1 and material is in evidence which 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.

901.5.2.4 Type III, 21-inch (535 mm) trenching for cable-conduit is specified if material which would be classified as other than Class A Excavation, as defined in Sec 203.1.1, is encountered. The cable-conduit shall be embedded in sand as shown on the plans and the trench backfilled.

901.5.2.5 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 (300 mm) above the top of conduit or cable-conduit. The bottom of the trench shall be free of such material before the conduit is placed. No conduit shall be placed without approval of the trench by the engineer. Backfill material shall be deposited in layers not exceeding 6 inches (150 mm) 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 which 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 with planks, a box or other approved means so that it will not be damaged. All disturbed areas shall be restored to the satisfaction of the engineer.

901.5.3 Pull and Junction Boxes. Pull and junction boxes shall be installed at locations shown on the plans and in accordance with applicable requirements of Sec 902.

901.5.4 Pole Foundation and Installation.

901.5.4.1 Concrete foundations for ground mounted poles shall be of Class B concrete and shall have dimensions not less than shown on the plans. Forms will not be required for concrete placed below finished ground line. All conduits 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 be spaced by means of a template, the center of which shall coincide with the center of the base. Installation of poles on integral concrete median and foundation shall be to the dimensions and design shown on the plans.

901.5.4.2 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.

901.5.4.3 The minimum installing torque for screw anchor foundations shall be as shown on the plans and 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.

901.5.4.4 Leveling and raking of poles on structures may be accomplished by use of shims, not to exceed a total of 1/2 inch (13 mm), on bolts.

901.5.4.5 Where poles are to be placed on existing foundations or structures with anchor bolts in place, it shall be the contractor's responsibility to furnish poles with a base to fit the anchor bolt spacing.

901.5.5 Luminaires. Luminaires for roadway lighting shall be adjusted to give proper illumination on the roadway. Luminaires for underpass lighting shall be interconnected with 1-inch (25 mm) minimum rigid conduit unless other provisions are incorporated into the structure. Conduit shall be in accordance with Sec 902.5.3.

901.5.6 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 mils (2.5 µm) 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 not less than 10 MΩ. Any circuit less than 10 MΩ to ground will be rejected. The contractor shall provide a suitable 500-volt DC, zero to 100-MΩ 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.

901.5.6.1 After the circuits have been tested and found acceptable, the contractor shall, upon concurrence of 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.

901.5.6.2 When the test period is initiated and until it is completed, or following the turn-on of temporary lighting, the contractor shall provide 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 MoDOT personnel or a third party to correct the malfunction. If this option is invoked, the entire cost of the work performed by MoDOT personnel or the third party will be computed as described in Sec 108.9 and deducted from the 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 that results either directly or indirectly from a malfunction during the test period. The contractor and surety shall indemnify and save harmless the State, the Commission, its agents, employees and assigns for any legal liability for such a malfunction.

901.5.7 Installation of Cable and Cable-Conduit.

901.5.7.1 The cable-conduit combination shall be installed in a trench of the type specified. Cable-conduit runs shall be continuous without splice between control panel, handholes, pull boxes, poles and junction boxes. All conduit ends shall be sealed around the cables with an approved readily-workable, soft, sealing compound. The compound shall be workable at temperatures as low as 30 F (-1 C) and shall not melt or run at temperatures as high as 175 F (80 C). Cable-conduit shall be allowed to "snake" in the trench, but there shall be no sharp bends and if

two or more assemblies are placed in a common trench, they 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 (450 mm) above the top of the foundation. The conduit of the cable-conduit shall then be cut off circumferentially approximately 6 inches (150 mm) 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. 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.

901.5.7.2 The ground wire shall be attached to a ground lug. Type AT poles shall be equipped with the grounding lug inside the transformer base and Type B and MB poles shall be equipped with the grounding lug inside the pole.

901.5.7.3 Cable Splicing. Splices shall be made only in pull boxes, junction boxes and pole bases. No more than four cables shall be spliced in above-ground tee splices in pole bases and junction boxes immediately adjacent to wall mounted brackets or underpass luminaires. No more than three pairs of power cables shall 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. Where junction boxes are not shown on the plans with underpass luminaires, splices may be made in the luminaire housing. Tee splices shall only be made at the locations shown on the plans.

901.5.7.3.1 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 premolded fused connector assembly. Line splicing in all breakaway pole bases shall be accomplished with a premolded fused slip connector assembly as shown on the plans. After a conductor splice is made, it 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. The splice block shall be designed for the wire size used, have one port per wire and the wires secured with set screws. The set screw holes shall be protected with removable plugs. Any required taping shall be accomplished with a rubber, pressure-sensitive, all-weather 30-mil (750 µm) splice tape. The tape shall be applied half-lap to a thickness equal to 1 1/2 times the thickness of the factory applied insulation and sheath and taper off over the sheath neatly to a point approximately 3 inches (75 mm) from the conductor splice. All sharp points and edges of the connector shall be padded and all voids filled with extra wraps of plastic tape. The tape shall not be stretched excessively or in such a manner as to cause creeping.

901.5.7.3.2 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 installed in accordance with the manufacturer's recommendations. The resin splice kit 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.

901.5.7.4 Cables shall be pulled through rigid conduit by a cable grip providing a firm hold on exterior coverings. 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 a 6-foot (2 m) loop coiled in each pull box and a 3-foot (1 m) loop coiled in each junction box. Where cable-conduit enters a pull box, conduit shall be cut away from cables in accordance with Sec 902.5.1.1.

901.6 Maintenance Information. Before acceptance of the work, the contractor shall furnish the engineer four copies of the manufacturers' instructions for maintenance and operation of all lighting equipment, wiring diagrams of the system and a parts list for the ordering of any parts.

901.7 Final Clean Up. Final cleaning up of right of way shall be in accordance with Sec 104.11.

901.8 Method of Measurement.

901.8.1 Measurement of trenching, including backfilling, except for rigid conduit, will be made to the nearest linear foot (0.5 m) along the centerline of the trench. No measurement of trenching will be made for rigid conduit.

901.8.2 Measurement of rigid conduit will be made to the nearest linear foot (0.5 m) as shown on the plans. Contract quantities will be used in final payment except as hereinafter provided.

901.8.3 Measurement of power cable, pole and bracket cable, multiconductor cable, wire and cable-conduit will be made to the nearest 10 linear feet (5 m) as shown on the plans. Contract quantities will be used in final payment except as hereinafter provided.

901.8.4 Measurement of luminaires and bracket arms, including all required material and hardware, will be made per each as separate items.

901.8.5 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.

901.8.6 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.

901.8.7 Measurement of Type MB poles, complete in place, will be made per each as a single item including 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.

901.8.8 Measurement of control stations, including all specified equipment, will be made per each.

901.8.9 Measurement of power supply assemblies, including all specified equipment and cable, will be made per each.

901.8.10 Measurement of pull boxes, including all specified material, will be made per each.

901.8.11 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.

901.8.12 Measurement of temporary lighting installations will be made per lump sum.

901.8.13 Measurement of navigation lighting systems will be made per lump sum.

901.9 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 the contract does not contain a unit price for Type III Trenching and material which would be classified as other than Class A Excavation, as defined in Sec 203.1.1, is encountered on construction, payment for such trenching will be made at a unit price of three times the contract unit price for Type II Trenching per linear foot (meter).

901.9.3 Accepted navigation lighting systems, complete in place, will be paid for at the contract lump sum price. Payment will be considered full compensation for all labor, material and equipment to perform the described work, including, but not limited to, furnishing and installing all cable, conduit, controllers, light fixtures, lamps, and supports.

SECTION 902 – TRAFFIC SIGNALS

Delete Sec 902 and substitute the following: ***04/00; 07/00; 10/00; 01/01; 04/01; 07/01; 04/02; 07/02***

SECTION 902

TRAFFIC SIGNALS

902.1 Description. This work shall consist of furnishing and installing traffic signal equipment and material as shown on the plans. All work shall meet NEC, NESC and NEMA standards.

902.2 General. Existing traffic signals shall be maintained in effective operation by the contractor except for shutdowns approved by the engineer for alterations or final removal. After any modifications have been made or after work is begun on an existing signal installation, the contractor shall maintain the signals in accordance with Sec 902.5.9.1. The contractor shall notify local traffic control agencies at least two days, excluding weekends and state holidays, prior to operational shutdown of any traffic signal. The contractor shall notify the engineer at least two days, excluding weekends and state holidays, prior to disconnecting existing vehicle or pedestrian detection. All traffic signal equipment that the contractor uses or installs on the project, whether furnished by the Commission or the contractor, either on a temporary or permanent basis, shall, upon installation or upon initial use by the contractor, be operated and maintained by the contractor until the project is completed and accepted. Any malfunction of an existing signal installation resulting from the contractors operation, regardless of the nature of the work, shall be corrected at the contractor's expense in accordance with Sec 902.5.9.1. If any adjustments are required to the operation of an existing signal installation due to the contractor's operation, the contractor shall provide a minimum of two working days notice to the engineer.

902.2.1 Temporary Traffic Signals. Temporary traffic signals shall consist of furnishing and installing poles for span wire, span and tether wires, control and power cable, connection to a power source, maintenance of the installation and all other equipment and material necessary to provide the temporary installation including the controller, signal heads and mounting hardware, unless Commission furnished. If the temporary traffic signal installation is not shown on the plans, the contractor shall submit a plan to the engineer for approval prior to the installation of temporary signals. Any existing or Commission furnished signal equipment to be used in the temporary signal shall be shown on the temporary signal plan. Temporary signals shall have the signal heads covered until they are placed in operation. A minimum of two signal faces, in accordance with Sec 902.4, shall be oriented toward each street approach positioned a minimum of 8 feet (2.5 m) apart center to center and a minimum of 16 feet (5 m) above the surface of the traveled way to the bottom of the backplate. Existing signals shall not be taken out of operation until the temporary signals are ready for operation and approved by the engineer. A flashing operation shall be used during shutdown of the temporary signals.

902.2.2 All temporary signal equipment shall be removed by the contractor after the new installation is in operation or as directed by the engineer. Contractor furnished equipment which shall remain the property of the contractor may be new or used. Contractor furnished equipment which shall become the property of the Commission shall be of new stock and meet all applicable specifications. Commission owned equipment shall remain the property of the Commission and shall be disposed of as shown on the plans or as directed by the engineer.

902.2.3 The contractor shall pay all electrical costs incurred by operation of the temporary signals and the new signal system until the signals are accepted for maintenance. For temporary signal installations where there is no existing signal power supply, it is the responsibility of the contractor to make any necessary arrangements for providing power to the temporary signals. Portable generators shall not be used to provide power to temporary signals. No direct payment will be made for power costs. All wire and cable for temporary signals shall be suspended overhead with proper clearance or buried a minimum of 18 inches (450 mm) underground.

902.2.4 Temporary signal installations shall be installed to meet the construction schedule. The contractor shall provide a minimum of two working days notice to the engineer in advance of the signal turn-on. The contractor shall be responsible for maintaining the signals in proper operating condition. Maintenance of temporary traffic signals shall be in accordance with Sec 902.5.9.1. Any damage to the traffic signal installation from any cause whatsoever shall be repaired at the contractor's expense.

902.3 Material. All material shall conform to Division 1000, Material Details, and specifically as follows:

Item	Section/Specification
Concrete	501
Galvanized Coating of Traffic Signal Posts and Appurtenances	712
High-Strength Bolts, Nuts and Washers	712
Low-Carbon Steel Bolts, Nuts and Washers	712
Structural Low Alloy Steel	712
Reinforcing Steel for Concrete	1036
Wood Poles for Power Supplies and Temporary Installations	1050
Electrical Conduit	1060
Electrical Conductors	1061
Pull and Junction Boxes	1062
Nuts for Anchor Bolts	ASTM A 563, Grade C, D or DH or ASTM A 194, Grade 2 or 2H
Stainless Steel Bolts, Screws and Washers	ASTM A 193, Grades B5, B6, B7 or B16
Stainless Steel Nuts	ASTM A 194

902.3.1 Bolts, nuts and washers, except stainless steel, shall be galvanized in accordance with AASHTO M 232 (ASTM A 153), Class C or mechanically galvanized in accordance AASHTO M 298 (ASTM B 695), Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils (150 µm). Anchor bolts shall have a minimum yield strength of 55,000 pounds per square inch (380 MPa) and a minimum elongation of 14.0 percent in 2 inches (50 mm) or 12.0 percent in 8 inches (200 mm). For anchor bolts and nuts and for high strength bolts and nuts except those in accordance with AASHTO M 164, 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 AASHTO M 164, 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 that the bolts furnished conform to the requirements specified. Bolts and nuts specified to meet ASTM A 307 shall be accompanied by a manufacturer's statement that the bolts and nuts were manufactured in accordance with ASTM A 307.

902.3.2 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 applicable provisions of Sec 703. The entire exposed surface, including sides and top, shall be surface sealed in accordance with the applicable requirements of Sec 703.3.18.

902.3.3 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 the product of reputable manufacturers, conform to requirements of CALTRANS 170 Specifications, ICEA, IMSA, ITE, MUTCD, NEMA, RETMA, NEC and the regulations of the National Board of Fire Underwriters, as applicable, and meet the approval of the engineer. A list of pre-approved equipment and material is available through Traffic or MoDOT's web site.

902.3.4 The configuration and installation of equipment mounted on substation and service poles shall meet the requirements of the utility company or municipality furnishing electrical power.

902.3.5 Three 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.

902.4 Equipment. All equipment shall meet the requirements established in *Equipment and Materials Standards of the Institute of Transportation Engineers* and as specified herein.

902.4.1 Signal Heads. Each signal head of one or more signal faces shall be conventional or, if designated on the plans, optically limiting. The contractor has the option to furnish aluminum or polycarbonate signal heads. Signal heads shall meet the following requirements:

(a) All signal heads shall be weatherproof and black in color in accordance with Sec 902.4.1.10. All indications shall be 12 inches (300 mm) unless otherwise specified.

(b) All red and green circular signal indications in conventional signal heads shall be illuminated with light emitting diode (LED) modules. LED modules shall be in accordance with ITE specifications and standards for LED vehicle traffic signal modules and the following:

(1) The lens of each red indication shall be tinted with a wavelength-matched color to reduce sun phantom effect and enhance on/off contrast. The tinting shall be uniform across the lens face. If a polymeric lens is supplied, a surface coating shall be applied to provide abrasion resistance.

(2) LED modules shall not contain Aluminum Gallium Arsenide (AlGaAs) LEDs.

(3) LED modules shall provide constant light output under power. Modules with dimming capabilities shall have the option disabled or set on a non-dimming operation.

(4) In the event of a power outage, light output from the LED modules shall cease instantaneously.

(c) Incandescent and optically limiting traffic signal lamps shall be in accordance with the *Institute of Transportation Engineers Standard for Traffic Signal Lamps* and the following specifications. Lamps shall be incandescent or optically limiting traffic signal lamps, as specified on the plans, and compatible with the design requirements of the optical systems of standard traffic signals. The construction features of the traffic signal lamps require that the filament shall be adequately supported to withstand the vibration induced from traffic and wind when burning in a horizontal position. Incandescent bulbs for signal indications (conventional, optically limiting and pedestrian signal heads) shall be certified by the manufacturer.

(1) Lamps shall meet the following requirements:

	Incandescent 1260 Rated Lumens	**Incandescent 1750 Rated Lumens**	**Optically Limiting**
Bulb Type	A21, Clear	A21, Clear	Sealed Beam
Base (Brass)	Medium Screw	Medium Screw	Three Prong
Class of Lamp	C	C	----
Filament	C-9 or C-11V with reflector	C-9 or C-11V with reflector	----
Filament Support (not including power leads)	5 or 6	5 or 6	----
Light Center Length, inches	2-7/16	3	----
Position of Burning	Horizontal	Horizontal	Horizontal
Watts	116	135	150
Rated Voltage	130	120 - 125	115
Rated Initial Lumens, Minimum @ Rated Voltage	1260	1750	N/A
Rated Beam Candlepower, candelas	N/A	N/A	950
Rated Average Life, Hours @ Rated Voltage	6000	6000	6000

2) The glass envelope of the lamps shall be legibly and permanently marked to show the manufacturer's insignia or trademark, design voltage and rated lumens or wattage.

(d) The position of signal indications shall be as specified in the contract.

(e) Each traffic signal face shall consist of a number of identical signal section housings rigidly fastened together.

(f) Signal heads shall not be field painted.

902.4.1.1 Housing, Door and Visor. If existing housings are to be combined with new housings, the new housings shall be adaptable to the existing. All new signal sections shall be clean, smooth and free from imperfections. The connection between signal housings shall be weatherproof. Housings shall be rigidly fastened together by a three or four bolt assembly or other connectors approved by the engineer. Doors which will exclude dust and moisture shall be used to ensure a weatherproof unit. A tunnel visor shall be supplied with each signal section, and each door shall have provisions for attachment of the tunnel visor. All visors shall be held in place by four stainless steel fastening screws or bolts and shall be capable of being removed without opening the signal head door. Internal bosses or inserts shall be provided in each housing for mounting a terminal block and attachment of back plates. The top and bottom exterior of the housing shall be flat to ensure perfect alignment of assembled sections. The housing of each section shall be one piece with sides, back, top and bottom integrally molded. The design of the housing shall be such that, with the aid of simple tools and the addition of standard parts, it shall be possible to make any assembly consisting of one or more signal sections and, with the addition of standard bracket assemblies, assemble signal faces into multi-way traffic signal head configurations.

(a) Aluminum Housing. Each housing shall be die cast aluminum.

(b) Polycarbonate Housing. All material used in construction of this type of signal head shall be of ultraviolet stabilized color-impregnated polycarbonate resin. It shall have a minimum thickness of 0.09 inch (2.2 mm) and shall be ribbed or plated to produce added strength. If signal housings are not ribbed, minimum 0.10-inch (2.5 mm) aluminum plates shall be furnished and installed inside and outside the section housing at all points of attachment of the pipe bracket.

902.4.1.2 Traffic Signal Lenses. All lenses shall be glass. Signal lens nominal diameter shall be as specified. Arrow lenses shall be of the size, color and design specified. Dull or dark gray enamel shall be baked or fired into the convex surface of the lens so that only the arrow indication will be illuminated. The enamel shall be hard, durable and not peel or flake. The enamel shall totally hide the light from a 200-watt lamp. The lens and reflector, in conjunction with a molded gasket and lamp receptacle, shall form a sealed unit. All lenses shall be secured with screws and tabs. Compression mounting shall not be used.

902.4.1.3 Reflectors. All reflectors shall be aluminum and furnished with a non-corrosive holder mounted either in the housing or on the door.

902.4.1.4 Electrical. The receptacle shall be designed to hold a Type A-21, medium base, traffic signal lamp. Rotation of the receptacle for positioning the lamp filament shall be possible without using tools. The terminal wire shall not be spliced. If single signal sections are specified, each section shall be furnished with a terminal block. All terminal blocks shall be rigidly secured to the section housing. A minimum of four terminals shall be provided for each terminal block. A lamp receptacle retainer shall be provided which can be installed or removed without the use of tools. Retaining rings designed to encompass and be embedded into the receptacle exterior surface shall not be used.

902.4.1.5 Louvers. Louvers, if specified in the contract, shall be installed in a tunnel visor with the fins or baffles in a vertical position. Louvers shall be marked as to degree of cut-off. The degree of cut-off shall be stamped on the louver or printed on a decal on the front of the louver and be visible after installation.

902.4.1.5.1 Fixed louvers shall be formed of 0.025-inch (0.6 mm) sheet aluminum. The top and bottom bends of each fin shall be securely fastened to the inside of the supporting ring. The angles of cut-off from either side of the center axis of the light beam shall be provided by six types of louvers: Type A - 3 degrees, Type B - 7 degrees, Type C - 10 1/2 degrees, Type D - 14 degrees, Type E - 18 1/2 degrees and Type F - 26 1/2 degrees.

902.4.1.5.2 Adjustable louver units shall be composed of an ABS plastic housing and polycarbonate baffles. The unit shall be designed to prevent light leakage between the housing and the visor. The unit shall have an adjustable view range of 7 to 42 degrees. All plastic materials shall be ultraviolet stabilized. All hardware shall be brass or stainless steel.

902.4.1.6 Hardware. Hardware shall be 1 1/2-inch (38 mm) galvanized steel or unfinished aluminum, except aluminum pipe brackets and side mount brackets. Aluminum pipe brackets shall have a spun finish. Side mount

brackets may be constructed of molded, glass-impregnated polycarbonate no greater than 12 inches in length. Elbows, tees and crosses shall be straight threaded and furnished with a square head set screw at each connection point to ensure rigid mounting. Fittings attached to the signal housing shall incorporate serrations or, by the use of an adapter ring, be compatible with the serrations on the signal housing. Fittings shall be secured to the signal housing by a closed threaded nipple and hex nut. Cast nipples shall not be used.

902.4.1.7 Backplates. Backplates, as shown on the plans, shall be provided on all signal heads. The backplates shall be black in color and constructed of flat pre-cut or preformed thermoplastic. Flat pre-cut thermoplastic backplates shall have a minimum thickness of 0.250 inches (6 mm). Preformed thermoplastic backplates shall have rolled out edges and a minimum final thickness of 0.1 inches (2.5 mm). Stainless steel bolts, nuts and flat washers shall be used to fasten the backplate to the head. Bolt lengths shall be selected to not interfere with maintenance operations. Any connection to the top of any signal section shall be watertight.

902.4.1.8 Optically Limiting Signal Heads. The signal section shall be a self-contained assembly consisting of an optical unit, section housing, housing door, terminal block and necessary gaskets to ensure a weatherproof unit. It shall be capable of separate mounting or inclusion in a signal face containing two or more signal sections. If existing housings are to be combined with new housings, the new housings shall be adaptable to the existing. All new signal sections shall meet the following requirements:

(a) Each signal housing shall be die cast aluminum having a chromate preparatory treatment. The signal housing and lens holder shall be predrilled for backplates and visors. All access openings shall be sealed with weather resistant gaskets. Hinge and latch pins shall be non-ferrous metal or stainless steel. The lens holder and interior of the housing shall be optical black. The housing shall mount to standard 1 1/2-inch (38 mm) fittings as a single section, as a multiple section face or in combination with conventional signals. The signal housing shall be provided with an adjustable connection that permits incremental tilting from zero to 10 degrees above or below the horizontal while maintaining a common vertical axis through the mounting assembly. Housing connection shall permit external adjustment about the mounting axis in 5-degree increments. Attachments such as visors, backplates or adapters shall readily fasten to mounting surfaces without affecting weatherproof characteristics and light integrity of the signal.

(b) The optical system shall consist of an objective lens, optical limiter-diffuser, lamp, lamp fixture and optical masking tape.

(1) The objective lens shall be a high-resolution planar incremental lens, hermetically sealed within a flat laminant of weather-resistant acrylic or approved equivalent. The lens shall be symmetrical in outline and if rotated to any 90-degree orientation about the optical axis, shall not displace the primary image.

(2) The optical limiter-diffuser shall provide an accessible imaging surface at focus on the optical axis for objects up to 1200 feet (365 m) distant and permit an effective veiling mask to be applied as determined by the desired visibility zone. The optical limiter-diffuser shall be provided with positive positioning and composed of heat resistant glass.

(3) The lamp shall be 150-watt, 115-volt AC, sealed beam with an average rated life of at least 6000 hours. It shall have a three-prong base and an integral reflector. The lamp shall be attached to the diffusing element with a collar having a specular inner surface.

(4) The lamp fixture shall consist of a separately accessible housing and integral lamp support, an adjustable ceramic socket and a self-aligning, quick release lamp retainer. Electrical connection between section housing and lamp housing shall be accomplished with an interlock assembly which disconnects the lamp holder when the door is opened.

(5) A signal lamp intensity control shall be supplied in each signal section to provide dimming of the signal lamp as the ambient light intensity drops below approximately 3 footcandles (32 lux).

(6) Each signal section shall be installed and directed and the optical limiter masked, in accordance with manufacturer's instructions to provide indications in accordance with the plans or as directed by the engineer.

902.4.1.9 Pedestrian Signal Heads. Pedestrian signal heads shall conform to ITE specifications and standards for pedestrian traffic control signal indications and the following:

(a) Pedestrian signal head housings shall be constructed as shown on the plans of a one-piece, 0.250-inch (6 mm) thick, polycarbonate material. The housing shall include an integral mounting bracket designed for side-of-pole mounting on all makes of signal poles with a terminal compartment and minimum 5-position, double-row terminal block.

(b) The door, lens and any openings in the housing shall have gaskets or seals to exclude dust and moisture from the inside of the compartment.

(c) Lenses shall be constructed of polycarbonate material.

(d) Pedestrian signal head units shall be provided with a manufactured, preformed rectangular visor or screen-type louver.

(e) All plastic materials shall be ultraviolet stabilized.

(f) 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. The LED module shall be in accordance with applicable portions of Sec 902.4.1(b).

(g) 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 located to the right of the "UPRAISED HAND" symbol.

902.4.1.10 Painting and Finishing. All aluminum signal head parts, including the housing, housing door, visors, louvers and backplates, except the mounting brackets and other hardware, shall be primed and painted flat black in their entirety. All polycarbonate signal head parts, including the housing, housing door, visors and backplates shall be constructed from ultraviolet stabilized black-impregnated polycarbon resin. The mounting brackets and hardware, except the aluminum pipe brackets and polycarbonate side mounted brackets, shall be galvanized steel or unfinished aluminum. Aluminum pipe brackets shall have a spun finish. Painting of the mounting brackets and hardware will not be permitted. All metal parts reused for modification of a signal installation shall be painted in accordance with the requirements for new material. If the painted surface of any equipment is damaged, such surface shall be repaired to the satisfaction of the engineer.

902.4.2 Signs and Luminaires.

902.4.2.1 Signs. Signs for signal installations will be furnished by the Commission. They shall be mounted as shown on the plans. The contractor shall furnish all material required for sign mounting.

902.4.2.2 Luminaires. Luminaires shall be in accordance with Sec 901.4.4. Light distribution shall be Type III medium distribution semi-cutoff.

902.4.3 Posts and Mast Arms. A grounding lug shall be provided for all units. A grounding conductor shall provide grounding continuity for all metallic, noncurrent-carrying poles in one circuit.

902.4.3.1 Steel Pedestal Posts. Steel pedestal posts shall be 4 1/2-inch (114 mm) outside diameter schedule 40 steel pipe. The base shall be cast iron, free from imperfections and provided with a suitable plastic, fiberglass or cast door for wiring access. The grounding lug shall be inside the base. The bolt circle and hole diameter shall be as shown on the plans. After fabrication, posts and bases shall be fully galvanized.

902.4.3.2 Aluminum Pedestal Posts. Aluminum pedestal posts shall be schedule 80 straight tubing of 6063-T6 aluminum alloy in accordance with ASTM B 210, with a 4 1/2-inch (114 mm) outside diameter. The pedestal base casting shall be either permanent mold casting of Alloy 356.0 F, in accordance with ASTM B 108 or sand castings of Alloy 356.0 F, in accordance with ASTM B 26. The base shall be free from imperfections and provided with a suitable door for wiring access. The base and post shall be joined by threaded connection. Welded connections will not be allowed. The grounding lug shall be provided inside the base. All hardware shall be non-ferrous metal or stainless steel.

902.4.3.3 Signal Post and Mast Arm Pre-Approval. Fabricators shall submit six copies of shop drawings and supporting calculations to Traffic. Submittals shall be approved by Traffic in writing prior to fabrication of the signal posts and mast arms. Shop drawings shall indicate complete design details required for post and mast arm fabrication, including material grades and thicknesses, welding and orientation of any longitudinal seams. The projected areas and weights (masses) of signs and signals used in the design of the post and mast arms shall be shown on the shop drawings. Design details for all possible post and mast arm combinations as shown on the plans may be submitted. Shop drawings shall provide post and mast arm installation and hardware details. 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. Manufacturers shall submit all required documentation, in accordance with Sec 902.4.3.4.3. Upon written approval, pre-approved drawings may be used on any project where the design conditions of the shop drawings are not exceeded.

902.4.3.4 Steel Posts and Mast Arms. Steel posts and mast arms shall be continuously tapered, hollow shafts fabricated as one continuous shaft or as individual segments, not less than 10 feet (3 m) in length, joined together using electrically welded, intermediate, transverse, full penetration, circumferential joints. Steel posts and mast arms shall be fabricated from basic oxygen or open hearth steel sheet. The continuous, tapered, hollow shafts or individual segments shall be manufactured from one or two lengths of steel sheet, with one or two continuous, welded, longitudinal seams. The longitudinal seams in the mast arm shall be located outside of the upper half of the cross section of the member. Where transverse, full penetration, circumferential welds are used, the fabricator shall furnish to the engineer written certification that 100% of all such welds have been radiographed or ultrasonic tested by an independent testing agency using a qualified non-destructive testing technician, as described in Section 6.14.7 of ANSI/AWS D1.1, and equipment calibrated annually. The testing agency shall be approved by the engineer prior to fabrication. Post base and mast arm attachment plates shall be plate steel attached to the larger end of the shafts by continuous welds on the inside and outside of the shaft. After manufacture, the material shall have a minimum yield strength of 48,000 pounds per square inch (330 MPa).

902.4.3.4.1 A handhole equipped with a suitable metal cover shall be provided in the post near the base and 12 inches (300 mm) above the mast arm connection if luminaire mounting is specified. A grounding lug or connector shall be provided inside the post near the handhole. A removable metal cap shall be provided on the top of the post and on the small end of each mast arm. All handhole covers and metal caps shall be securely attached to the post or arm with a galvanized steel chain. The chain shall be attached to the inside of the post or arm and be of sufficient length to allow maintenance access. An identification tag shall be provided with all posts and mast arms as shown on the plans. The tag shall be aluminum or stainless steel with embossed or engraved letters and numbers. The post tag shall be attached to the pole 6 inches (150 mm) above the top of the handhole. The mast arm tag shall be attached 3 inches (75 mm) from the base of the end cap. The base plate 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. All poles, shoe bases, base plates and cast steel or cast iron nut covers shall be fully galvanized after fabrication. All anchor bolt nuts shall be completely covered by nut covers. Luminaire bracket arms, when specified, shall be included with the post and mast arm, and no direct payment will be made. The contractor has the option to furnish posts with shape, gage and dimensions meeting or exceeding those required by the plans and specifications, provided shop drawings are submitted and approved in accordance with Sec 902.4.3.3.

902.4.3.4.2 Welding and fabrication of the assemblies shall be in accordance with the ANSI/AWS D1.1 Structural Welding Code-Steel. All requirements of the welding code for tubular structures shall apply to the fabrication for the post and mast arm shafts and shall include any welds used to attach these members to plates or other hardware. The manufacturer shall employ qualified personnel to perform all visual and nondestructive testing (NDT) required. In addition to the visual inspections and NDT that may otherwise be required by the welding code, the manufacturer

shall perform 100 percent magnetic particle (MT) testing of circumferential fillet welds used to attach the flange plate to the larger end of the mast arm shaft. NDT personnel shall be qualified as set forth in paragraph 6.14.7 of ANSI/AWS D1.1. Qualifications of NDT personnel shall be submitted to the engineer for approval.

902.4.3.4.3 The post and mast arm manufacturer shall be certified under the American Institute of Steel Construction (AISC) certification program, Conventional Steel Building or higher category. Evidence of current AISC certification will be required prior to the approval of shop drawings, and lapsing of the certification will be cause for the manufacturer's removal from the approved list of suppliers.

902.4.3.4.4 Steel posts, luminaire bracket arms, mast arms, nut covers and plate steel bases shall be hot-dip galvanized inside and out after fabrication, visual inspections and NDT testing. Galvanized material shall be handled in a manner to avoid damage to the surface. Any galvanized material on which the coating has been damaged will be rejected or may, with the approval of the engineer, be repaired in accordance with Sec 712.14.

902.4.3.4.5 Fabricator's Certification. Prior to erection of the posts and mast arms, the contractor shall furnish to the engineer a fabricator's certification in triplicate. The certification will specifically state the fabricated posts and mast arms have been quality control inspected by the fabricator and all material and manufacturing processes used were in full compliance with the specification requirements and the approved shop drawings and weld procedures. The certification shall be accompanied by supporting documentation which shall include the results of the visual inspections and NDT in accordance with Sec 902.4.3.4.2 and copies of the pre-approved drawings required by Sec 902.4.3.3.

902.4.3.6 Construction Requirements. Prior to installation, manufacturer and drawing numbers shall be submitted by the contractor to the engineer for approval in writing. Four copies of applicable pre-approved drawings shall be supplied with the poles.

902.4.3.7 Span Wire Assemblies. Span wire assemblies shall include 3/8-inch (10 mm) steel messenger wire, 1/4-inch tether wire, guy wire, all bolts, nuts, washers, clamps, cable straps and other appurtenances shown on the plans or necessary for proper installation. Messenger wire shall be Class A galvanized, high-strength grade, seven-wire strand in accordance with ASTM A 475. Tether wire shall be seven-wire high-strength steel cable. Clamps shall be fabricated from low alloy steel. Steel posts for span wire assemblies shall have wire inlets and cable guides with 1 1/2-inch (38 mm) raintight insulator bushings and other features specified in the contract and shall be in accordance with applicable requirements of Sec 902.4.3.4. Wood poles and steel posts for span wire assemblies shall be as specified in the contract and as shown on the plans. No direct payment will be made for luminaire bracket arms, if specified. No direct payment will be made for conduit, junction boxes, service entrance caps, attachment hardware or other appurtenances on the wood poles or steel posts as shown on the plans.

902.4.4 Power Supply Assembly. The power supply assembly shall be in accordance with Sec 901.4.6.

902.4.4.1 Luminaire Control. If luminaires are specified as part of the signal conduit and wiring system on the signal posts or on separate light poles, a lighting control cabinet shall be provided and installed as shown on the plans. The lighting control cabinet shall contain a control panel constructed of the same material as the cabinet. Circuit breakers, 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 sufficient size to house all equipment as shown on the plans. Cabinets shall be dusttight, watertight, NEMA 4 and constructed of aluminum or stainless steel. All hinges, catches and other hardware shall be stainless steel. Cabinets shall have a No. 2 Corbin cabinet lock. Photoelectric switches and contactors shall be in accordance with Sec 901.4.5. Circuit breakers shall be Type B circuit breakers in accordance with Sec 901.4.5.6.

902.4.5 Traffic Controller Assemblies. Traffic controller assemblies are defined as the complete assembly of all required equipment and components for control of traffic signal indications. Each assembly shall consist of a controller cabinet, signal controller, back panel, conflict monitor, card rack assembly, all required wiring, switches and connectors and all other equipment as defined in these specifications and as shown on the plans. Double controller assemblies to control two intersections shall consist of a controller cabinet, two signal controllers, two back panels, two conflict monitors, two card rack assemblies, all required wiring, switches and connectors and all other equipment as defined in these specifications and as shown on the plans.

(a) Each controller and its associated equipment shall be designed to operate on 120 volts, 60 hertz, single phase, alternating current.

(b) Variations in the voltage of the power supply of plus or minus 10 percent or sustained temperatures inside the cabinet between -20 F (-28 C) and 165 F (74 C) shall not change the total time cycle of pretimed controllers or the length of any interval, portion, period or unit extension of actuated controllers by more than 5 percent or cause electrical or mechanical damage. Heater elements shall not be used to attain compliance with these requirements.

(c) Vibration shall not affect normal operation of any equipment.

(d) All controllers and other specified auxiliary equipment shall be properly protected with fuses on each applicable unit. Fuses shall be installed in 1/4 twist or screw-in type fuse holders. Pop-out fuse holders shall not be used.

902.4.5.1 Controller Cabinets. Controller cabinets shall be cast aluminum or 0.125 inch (3 mm) reinforced sheet aluminum alloy and be of clean-cut design and appearance. The cabinet shall provide ample space for housing all equipment and components. Controller cabinets housing solid-state controllers shall be furnished with unused cabinet space measuring 18 inches (450 mm) wide by 12 inches (300 mm) high by 12 inches (300 mm) deep unless coordination equipment is specified on the plans. For pretimed and actuated NEMA controllers, cabinet size shall be not less than 54 inches (1370 mm) high by 38 inches (965 mm) wide by 25 inches (635 mm) deep and support a twelve-position backpanel. Double controller cabinets for two controllers shall be not less than 57 inches (1450 mm) high by 74 inches (1880 mm) wide by 17 inches (430 mm) deep and shall support two twelve-position back panels. All double cabinets shall have two doors that are hinged on the outside corners of the cabinet so that the doors open away from each other. Double cabinets shall have a divider between the two halves of the cabinet with an 8-inch (200 mm) opening between the compartments at the bottom of the divider for wiring between the compartments. The cabinet shall contain a rigid mounting table, sliding ways or hinged support of such construction that the controller and auxiliary equipment may be withdrawn from the cabinet without breaking any electrical connections or interrupting normal controller operation. Hinged supports shall be welded to the controller cabinet. Electrical connectors on the controller and auxiliary equipment to all circuits shall be NEMA 1/4 twist or MS type. Components of controller cabinets shall meet the following requirements.

(a) A hinged door or doors shall provide complete access to the interior of the cabinet. Door holds shall secure the door in an open position at least 90 degrees from the closed position and be furnished with each cabinet. The doors shall fit against a raintight gasket. Each door shall have a stamped or raised outside designation, "Traffic Control" or other approved identification. Each main cabinet door shall have a No. 2 Corbin cabinet lock and provisions for locking with a padlock. An auxiliary door, positioned on each main cabinet door, equipped with a raintight gasket, shall allow access to a police panel and be equipped with a lock whose key will not unlock the main door. Two keys shall be furnished for each type lock used. The door hinges and pins shall be of corrosion-resistant metal. Pins shall be rolled or solid rod, at least 1/8 inch (3 mm) in diameter, except if continuous hinges are furnished, the pins shall be continuous the full length of the hinges and shall be not less than 1/16 inch (1.5 mm) in diameter.

(b) The back panel in all controller cabinets shall be hinged at the bottom to permit the top of the panel to be rotated forward and down to an angle of not less than 45 degrees with all components, including load switches, attached for maintenance purposes. The bottom of the back panel shall be not less than 6 inches (150 mm) above the bottom of the cabinet.

(c) Cabinets housing solid-state controllers shall have a thermostatically controlled ventilating fan with exhausting capability in an enclosure of at least 150 cubic feet per minute (0.07 m^3/s) for cabinets up to 30.5 cubic feet (0.9 m^3) and at least 250 cubic feet per minute (0.12 m^3/s) for cabinets 30.5 cubic feet (0.9 m^3) and more, installed in the top of the cabinet. These cabinets shall be supplied with a replaceable furnace-type fiberglass filter of at least one square foot (0.06 m^2) area mounted behind louvers in the lower one-fourth of the door.

(d) Each controller cabinet shall be furnished with a clearly labeled switch mounted in the access or police panel to place the signals on flash. Operation of this switch shall not affect the electrical power supply to the controller.

(e) Each cabinet shall be provided with a grounded service outlet and a switch-controlled lamp receptacle.

(f) Each cabinet shall contain a separate aluminum power panel containing the following equipment.

(1) One Type B circuit breaker in accordance with Sec 901.4.5.6. The breaker shall interrupt power to the controller and signals. The frame size and trip rating is shown on the traffic signal plans or designated in the contract.

(2) One Type B circuit breaker in accordance with Sec 901.4.5.6. The breaker shall be an auxiliary breaker which interrupts power to cabinet lamp and receptacle. The frame size and trip rating shall be 15 amperes.

(3) One mercury contactor controlling power to the signal bus.

(4) One radio frequency line filter.

(5) One line surge protector.

(6) One terminal block for AC power input.

(7) One ground bus terminal block.

(8) One isolated neutral bus terminal block.

(g) If specified, a manual operation push button shall be installed in the police panel. The push button shall be wired for manual operation of the signals. The push button shall be water-resistant and designed to protect the user against electrical shock and shall be supplied with a coiled cord with a nominal 6-foot (2 m) stretched length. A clearly labeled switch shall also be installed in the police panel to switch between manual or automatic operation of the controller.

902.4.5.2 Flasher Unit. Each controller, through terminal options, shall permit yellow-red or red-red flash operation. Indications shall be flashed at not less than 50 nor more than 60 flashes per minute, with approximately 50 percent dwell time. A two-circuit flasher, alternate flash and three flasher field circuits for each of the two flasher circuits will be required. A separate flasher shall provide flashing pedestrian indications when required by the contract. The timing of flashing pedestrian intervals shall be separately adjustable from all other timed intervals. The flasher shall be solid-state with ratings not less than 15 amperes per circuit and shall comply with the latest revision of NEMA Standards Publication TS. The flasher units shall have a 150-volt metal oxide varistor (MOV) placed on each output flash terminal. Uniform code flash circuitry is required for each controller. Flashing operation shall be in accordance with the MUTCD.

902.4.5.3 External Time Switches. External time switches shall be solid-state, key board entry and contain filtering and shielding circuitry to protect the unit's operation against electrical interference. Timing shall be based on the 60 Hz power supply frequency. Each unit shall contain a programmable automatic central daylight time compensation feature. Each unit shall contain a back-up power source to maintain time and memory functions during loss of AC power. Each unit shall provide a weekly program with at least 20 event changes per week.

902.4.5.4 Wiring. All wiring shall be insulated, stranded copper wire and shall be neatly bundled and secured with plastic cable ties. For double controller cabinets, all wiring for each intersection shall be terminated in the same compartment of the cabinet as the signal controller for that intersection. Incoming field circuits shall be routed horizontally from the conduit to the back of the cabinet, then vertically to the terminal block. All terminals shall be labeled and not be visibly obstructed. All field leads shall be identified by means of round aluminum identification tags with a minimum thickness of 0.1 mils (2.5 µm) attached to the cables with a copper wire to correspond with the plans. The outgoing signal circuits shall be of the same polarity as the line side of the power supply and the common return of the signal circuits shall be of the same polarity as the ground side of the power supply. The power supply shall be provided through three single conductor cables. 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. All field conductors shall be terminated in the controller cabinet on a 600-volt heavy duty one piece mechanical screw connector offset tang assembly attached to a barrier terminal strip. Each mechanical screw connector shall accommodate up to four No. 12 AWG (4 mm^2) conductors. The connector shall be mounted horizontally on the inside of the cabinet back approximately 6 inches (150 mm) from the bottom of the cabinet. All wiring to the terminal strips except the incoming field circuits shall be performed by the controller manufacturer. The terminal strips shall mount at least:

(a) Two terminals for the power supply.

(b) An unfused terminal for neutral side of power supply line.

(c) One terminal for each signal lamp circuit and one terminal for the common return from each signal face.

(d) If detectors are used:

(1) Two terminals for each detector.

(2) Screw terminal strips mounted vertically on the side of the cabinet approximately 6 inches (150 mm) from the bottom of the cabinet.

(3) All inductive loop detector inputs shall be protected with two 30-volt metal oxide varistors (MOV) with a 30 J rating. An MOV shall be connected between each field terminal and cabinet ground.

(e) Terminals for interconnect cable when the controller is to be hard-wire interconnected shall be fused and provided with a 150-volt metal oxide varistor (MOV) with an 80 J rating.

(f) Terminals for closed loop system interconnect cable shall be fused and provided with a 30-volt oxide varistor (MOV) with a 30 J rating.

902.4.5.5 Back Panel Wiring. All wiring on the back side of the controller back panel shall be neatly bundled and secured with plastic cable ties. Any multi-conductor cable between the controller or auxiliary equipment and the back panel shall be contained in an expandable braided sleeving. All wiring shall be discrete insulated wires and shall be soldered directly to lugs on the back of terminal blocks and sockets. Printed circuit boards shall not be used. Regardless of the number of phases specified on the plans, all load switch positions shall be completely wired for use. If no pedestrian phases are specified, twelve position back panels for actuated NEMA controllers shall be configured for operation of eight phases and four overlaps. If pedestrian phases are specified, twelve position back panels shall be configured for operation of eight phases and four pedestrian phases or a combination of overlaps and pedestrian phases if specified on the plans. Twelve position back panels for pretimed controllers shall be configured for operation of 36 circuit outputs from the controller unless otherwise specified on the plans. A flash transfer relay socket shall be provided for each pair of load switch positions. Flash circuit 1 shall be wired to positions 1, 3, 5, 7, 9 and 11. Flash circuit 2 shall be wired to positions 2, 4, 6, 8, 10 and 12. All flash transfer relay sockets shall be fully wired for operation. All controller harness wiring shall be connected to labeled terminals on the front of the panel.

902.4.5.6 Solid-State Controllers. This section describes the general specifications for actuated solid-state controllers. If requested by the engineer, the contractor shall provide a prototype controller for testing and evaluation.

(a) Each controller shall be solid-state keyboard entry and the circuit design shall use microprocessor techniques.

(b) Timing shall be accomplished in a digital manner by counting the 60 Hz power supply frequency. Timing circuits, interval and phase switching functions shall be accomplished by solid-state circuitry. It shall not be necessary to remove or change wires or use any tools to make timing interval adjustments. The controller shall indicate the right of way conditions of the phase timing interval in effect, detector or actuation on each phase and memory conditions or demand on each phase for vehicles and pedestrians by use of status lights or display panels.

(c) Opening and closing of signal lamp circuits shall be performed by plug-in solid-state load switches, rated at not less than 10 amperes and loaded no greater than 6.7 amperes, located external to the controller. All load switch jacks shall be completely wired to field output terminal strips. Actuated and pretimed controllers shall have a minimum of twelve load switch jacks. Each load switch shall provide three independent circuits with "on" indicator lamps and shall comply with the latest revision of NEMA Standards Publication TS.

(d) Each controller assembly shall contain a conflict monitor external to the controller circuitry conforming to NEMA Standards Publication TS. The monitor shall cause immediate transfer to flashing operation

when conflicting or absent indications occur or when a voltage fault occurs. When the conflict monitor actuates flashing operation, the controller shall freeze or stop timing in the condition causing the actuation until manually reset. A single lamp failure in any signal head shall not cause the monitor to actuate.

(e) For double controller cabinets, two sets of switches are provided, one set for each controller installed in each compartment. Each controller cabinet shall be furnished with the following switches:

(1) Power Interrupt Switch - A switch located inside the main cabinet shall interrupt electrical power to the controller during maintenance on the controller. Operation of this switch shall not affect the flash operation. This switch shall not be accessible via the police panel.

(2) Flash Switch - A switch mounted in the police panel shall place the signal on flash. Operation of this switch shall not affect the electrical power supply to the controller. When the signals are returned to normal operation the external start shall be activated causing the controller to revert to the programmed initialization phase(s).

(3) Stop Time Switch - A three position switch mounted inside the main cabinet shall provide the following functions:

a. Stop Time - Causes the controller to stop time.

b. Normal - Allows the controller to cycle all phases, but during conflict monitor flash causes the controller to stop time.

c. Run - Allows the controller to cycle all phases and during any flashing operation allows the controller to continue cycling all phases without displaying them on the signal heads.

(f) During flash condition, controller operation shall permit the cycling of all signal phases without an external load being connected to the field terminals.

(g) Solid-state controllers shall have electronic filters to prevent interference caused by the opening and closing of circuits in electro-mechanical auxiliary equipment.

(h) The controller shall be of modular design. Each module shall be constructed for individual removal and replacement in the controller by multiple prong jacks or outlets without modifying wiring. Hand operable positive locking devices shall be used to hold the modules securely in the controller.

(i) The functional operating circuits and their associated components shall be grouped in plug-in printed circuit assemblies. Similar assemblies shall be interchangeable between controllers manufactured by the same company.

(j) The controller shall contain the necessary phase sequence, interval sequence timing, power supply and monitoring equipment required to supervise the operation for the phasing shown on the plans, including any future controller expansion. If future phases are specified, the controller shall be completely configured to accept the future phases.

(k) Controllers which are interconnected shall have a coordinated/free operation switch. This switch will allow the controller to operate in coordination with the system or run free.

(l) High energy transient surge protection shall be provided on all solid-state controllers to minimize damage to the controller and auxiliary equipment. This device shall be located on the incoming 120 volts, 60 Hz power service between the controller and signal circuit breaker and the power inputs to the controller and auxiliary equipment. The arrestor shall meet the latest NEMA specifications for surge protection.

(m) All flash operation called from a source external to the controller shall occur through the flash transfer relay.

(n) Any multi-conductor cable shall be contained in an expandable braided sleeving.

(o) Switches or relays which completely interrupt power to the signal heads other than the protective circuit breaker shall not be installed in the cabinet.

(p) All controllers shall be capable of downloading all programming data to a printer via a front panel RS-232 connection. The controller shall be capable of printing directly to a printer or via an external PC computer. If an external computer is required, the required PC software shall be provided with the controller.

(q) All controllers shall be provided with internal pre-emption functions and circuitry.

902.4.5.6.1 Solid-State Actuated Controller. Each solid-state actuated controller shall meet the latest revision of NEMA Standards Publication TS. Actuated controllers shall meet the following requirements:

(a) Recall by keyboard entry shall be provided for each phase to furnish continuous recall. With the recall function in the "OFF" position the controller shall operate normally with the right of way being transferred only upon pedestrian or vehicle actuation or external force-off control.

(b) Controllers shall be furnished with provisions for external maximum control for each signal phase complete with wiring to permit installation of a coordination unit. All wiring to facilitate coordination shall be terminated on terminal strips and complete information stating the function of each terminal shall be shown on the controller wiring diagram.

(c) All phases shall contain a non-locking memory feature. This feature shall be energized or de-energized by keyboard entry.

(d) All phases shall be activated or inactivated by keyboard entry.

(e) On the cabinet inside door test panel, an external push button switch for each vehicle and pedestrian phase shall be provided. Each switch shall provide call to the phase assigned and ability to extend the phase. This detector input shall be independent of the circuitry between the amplifier and backpanel.

(f) On controller cabinets with internal coordination in a 7- or 12-wire interconnect system, a MoDOT D-plug shall be provided between the D-plug on the controller and the interconnect panel on the cabinet. In the absence of the sync signal, the coordination interface shall be configured to cause the controller to default to free operation. Configuration of the MoDOT D-plug shall be as follows:

Pin	Assignment
D1	Cycle 1
D2	Cycle 2
D3	Cycle 3
D4	Cycle 4
D5	Future (Cycle 5)
D6	Future (Cycle 6)
D7	Split 1
D8	Split 2
D9	Split 3

Pin	Assignment
D10	Split 4
D11	Offset 1
D12	Offset 2
D13	Offset 3
D14	Future (Offset 4)
D15	Future (Offset 5)
D16	Pre-empt 1
D17	Pre-empt 2
D18	Pre-empt 3

Pin	Assignment
D19	Future (Pre-empt 4)
D20	Flash
D21	Hardware Interconnect*
D22	Future
D23	Future
D24	Future
D25	Future

* Omit when activated through the cycle, split or offset inputs.

(g) The MoDOT D-Plug shall be a Cinch TRW Super D Connection as follows:

1 - Part #TB 25 P	Plug
1 - Part #TB 25SLB-1	Socket

1 - Part #SHD-25GL	Hood with Latch
1 - Part #SHD-25GFCS	Hood with Filler Ends

(h) Actuated controllers shall be fully configured for operation of a minimum of eight vehicle phases, four pedestrian phases and four overlaps regardless of the number of phases shown on the plans.

902.4.5.6.2 Timing Function. Timing intervals or periods shall be set by means of keyboard entry. Each timing interval shall be adjustable to any value within the following minimum ranges for each phase. Zero may be satisfied by a time increment of up to 100 milliseconds.

Interval	Range
Minimal Initial	0 - 99 seconds
Unit Extension or Passage Time	0 - 9.9 seconds
Yellow Clearance	0 - 9.9 seconds
Red Clearance	0 - 9.9 seconds
Maximum I Green	0 - 99 seconds
Maximum II Green	0 - 99 seconds
Walk	0 - 99 seconds
Pedestrian Clearance	0 - 99 seconds
Seconds per Actuation	0 - 9.9 seconds
Maximum Initial	0 - 99 seconds
Time Before Reduction	0 - 99 seconds
Time to Reduce	0 - 99 seconds
Minimum Gap	0 - 9.9 seconds

902.4.6 Auxiliary Equipment and Interfaces for Controllers. Interface panels shall be aluminum panels installed in the controller cabinet containing the required terminals and equipment. Interface panels shall be neatly laid out, neatly wired and easily accessible. Each auxiliary unit shall be enclosed in a suitably finished metal case. It shall be mounted in the controller cabinet unless otherwise specified. The function of each auxiliary unit shall be indicated by an identification plate on the case. Auxiliary equipment cases shall be ventilated. Temperature, voltage and frequency shall be in accordance with Sec 902.4.5.

902.4.6.1 Pre-emption Interface. The pre-emption interface shall consist of internal pre-emption functions in the controller, any field wire termination panels, relays, wiring and connectors required for proper operation. The pre-emption interface shall be wired to transfer control of the signals to the pre-emption sequence when actuated and shall provide the color sequence specified. After release of pre-emption, normal controller operation shall be automatically resumed except that actuated controllers shall be on recall for one complete cycle.

902.4.6.2 Master and Local Coordination Interface. The coordination interface shall consist of internal coordination functions in the controller. The coordination interface shall also consist of any field wire termination panels, wiring and connectors required for proper operation. The master coordination interface shall supervise the actuated controller operating the signals in the intersection at which it is located. Local coordination interfaces shall be supervised by the master coordination interface and shall in turn supervise the actuated controllers operating the signals at the intersections where they are located. Coordination interfaces shall be connected to one another or to a telephone interconnection unit by a multi-conductor cable. The master coordination interface shall be furnished with internal time-based functions in the controller. The coordination interface shall provide the following:

(a) Fully actuated operation.

(1) Cycle length of the actuated controller may vary with traffic demand but shall not exceed the cycle length set on the coordination interface.

(2) Vehicle and pedestrian detectors shall remain energized.

(3) During periods of light traffic, the actuated controller shall respond to detector demand on any signal phase.

(4) When there is continuous demand for all signal phases, the coordination interface shall cause termination of each signal phase in accordance with the time intervals set on the coordination interface for each signal phase.

(5) The actuated controller shall not be forced to transfer right of way to a signal phase if there is no demand.

(b) Semi-actuated operation.

(1) Signal phases controlling the street on which signal progression is desired shall be placed on maximum recall.

(2) Vehicle and pedestrian detectors shall remain energized.

(3) Transfer of right of way from the coordinated signal phase(s) shall not occur until there is detector actuation for a non-coordinated signal phase and only after the coordination interface has terminated the coordinated signal phase(s).

(4) The right of way interval awarded the coordinated signal phase(s) shall be governed by the time interval set on the coordination interface.

(5) If detector actuations for a non-coordinated signal phase(s) causes the phase(s) to time to maximum, the phase(s) shall be forced off and the coordinated phase(s) awarded right of way.

(6) If demand for the non-coordinated signal phase(s) is not sufficient to extend the phase(s) to maximum, right of way shall transfer to the coordinated phase(s) and remain there until demand for the non-coordinated phase(s) occurs and the coordination interface times the coordinated phase(s) to maximum.

(7) Detector actuation on a non-coordinated signal phase(s) occurring during the coordinated phase(s) right of way interval shall cause a call to be placed and retained for the non-coordinated signal phase(s).

(c) Fixed cycle length operation.

(1) All signal phases shall be placed on maximum recall.

(2) Vehicle and pedestrian detectors shall remain energized.

(3) The coordination interface shall control the time interval that each signal phase is awarded right of way.

(d) Free operation.

(1) When permitted by internal time-based functions, the coordination interface shall provide free operation of associated actuated controllers. During this operation the actuated controller shall operate without supervision by the coordination interface.

(2) Pretimed controllers, in a signal system supervised by a master coordination interface, shall revert to dial 1, reset 1 or internal time based coordination during free operation at the user's option.

902.4.6.2.1 Each coordination interface shall have the following minimum operational characteristics:

(a) Three cycles.

(b) Eight splits.

(c) Eight force off periods per split.

(d) Three offsets per cycle.

(e) Selectable recall by signal plan.

902.4.6.2.2 Each coordination interface shall have all of the following methods of synchronizing to the master sync pulse:

(a) Dwell. The coordinator shall establish a new offset by stopping the cycle timer in the coordinated phase(s) green, until the new offset value is reached.

(b) Dwell with Interrupt. The coordinator shall establish a new offset by stopping the cycle timer in the coordinated phase(s) green. The maximum time the coordinator can dwell shall be adjustable from 1 to 99 seconds.

(c) Shortway. The coordinator shall establish a new offset by the shortest route possible.

902.4.6.2.3 Each master coordination interface shall be furnished with necessary relays and internal functions in the controller to provide the following supervisory functions:

(a) Semi-actuated operation.

(b) Fixed cycle length operation.

(c) Free operation.

(d) Cycle Transfer (cycle 1 to cycle 2, cycle 3 or cycle 4 and vice versa; cycle 2 to cycle 3 or cycle 4 and vice versa; cycle 3 to cycle 4 and vice versa).

902.4.6.2.4 Each controller shall be capable of permitting the manual selection of the following:

(a) Cycle Length 1, 2, 3, 4 or System.

(b) Offset 1, 2, 3, 4 or System.

(c) Semi-actuated operation, fixed cycle length operation or free operation.

902.4.6.4 Remote "ON - OFF" Switch (Pedestrian Interval Sequence). The following type "On - Off" switches shall be furnished as specified:

(a) Type I. This item shall consist of one manually operated heavy duty switch in a circuit not exceeding 18 volts. Necessary relays shall be located in the controller cabinet for including or excluding the pedestrian phase in the phasing sequence or switching signals between flashing and sequence operation. This shall be accomplished by energizing or de-energizing the pedestrian signal indications and push-button detectors. The switch shall be enclosed in a weatherproof, cast aluminum housing equipped for post mounting. The housing shall have a suitable lock, the key of which shall not unlock the controller cabinet. The housing shall be tapped for conduit.

(b) Type II. This item is operationally identical to Type I except the switch may be 120 volts and shall be located in the access panel of the controller cabinet.

902.4.6.5 Time Base Coordination Interface. The time base coordination interface shall consist of internal time base coordination functions in the controller.

(a) Timing base shall be the 60 Hz power line frequency. Timing error due to power failure or low voltage shall not exceed plus or minus 0.005 percent during these conditions. Changes to and from standard time and daylight time shall be programmed to automatically occur at the specified times. Memory and timing shall be maintained for at least 48 hours during an AC power failure. A power failure indicator shall be provided.

(b) The interface shall have a multi-digit security access code or key and lock security access.

(c) The interface shall be zero time based, settable to the second, programmable for 52 weeks, accommodate at least three weekly programs, twelve day programs and not less than twelve exception day programs. Total event changes shall not be less than 160. It shall be possible to interrogate the interface to determine the year, month, day, hour, minute, second, a.m. and p.m., as well as program information programmed in the unit. Indicators shall show the condition of all outputs.

(d) The interface shall permit the controller to operate free or in coordination. When in coordination, all maximum green limits shall be inhibited. The interface shall be capable of continuously generating not less than four cycle lengths from 40 to 255 seconds.

(e) The interface shall be capable of continuously generating eight individual force-off commands in each cycle length even though it may not be necessary to use all of the force-off commands. It shall also place a continuous call to the detector inputs of the coordinated phases. Position of the force-off and continuous call functions shall be settable at any percentage point or seconds in any selected cycle length.

(f) The first program of the day shall be implemented at the beginning of the minute selected. When changing from one cycle length to another while in the coordination mode, the change to the new cycle length shall not occur until the present cycle length has terminated. If the controller is operated in the free mode between cycle lengths, the next cycle length programmed shall begin at the beginning of the minute selected.

(g) The interface shall be furnished with the capability of generating a daily reference point at which time all cycles are resynchronized. This daily reference point shall be either 12:00 midnight or a selectable time of which 12:00 midnight could be selected. The resynchronization reference time is an arbitrary point in time which marks the beginning of all cycles on a daily basis.

(h) When designated, the interface shall be capable of generating an absolute reference point at which time all cycles are resynchronized. This absolute reference point shall be a selectable time by date and hour and minute which marks the beginning of all cycles.

(i) While under coordination, the designated coordinated phase(s) shall be capable of releasing from a hold status and operating in the actuated mode. The controller unit shall operate in actuated mode from a designated hold release point to the corresponding force-off point(s) of the coordinated phase(s).

(j) Three instruction manuals covering operational information shall be furnished with each interface.

902.4.7 Detectors.

902.4.7.1 Induction Detector Probes. The encapsulated induction detector probe shall detect the passage or presence of all vehicles with a standard induction loop detector amplifier. The induction detector probe shall operate in a temperature range from -35 F (-37 C) to +165 F (+74 C) with 0 to 100 percent humidity. The operating field intensity range shall be 0.2 to 1.0 oersted with a nominal inductance of 20 µH plus 20 µH per 100 feet (30 m) of cable. The nominal DC resistance shall be 0.5 Ω plus 3.2 Ω per 100 feet (30 m) of probe cable. Induction detector probes shall be as specified on the plans and shall conform to the following:

(a) The sensing probes shall be cylindrical having maximum dimensions of 7/8-inch (23 mm) diameter by 4 inches (100 mm) long. The sensing probes shall be suitable for installation in a one-inch (25 mm) diameter bored hole. The interconnecting four conductor cable and lead-in cable shall be suitable for installation in a 1/4 inch (6 mm) wide pavement sawed slot.

(b) The jacket on the interconnecting cable and the casing on the sensing probe shall be an abrasion resistant polyurethane elastomer. The device shall be impervious to moisture and chemically resistant to all normal motor vehicle petroleum products. Lead-in cables shall be shielded, chemical resistant and completely waterproof.

(c) The combined probe sets, manufacturer specified lead-in cable and detector probe shall detect all vehicles up to a lead-in cable length of 750 feet (228 m) with up to six probes per set.

(d) The conductor cable from the probes to the detector panel in the controller assembly shall be as specified by the detector manufacturer, shall be continuous and unspliced and shall be a minimum of 50 feet (15 m) in length. Probes shall be assembled in a set to form a vehicle detector as shown on the plans. No more than six probes shall be assembled as a set. The cables between probes shall be long enough to provide the spacing shown on the plans plus 5 feet (1.5 m). If no spacing is shown, 15 feet (4.5 m) of cable shall be provided between probes. Each set of probes shall have one lead-in cable.

(e) Probes installed under bridge decks shall be protected by completely encapsulating them in a conduit system. The probes shall be oriented so that the detection zone is above the bridge deck and shall be installed in gasketed junction boxes anchored to the bottom of the deck. The junction boxes shall have a minimum size of 6 x 6 x 4 inches (150 x 150 x 100 mm) and the probes shall be rigidly anchored in the box. The probes shall be no more than 18 inches (450 mm) below the top of the bridge deck. Conduit shall be sized so that the probe and cable can be pulled through the conduit. Any conduit bends shall be such that probe and cable can be pulled through the bend. External conduit on the structure be in accordance with Sec 902.5.3.6.

902.4.7.2 Push-Button. Pedestrian push-button detectors shall be direct push contact type. Each detector shall be a removable contact assembly mounted in a cast aluminum case. The housing shall be shaped to fit the curvature of the post to which it is attached and shall provide a rigid installation. Contacts shall be normally open, entirely insulated from the case and operating button and have connecting terminals. The case shall have one outlet tapped for 1/2-inch (13 mm) pipe. The operating button shall be recessed and made of brass or corrosion-resistant metal alloy or non-metallic material. The operating voltage shall not exceed 24 volts. The entire assembly shall be weatherproof, secure against electrical shock to the user and of such construction as to withstand continuous hard usage.

902.4.7.3 Induction Loop Detectors. Induction loop vehicle detectors shall detect a vehicle stopped within the field of the loop or passing over it at speeds up to 80 mph (130 km/h). Induction loop detectors shall be card rack mounted. For double controller cabinets, card rack assemblies and detectors shall be installed in the same compartment as their associated controller.

902.4.7.3.1 Card Rack Detectors. Card rack detectors shall meet the following requirements:

(a) Card rack-mounted detectors shall incorporate two detection channels.

(b) Each detector channel shall have at least a two-frequency selection capability, at least two levels of operational sensitivity and be capable of tuning to a minimum inductance range of 70 to 1000 µH.

(c) All controls and indications shall be mounted on the front panel of the sensing unit, with the exception of extension and delay timing controls on card rack mounted detectors.

(d) A manual control shall be provided for each channel to select pulse or full presence operation.

(e) Each detector channel, after installation and initial adjustment, shall automatically tune itself to various loop configurations ranging in size from 6 x 6 feet (1.8 x 1.8 m) minimum to 6 x 100 feet (1.8 x 30 m) maximum. The maximum lead-in length shall be 750 feet (230 m).

(f) Each detector channel shall time out and retune itself automatically if it senses a continuous vehicle occupation of the loop field for a nominal time of 10 to 30 minutes.

(g) In event of power loss to the detector or channel, a continuous call shall be made to the controller.

(h) All circuitry shall be of solid-state, digital design and incorporate temperature compensating components, with the exception of the output relay.

(i) If specified, each channel shall have extension and delay timing features, as follows:

(1) Delay timing range from 0 to 30 seconds in 1.0 second increments.

(2) Extension timing range from 0 to 7.5 seconds in a maximum of 0.5 second increments.

(j) The sensing unit shall have a light which shall illuminate when a vehicle is within the loop field. Other visual indications of relay closure may be used if approved by the engineer.

(k) Each detector and channel shall be in accordance with NEMA Standard Publication TS.

902.4.7.3.2 Card Rack Assemblies. The supporting and connecting rack for this type of detector shall contain space for a minimum of two power supplies and shall have a minimum of eight card positions for two channel detector units. Upper and lower slide guides shall be provided for the power supply and each detector card. Where detectors are specified, the rack and power supplies shall be included with the detectors and no direct payment will be made.

(a) The card mounting rack shall be attached to the controller cabinet by a hinge or pivot assembly which allows the rack to rotate horizontally so as to expose the rack wiring to facilitate maintenance operations. The rack shall be positioned to rotate out freely 90 degrees without conflicting with other wiring, equipment or the controller cabinet. Sufficient wire lengths shall be provided for rotation. The rack shall not block the backpanel or other termination panels.

(b) The power supply shall be capable of supplying a minimum of 200 mA to each detection channel position. The power supply shall be capable of operating a full rack of time delay detectors regardless of the amount and type of detectors required. Each power supply channel shall power no more than one detector card. Each channel shall be individually fused.

(c) Each card rack detector shall have a regulator for the power input. The regulator shall have the appropriate power and voltage rating for operation of the detector.

(d) Card racks shall mate with a 44-terminal, double row, 0.156-inch (4 mm) contact spacing, Cinch Jones card edge connection 50-44A-30M or equivalent. Input/output connector pin terminations shall be in accordance with NEMA Specification TS. All useable functions shall be fully wired for use.

(e) All circuitry shall be of solid-state, temperature compensating components.

(f) Unless shown differently on the plans, each detector in the card rack shall be associated with the appropriate phase as follows:

Channel	Card Position							
	1	2	3	4	5	6	7	8
1	ø 1	ø 1 or 6	ø 6	ø 6	ø 3	ø 3 or 8	ø 8	ø 8
2	ø 5	ø 5 or 2	ø 2	ø 2	ø 7	ø 7 or 4	ø 4	ø 4

(g) Each detector channel shall be clearly labeled with phase and direction.

902.4.7.3.3 Detector Loop Sealant. Loop sealant shall have the following minimum characteristics:

(a) The loop sealant used to fill the saw cuts and other gaps shall be of a type intended for and designed to be used as traffic loop embedding. The sealant shall be designed for installation when the surface temperature of the roadway is between 40 F and 120 F (4 C and 49 C) and exhibit minimal shrinkage and stringing during and after installation. The curing time of the sealant shall be a maximum of 72 hours. Cured sealant shall retain permanent flexibility to 0 F (-18 C), be temperature stable and ensure the integrity of the loop detector installation from -40 F to 200 F (-40 C to 93 C). The loop sealant shall adhere to the roadway pavement and resist the effects of weather (including freeze-thaw cycles), de-icing chemicals, salts, gasoline and motor oils, so that the operation of the detector is not affected.

(b) The three types of allowable loop sealant shall be two-part polyester resin, one-part moisture curing polyurethane and hot-melt bituminous.

(c) The loop sealant shall provide a minimum shelf-life of nine months. Before the installation of any detector loop sealant, the material safety data sheet (or an OSHA Form 20 along with the manufacturer's technical data sheet) shall be submitted to the engineer. Any sealant used on loop detectors shall meet the approval of the engineer.

(d) Loop sealant shall be proportioned, mixed and installed per the manufacturer's specifications and instructions. After the loop slots are cut into the pavement, the surface shall be cleaned with a power washer and all loose debris removed. After application of the sealant, the roadway shall be tack-free and capable of being open to the motoring public within four hours without tracking. Loop sealant shall fully encapsulate the loop wires as shown on the plans. One-inch (25 mm) long backer rods shall be placed every 3 feet (1 m) to ensure a one-inch (25 mm) depth coverage of loops. Excessive overfill will not be permitted.

902.4.7.4 Calling Detector Relay. A calling detector relay shall operate with any detector and allow the detector to place only one actuation when the red indication is being displayed to its associated phase. The relay shall be self-contained.

902.4.7.5 Microwave Vehicle Detectors. The unit shall detect all licensed vehicles moving within the field of detection at speeds from 2 to 80 mph (3 to 130 km/h). The unit shall have a minimum detection range from 3 to 200 feet (1 to 60 m) for all licensed vehicles. The pattern spread of the detection field shall be no more than 16 degrees. The unit shall be self-tuning and capable of continuous operation over a temperature range of -35 F (-37 C) to +165 F (+74 C). The unit shall be microprocessor based using Doppler microwave at an operating frequency of 10.525 GHz. The unit shall have Federal Communications Commission (FCC) certification and be tested to the applicable FCC specifications. The unit shall be capable of side-fire mount or overhead mount. The enclosure shall be constructed of aluminum or stainless steel and shall be water resistant. The unit shall be capable of detecting directional traffic and the direction shall be user selectable. All user operated controls and adjustments shall be clearly marked and easily accessible. The unit shall have a relay detection output to the controller with a minimum 5 A rating and be designed to place a constant call to the controller in the event of any failure. The unit shall have an easily accessible indicator showing activation of detection relay. Required wiring shall be as specified by the manufacturer. Mounting hardware for the type of mounting shown on the plans and power supply equipment shall be as specified by the manufacturer and shall be provided with the unit.

902.4.7.6 Video Detection System. This work shall consist of furnishing, installing and placing into operation a vehicle detection system that detects vehicles by processing video images and providing detection outputs to a traffic signal controller. The system shall include all equipment shown on the plans and described in these specifications and shall include any incidental items necessary for the satisfactory operation and maintenance of the system.

902.4.7.6.1 Material. All equipment shall be in accordance with Secs 902.3.3 and 902.4.7.6.

902.4.7.6.2 System Requirements. The video detection system shall provide flexible detection zone placement at any location and at any orientation within the combined field of view of the image processors. Preferred presence detector zone configurations shall be a box or lines placed across lanes of traffic or lines placed parallel with lanes of traffic. Detection zones shall be capable of overlapping.

902.4.7.6.2.1 The detection zones shall be created by using a track ball to draw the detection zones on the video image. A graphical user interface shall be built into the automatic control unit (ACU) and displayed on a video monitor or computer. It shall be possible to edit previously defined detector configurations to fine-tune detection zone placement.

902.4.7.6.2.2 When a vehicle is detected by crossing a detection zone, there shall be a visual change on the video display, such as a flashing symbol or a change in color or intensity to verify proper operation of the detection system.

902.4.7.6.2.3 Overall performance of the video detection system shall be comparable to inductive loops. Using camera optics and in the absence of occlusion, the system shall be able to detect vehicle presence with 95% accuracy under normal day and night conditions with only slight deterioration in performance under adverse weather conditions, including fog, snow and rain. When visibility exceeds the capabilities of the camera, the system shall default to placing a call on all detectors.

902.4.7.6.3 System Components. The video detection system is defined as the complete assembly of all required equipment and components for detection of vehicles. Each system shall consist of the video camera(s), lightning arrester for video cabling, an ACU, a track ball, software and license for system control via a computer, if applicable, one dial-up modem, 56.6 kbps maximum connection and V.90 compliant, and a monitor. All camera views shall be obtainable without requiring the disconnection and reconnection of cables within the system.

902.4.7.6.3.1 The video detection system shall be programmable via one dial up modem connection at a minimum of 19,200 bps to the camera(s). It shall provide still image and real time detection displays to a remote computer using supplied system software through the modem.

902.4.7.6.3.2 System Software. The system shall include software that detects vehicles in multiple lanes using only the video image. Detection zones shall be defined using a video monitor and a pointing device to place the zones on a video image, which may include a laptop computer. A minimum of 12 detection zones per camera shall be available.

902.4.7.6.3.3 Automatic Control Unit. The bus connections used to interconnect modules of the ACU shall be gold-plated DIN connectors. Serial communications to a computer shall be through an RS-232/RS-422 serial port. The port shall have the capability to access detection system data as well as the real-time imagery needed to show detector actuations. A subminiature "D" connector on the front of the ACU shall be used for serial communications with a computer running supplied system software.

902.4.7.6.3.3.1 The equipment shall be provided with either a NEMA TS1 or NEMA TS2 interface as shown on the plans.

902.4.7.6.3.3.1.1 For TS1 systems, the ACU process unit shall be equipped with a TS1 detector interface for a minimum of 16 detector outputs, or 32 detector outputs if required by specifications. NEMA red/green inputs for each phase shall be available to provide delay/extend functions, either through the detector or the controller. Logic output levels shall be compatible with the TS1. A subminiature "D" connector on the front of the ACU shall be used for interfacing to these outputs.

902.4.7.6.3.3.1.2 For TS2 systems, the ACU processor unit shall be equipped with a TS2 Type 1 detector interface, where detector information is transmitted serially via an RS-485 data path. NEMA red/green inputs for each phase shall be available to provide delay/extend functions, either through the detector or the controller. A 15-pin subminiature "D" connector, meeting the requirements of the TS2 standard, shall be used for the serial detector output. A minimum of 32 detector outputs is required.

902.4.7.6.3.3.2 The video detection system shall be provided for either single camera or multiple camera installations as shown on the plans.

902.4.7.6.3.3.2.1 For single camera installations, the ACU shall have a RS-170 (NTSC) video input to process the camera or any other synchronous video source in real-time. The ACU shall have an RS-170 (NTSC) video output.

902.4.7.6.3.3.2.2 For multiple camera installations, the ACU shall have a minimum of four RS-170 (NTSC) composite video inputs to process the synchronous video cameras or any other synchronous video source in real-time. A fifth video input shall be provided to allow connection of a local surveillance camera or other non-detection video source. The video from the auxiliary input shall not be processed for video detection. The ACU shall have an RS-170 (NTSC) composite video output, which may correspond to any of the video inputs, as selected remotely via RS-232 or locally by front panel switch. Multiple video inputs requiring external cable connections will not be permitted.

902.4.7.6.3.3.3 The ACU or computer shall store a minimum of two separate detection zone configurations. The ACU shall be capable of switching to any of the different detector patterns at the request of the user and shall be a menu selection with a track ball.

902.4.7.6.3.4 Monitor. The monitor shall have a 9-inch (220 mm) screen, an NTSC-M system and BNC video in-out connections. The monitor shall be installed to automatically be powered on when the cabinet door is opened and automatically be powered off when the cabinet door is closed. A manual on/off switch shall be provided.

902.4.7.6.3.5 Video Camera and Housing. The ACU supplier shall furnish the video camera for traffic detection. The camera shall produce a video image of vehicles under normal roadway lighting conditions regardless of time of day. The video shall produce a clear image for scenes with a luminance from 0.009 to 929 footcandles (0.1 to 10,000 lux).

902.4.7.6.3.5.1 The camera shall provide a minimum resolution of 500 lines horizontal and 350 lines vertical.

902.4.7.6.3.5.2 The camera shall include an electronic shutter or auto iris control based on average scene luminance and shall be equipped with an auto iris lens.

902.4.7.6.3.5.3 The camera shall have a variable focal length. The maximum aperture of the lens shall not be smaller than f1.8 and the minimum aperture shall not be larger than f300. The camera shall have a horizontal field of view ranging from a minimum angle of view between 5 degrees and 10 degrees wide to a maximum angle of view 45 degrees or more. The adjustments for focus and focal length shall be made without opening up the camera housing.

902.4.7.6.3.5.4 The camera shall be contained in an enclosure that is waterproof and dust-tight to NEMA-4 specifications. A heater shall be incorporated in the camera to prevent the formation of condensation and to assure proper operation of the lens' iris mechanism. The heater shall not interfere with the operation of the image sensor electronics, and it shall not cause interference with the video signal. The enclosure shall allow the camera to be rotated in the field during installation.

902.4.7.6.3.5.5 The housing shall be equipped with a sun shield that prevents sunlight from directly entering the lens. The sun shield shall include a provision for water diversion to prevent water from flowing in the camera field of view.

902.4.7.6.3.5.6 The total weight of the enclosure, camera, lens, housing, sun shield and mounting bracket shall be less than 10 pounds (4.5 kg).

902.4.7.6.3.6 Cable. Coaxial cable shall be a 75 ohm, precision video cable with 20 AWG (0.50 mm^2) solid or stranded bare copper conductor, maximum of 10.1 ohms/m Nom. D.C.R., solid polyethylene insulating dielectric, 96% minimum tinned copper double-braided shield with a black polyethylene outer covering. The signal attenuation shall not exceed 0.8 dB per 100 feet (30 m) at 10 MHz. Nominal outside diameter shall be 0.305 inches (7.7 mm). The cable shall be in accordance with Belden Type 8281, West Penn P806 or approved equal.

902.4.7.6.3.6.1 Seventy-five ohm BNC plug connectors shall be used with coaxial cable. The supplier of the video detection system shall approve the coaxial cable, BNC connectors and crimping tool. The manufacturer's instructions shall be followed.

902.4.7.6.3.6.2 Multi-conductor cable shall be per the manufacturer's recommendation and in accordance with Sec 1061.

902.4.7.6.3.6.3 All cable runs shall be continuous without splice from the cabinet to the camera.

902.7.6.4 Installation. The video detection system shall be installed per the manufacturer's recommendations. If requested by the engineer, a factory certified representative from the supplier shall be available for on-site assistance for a minimum of one day during installation.

902.4.7.6.4.1 The bottom of the video camera shall be mounted a minimum of 30 feet (9.0 m) above the pavement.

902.4.7.6.4.2 A separate grounded service outlet shall be provided in the controller cabinet for supplying power to the video detection system. Use of the grounded service outlet located on the cabinet door will not be permitted.

902.4.7.6.4.3 Before acceptance of the work, the contractor shall furnish the engineer three copies of the manufacturer's instructions for maintenance and operation of all components of the video detection system in accordance with Sec 902.6.

902.4.7.6.5 Warranty. The video detection system shall be warranted to be free of defects in material and workmanship for a minimum of two years. 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 ACU and computer software and shall be provided at no cost during the warranty period. The update of the ACU software to be National Transportation Communications for ITS Protocol (NTCIP) compliant shall be included.

902.4.7.6.6 Maintenance and Support. The supplier shall maintain an ongoing program of technical support and software updates for the video detection system following expiration of the warranty period. The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the video detection system.

902.4.7.6.7 Training. A minimum of one day of training shall be provided in the operation, setup and maintenance of the video detection system.

902.5 Construction Requirements.

902.5.1 Pull and Junction Boxes. Pull and junction boxes shall be installed at locations as shown on the plans. Concrete pull boxes shall be placed in traveled ways, auxiliary lanes, shoulders and low profile islands.

902.5.1.1 Conduit shall enter the pull box in the side of the box and shall extend a minimum of 2 inches (50 mm) and a maximum of 4 inches (100 mm) as shown on the plans. If it is necessary to increase the excavation depth and extend the pull box, no direct payment will be made. The excavated opening outside the pull box shall be wide enough to allow compaction of the backfill material. Cinders, broken concrete, broken 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 (150 mm) deep and each layer shall be thoroughly compacted before the next layer is placed. Where preformed pull boxes are used, the holes for the conduit shall be drilled as recommended by the manufacturer. The holes shall be round and no more than 1/2 inch (13 mm) larger than the conduit.

902.5.1.2 Drains for pull boxes shall be constructed as shown on the plans.

902.5.1.3 A pull box placed in a sodded area or shoulder shall have a concrete pad around the perimeter as shown on the plans. Concrete pads are not required for pull boxes installed in concrete shoulders. 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 (25 mm) above earth or sodded areas.

902.5.1.4 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.

902.5.1.5 Class 5 preformed pull boxes shall meet all requirements in the contract documents. Installation of Class 5 pull boxes shall be as shown on the plans and in accordance with the manufacturer's recommendations.

902.5.2 Concrete Bases. Excavation for bases shall be made in a neat and workmanlike manner. Forms shall be sufficiently rigid to prevent warping or deflection, level and rigidly held while concrete is being placed. Concrete shall be Class B or concrete of a commercial mixture in accordance with Sec 501. Conduit, ground rods and anchor bolts shall be held rigidly in place before and during concrete placement. Tops of all bases shall be finished level and the perimeter edged to a radius of 1/2 inch (13 mm). Exposed surfaces of bases shall be finished in a workmanlike manner as soon as practical after removing forms. Concrete shall be placed, finished and cured in accordance with applicable provisions of Sec 703.

902.5.2.1 Post Bases. Concrete bases for posts shall conform to dimensions shown on the plans. Metal forms, no less than 26 inches (660 mm) high, shall be used for all Type A bases. The top 12 inches (300 mm) of Type B flush bases shall be formed. Anchor bolts for steel posts and mast arms shall be as shown on the fabricators approved shop drawings. Conduit shall extend above all post bases a nominal 4 inches (100 mm).

902.5.2.2 Controller Bases. Concrete bases for controllers shall extend a minimum of 3 inches (75 mm) beyond the base dimensions on each side of the controller cabinet with minimum dimensions being those shown on the plans. A 4-inch (100 mm) thick concrete apron extending 2 feet (600 mm) in front of the base on the door-side of the controller shall be poured. The apron shall be 2 feet (600 mm) wider than the base, extending 12 inches (300 mm) on each side or as shown on the plans. Aprons shall be considered part of the controller base. The anchor bolt size for controller cabinets shall be as specified by the cabinet manufacturer. A minimum of four anchor bolts shall be used for single controller cabinets and a minimum of six anchor bolts shall be used for double controller cabinets. A ground rod shall be placed into the ground with a minimum of 8 feet (2.4 m) of earth contact. Bases for double controller cabinets shall have two ground rods, one positioned in each compartment. Conduit shall extend above all

controller bases no more than 1 inch (25 mm). Bases for double controller cabinets shall have two conduits to the first pull box, one positioned in each compartment. All conduit openings in the controller cabinet or controller cabinet base shall be sealed with an approved sealing compound after wiring is completed. This compound shall be readily workable soft plastic.

902.5.3 Conduit System. The contractor has the option to furnish and install rigid steel, intermediate metal, polyvinyl chloride (PVC) schedule 40 or heavy-duty polyethylene (PE) conduit. Conduit shall be placed a minimum of 18 inches (450 mm) below finished grade and shall slope to a pull box at a minimum rate of 0.5 percent unless otherwise shown on the plans. A change in direction of conduit shall be accomplished by bending the conduit uniformly to a radius which will fit the location or by the use of standard bends or elbows. Minimum radius of the bend shall be six times the internal diameter of the conduit. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. If it is necessary to cut and thread steel conduit, no exposed threads will be permitted. All conduit and fittings shall be free from burrs and irregularities. All conduit 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. If approved by the engineer, conduit may be installed either by trenching or pushing; however, payment will be made by the method specified in the contract for that conduit.

902.5.3.1 Metal Conduit. All metal conduit ends shall be provided with a bushing to protect the cable from abrasion. All metal conduits shall be electrically bonded by conduit clamps and bare No. 6 AWG (16 mm^2) stranded copper wire. All metal conduits in the controller base shall be electrically bonded to the power company ground.

902.5.3.2 Polyvinyl Chloride (PVC) Conduit. A bare No. 6 AWG (16 mm^2) stranded copper ground wire shall be installed in each conduit and attached to the ground lug in signal posts or lighting poles, except as otherwise specified in this section. All bare ground wires shall be electrically bonded. All bare ground wires in the controller base shall be electrically bonded to the power company ground. PVC conduit containing only fiber optic cable shall contain a bare or green jacketed No. 14 AWG (2.5 mm^2) stranded copper tracer wire instead of a bare No. 6 AWG (16 mm^2) copper ground wire. The tracer wire shall not be pulled into the controller cabinet or bases. An additional 6 feet (2 m) of tracer wire shall be coiled in each pull box through which the fiber optic cable passes. Tracer wire in pull boxes shall be capped, not electrically bonded to any ground wires and tagged "TRACER" in accordance with Sec 902.5.7.5. Payment for ground wire and tracer wire shall be included in the price bid for the conduit.

902.5.3.3 Conduit in Trench. Trenches shall be excavated to the width and depth necessary for conduit installation. All trenches shall be backfilled as soon as practical after the installation of conduit. Cinders, broken concrete and other hard or objectionable material which might cause mechanical damage to the conduit shall not be used for backfilling within 6 inches (150 mm) of the top of the conduit. The bottom of the trench shall be free of such material before the conduit is placed. No conduit shall be placed without approval of the trench by the engineer. Backfill material shall be deposited in the trench in layers not exceeding 6 inches (150 mm) 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 at approximately 1/3 to 1/2 of the depth of the trench. All disturbed areas shall be restored to the satisfaction of the engineer.

902.5.3.4 Pushed Conduit. If pushed conduit is specified, the conduit shall be installed without disturbing the existing surface. Pushed conduit may be placed by jacking, pushing, boring or other approved means.

902.5.3.5 Conduit in Median. If conduit in median is specified, it shall be placed on the existing pavement prior to construction of the raised median. If conduit is to be placed in concrete traffic barrier, the conduit shall be held rigidly in place before placement of concrete.

902.5.3.6 External Conduit on Structure. For existing structures or if provisions are not made in the plans for providing a conduit raceway in new structures as described in Sec 707, the conduit shall be external conduit on structure. Conduit on structure shall include conduit on bridges, retaining walls or other structures and shall be installed as shown on the plans or as directed by the engineer. The final location of all conduit and junction boxes shall be approved by the engineer before installation is begun. Conduit shall not be attached to prestressed concrete girders or prestressed-precast concrete deck panels. The conduit shall be secured to the concrete with clamps at no more than 5 foot (1.5 m) intervals. Concrete anchors shall meet federal specification FF-S-325, Group II, Type 4, Class I and shall be galvanized in accordance with ASTM A 153, B 695-91 Class 50 or constructed of stainless steel. Minimum embedment in concrete shall be 1 3/4 inches (44 mm). The supplier shall furnish a manufacturer's certification that the concrete anchors meet the required material and galvanizing specifications. If it is necessary to

anchor the conduit to steel bridge members, the attachment method shall not involve drilling, grinding or welding. Attachment method to steel members shall be approved by the engineer. Junction boxes shall be installed as shown on the plans or as directed by the engineer. Junction boxes shall be surface-mounted and installed such that covers are easily accessible. If the conduit crosses a bridge expansion joint, a conduit expansion fitting shall be used. The expansion fitting shall provide a minimum movement in either direction as shown on the plans or as specified by the engineer. No direct payment will be made for junction boxes, expansion fittings and any hardware or material required for conduit installation.

902.5.4 Signal Faces. Vehicle and pedestrian signal faces shall be covered or turned away from approaching traffic until placed in operation. When ready for operation, they shall be securely fastened in position facing approaching traffic. Horizontally mounted lamps shall be installed by the contractor with the open segment of the filament facing up. Vehicle and pedestrian signal faces shall be aimed laterally at the approximate center of the lane or lanes they control. Signal faces shall be aimed at a point behind the stop line a distance corresponding to the following requirements:

Approach Speed mph (km/h)	**Distance ft (m)**
30 (50)	160 (50)
40 (70)	240 (75)
50 (80)	330 (100)
60 (100)	430 (130)
70 (120)	560 (170)

902.5.5 Detector Loop. A slot for installation of induction loop cable shall be sawed in the pavement as shown on the plans. Each loop shall have a separate lead-in slot to the conduit. A separate conduit shall be installed between the sawed loop slot and the first pull box for each loop. The conduit opening at the end of the lead-in slot shall be at the bottom of the sawed slot. The slot shall be brushed or blown clean. The cable shall be pushed into the slot without damaging the insulation. After the loop cable is spliced to the lead-in cable, and before the slot is sealed, the resistance of the loop and lead-in cable to ground shall be checked. The resistance test shall be performed by the contractor in the presence of the engineer and documented. After a satisfactory test, showing a resistance of not less than 10 MΩ, the slot shall be sealed. The conduit opening at the end of the lead-in slot and any drilled conduit holes in the pavement shall be sealed with a pliable duct sealant prior to application of loop sealant. All sawed slots shall then be sealed with detector loop sealant. All detector cable between the loop and detector amplifier shall be twisted at least three turns per foot (10 turns per meter).

902.5.5.1 Microwave and Ultrasonic Detectors. Microwave and ultrasonic detectors shall be mounted at the locations shown on the plans in accordance with manufacturer's recommendations. All wiring shall be continuous and unspliced from the detector unit to the controller. The contractor shall make any necessary adjustments for proper operation of the detector.

902.5.6 Post Erection. Post bases shall be securely anchored to concrete bases. Pedestal posts shall be erected vertically without use of leveling nuts. Metal posts for span wire and cantilever mast arms shall be adjusted by leveling nuts. All posts for span wire and cantilever mast arms shall be raked as directed by the engineer. All signal posts shall be grounded by a bare No. 6 AWG (16 mm^2) stranded copper wire from the ground lug inside the post to a clamp fastened on metal conduit at the top of the concrete base, to a ground rod or through nonmetallic conduit to the ground bus in the controller.

902.5.7 Wiring.

902.5.7.1 All cable runs shall be continuous without splice from the connections in the terminal block of the signal head or disconnect hanger to the terminal strip in the controller cabinet, from the signal terminal block to another signal terminal block or as shown on the plans. When a terminal compartment is provided, all cable runs shall be continuous from the terminal compartment to the terminal strip in the controller cabinet. When parallel connections are required from a signal head on a mast arm to a side of post mounted signal head, cable shall be routed from the controller to the terminal compartment of the signal on the mast arm and then parallel-circuited back to the side mounted signal. All other conductor cable combinations to signal heads shall be as shown on the plans or as directed by the engineer. Where double controller cabinets are specified, wires shall be sorted between the controller and first pull box so that field wires enter the associated controller compartment.

902.5.7.2 Power cable runs shall be continuous without splice from the power disconnect switch located on the power supply to controller cabinet terminals. This power cable shall be encased in conduit of the size shown on the plans. Energized power cables shall run to circuit breakers. The neutral cable shall be terminated on the ground bus bar in the controller cabinet.

902.5.7.3 Where luminaires are required, pole and bracket cable shall be installed between the luminaire and the power source at the base of the post. Each luminaire shall be connected to its power source by a separate No. 12 AWG (4 mm^2) two-conductor cable. A premolded fused connector assembly shall be installed on each conductor between the source cable and the pole and bracket cable. The assembly and cable shall be insulated with a protective rubber boot designed for the premolded connector.

902.5.7.4 Induction loop dimensions shall be as shown on the plans. Exact location of loops shall be determined by the engineer. Each induction loop shall be connected to its detector by a separate lead-in cable. Single-conductor No. 14 AWG (2.5 mm^2) cable shown on the plans is an approximation of cable quantity required to construct the induction loop. If the number of turns shown on the plans is not in accordance with the manufacturer's recommendation for the sensing units furnished, the plans will be revised, the induction loop cable will be field-measured and quantities adjusted accordingly. Induction loop detector cable shall be installed in accordance with manufacturer's recommendations. Induction loop detector lead-in cable is shown on the plans as two-conductor No. 14 AWG (2.5 mm^2) cable. Should the manufacturer recommend a different type cable, the two-conductor cable shall be revised to manufacturer's specification, but shall be completely covered by the contract unit price for loop detector lead-in cable. Cable for loop detectors shall be continuous from the terminal strip in the controller cabinet to a splice with the detector leads in the pull box adjacent to the detector. The conductor splice shall be soldered without an open flame. The soldered splice shall then be capped and inserted into a direct buried splice kit.

902.5.7.5 Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, orange to yellow and green to green. 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 (2.5 µm) 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.

902.5.7.6 Cables shall be pulled through conduit by a cable grip providing a firm hold on exterior coverings. 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 a 6-foot (2 m) loop coiled in each pull box and a 3-foot (1 m) loop coiled in each junction box. All signal posts and controllers shall be grounded by bare No. 6 AWG (16 mm^2) stranded copper wire.

902.5.8 Test Equipment. During installation of equipment and material, the contractor shall furnish to the engineer suitable equipment to test all or part of the completed facility to establish compliance with requirements of the contract. Minimum test equipment shall be a voltmeter, ohmmeter and ammeter. For testing induction loop detectors, the contractor shall also provide a suitable 500-volt DC, zero to 100-MΩ range, hand-operated, resistance measuring device.

902.5.9 Test Period. After the project is open to normal traffic, the contractor shall notify the engineer in writing the date the signal or signal system, will be ready for testing. Upon concurrence of the engineer, the contractor shall place the signal or signal system in operation for a 15 consecutive day test period. If the signal is to operate independently of other signals or signal systems, it shall be tested as a single installation. If the signal is part of a system, the test period shall not be started until all signals in the system are ready to be tested. A system shall be tested as a unit. Any failure or malfunction of equipment during the test period shall be corrected at the contractor's expense and the signal or system 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. The contractor shall, in the presence of the engineer, demonstrate the proper action of the controller's monitor as part of the testing system, if applicable.

902.5.9.1 When the test period is initiated and until it is completed, following the turn on of temporary traffic signals or after work is begun on an existing signal installation, the contractor shall provide 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. In the event of a malfunction, the contractor shall provide adequate traffic control for the intersection until the signals

are restored to normal operation. Adequate traffic control shall be as shown on the plans or as directed by the engineer. If the signal or signal system malfunctions and a designated technician cannot be reached or cannot arrive at the intersection in a reasonable time in the judgment of the engineer, then the engineer may exercise the option to direct MoDOT personnel or a third party to correct the malfunction in the presence of the engineer. If this option is invoked, the entire cost of the work performed by MoDOT personnel or the third party will be computed as described in Sec 108.9 and deducted from the monies due the contractor. Whether or not the engineer elects to correct the signal malfunction, nothing in this specification shall be construed or interpreted to relieve the contractor of any liability for personal injury or property damage that results either directly or indirectly from a signal malfunction during the test period. The contractor and surety shall indemnify and save harmless the State, the Commission, its agents, employees and assigns for any legal liability incurred for such a signal malfunction.

902.6 Maintenance Information. Before acceptance of the work, the contractor shall furnish the engineer three copies of the manufacturer's instructions for maintenance and operation of all signal equipment including, but not limited to, controllers, conflict monitors, load switches, detectors and auxiliary equipment. At a minimum, the manufacturer's instructions shall include organized written instructions, wiring diagrams, diagrams showing component layouts and parts lists with part numbers. The contractor shall also furnish three copies of wiring diagrams of the installation or system.

902.7 Final Clean Up. Final clean up of right of way shall be in accordance with Sec 104.11.

902.8 Method of Measurement.

902.8.1 Measurement of conduit will be made to the nearest linear foot (0.5 m) as shown on the plans. Contract quantities will be used in final payment except as provided in Sec 902.8.10.

902.8.2 Measurement of conductor will be made to the nearest 10 linear feet (5 m) as shown on the plans. Contract quantities will be used in final payment except as provided in Sec 902.8.10.

902.8.3 Measurement of concrete for bases, including all specified material, will be made to the nearest 1/10 cubic yard (0.1 m^3) as shown on the plans. Contract quantities will be used in final payment except as provided in Sec 902.8.10.

902.8.4 Measurement of traffic controller assemblies, including all specified equipment, will be made per each.

902.8.5 Measurement of power supply assemblies, including all specified equipment, will be made per each. No direct payment will be made for cable, conduit and any additional work required to connect the power supply assembly to the utility company facilities.

902.8.6 Measurement of push button detectors, microwave detectors and induction probe detectors will be made per each. Measurement of two channel card rack mounted detectors will be made per each detector card. No direct payment will be made for the card rack assembly and card rack power supplies.

902.8.7 Measurement of posts, including all specified items, will be made per each.

902.8.8 Measurement of pull boxes, including all specified material, will be made per each. No direct payment will be made for junction boxes.

902.8.9 Measurement of signal heads and luminaires, including all required material and hardware, will be made per each.

902.8.10 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.

902.8.11 Measurement of temporary traffic signal installations will be made per lump sum.

902.8.12 Measurement of video detection systems, including all specified equipment, will be made per each.

902.9 Basis of Payment. Accepted traffic signals 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.

902.9.1 Accepted video detection systems will be paid for at the contract unit price per each. Payment will be considered full compensation for all labor, equipment and material to complete the described work and for placing the specified equipment into operation to the satisfaction of the engineer. 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.

SECTION 903 – HIGHWAY SIGNING

Delete Sec 903.2.3 and substitute the following: ***01/01***

903.2.3 Bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with the requirements of AASHTO M 232 (ASTM A 153), Class C, or mechanically galvanized in accordance with the requirements of AASHTO M 298 (ASTM B 695), Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils (150 µm). 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 that the bolts furnished conform to the requirements specified.

Delete Sec 903.3.2.2 and substitute the following: ***01/02***

903.3.2.2 Structural steel sign posts for ground mounting of signs shall be fabricated and erected as shown on the plans, and shall be of material in accordance with ASTM A 36, AASHTO M 223 Grade 50 or AASHTO M 222, minimum yield 50,000 pounds per square inch (345 MPa). Preheating of the material to be welded is required in accordance with good welding practice and welds shall be of full section and sound throughout. Dimensional defects and structural discontinuities will be cause for rejection. Posts built up by welding two lengths together will be permitted, provided the welds are ground smooth and flush with the base metal. Steel bases shall be arranged for anchoring to concrete footings with galvanized swedged steel bolts of the number and sizes shown on the plans. Posts and appurtenances, such as zee bars and flats, shall be hot-dip galvanized after fabrication. Posts with breakaway assemblies shall be cut at the hinge prior to galvanizing. Hinge plates shall not be attached to the posts at the time of galvanizing. All welds shall be mechanically cleaned before galvanizing. Shop drawings will not be required for structural steel posts.

Amend Sec 903 to include the following: ***04/00***

SECTION 903.10 TEMPORARY GROUND MOUNTED SIGNS

903.11 Description. This work shall consist of removing existing signs from their permanent supports, mounting on temporary sign supports, relocating temporary sign support structures as necessary, sign maintenance and replacement, and placing signs in their permanent location.

903.12 Materials. Temporary ground mounting posts shall be a breakaway wood or steel post design, including hinge plates, as shown on the plans. If the signs are required to be moved several times or are to be placed on new concrete pavement areas, portable structures made of wood and meeting the approval of the engineer may be used.

903.13 Construction Requirements.

903.13.1 Signs shall be mounted on temporary ground supports or, when the signs are required to be moved several times or relocated to improved areas, on a portable support structure. Temporary ground mounted sign supports shall be of a breakaway design conforming to the plans. Portable sign support structures shall be properly secured while in use to prevent signs tipping over due to natural wind or wind from large vehicles. Signs shall be mounted 6 to 12 feet (1.8 to 3.6 m) from the edge of shoulder to the sign edge closest to the shoulder and the bottom of the sign 7 to 8 feet (2.1 to 2.4 m) above the edge of the traveled way.

903.13.2 Signs shall be relocated within a single day and remain visible to and effective for the traveling public during all stages of construction.

903.13.3 The contractor shall maintain the signs during construction and place them in their permanent location when construction is completed. If a sign is damaged because of negligence by the contractor, the sign shall be replaced at the contractor's expense. All maintenance and replacement shall meet with the approval of the engineer.

903.14 Basis of Payment. Payment for temporary ground mounted signs will be made at the contract unit price per each and will be considered full compensation for all labor, equipment and material necessary to complete the described work.

SECTION 1002 – AGGREGATE FOR ASPHALTIC CONCRETE

Delete Sec 1002.4 and substitute the following: ***01/00***

1002.4 Hydrated Lime. Hydrated lime shall be thoroughly dry and free of lumps. It shall comply with AASHTO M 303, Type I or II, except the gradation shall be determined in accordance with AASHTO T 37.

SECTION 1005 – AGGREGATE FOR CONCRETE

Delete Sec 1005.2.2 and substitute the following: ***04/00***

1005.2.2 Fine aggregate subjected to the mortar strength test shall produce a mortar having a compressive strength at the age of 7 days of at least 90 percent of that developed at the same age by mortar of the same proportions and consistency made of the same cement and Standard Ottawa sand. Tests shall be made in accordance with AASHTO T 106. Cement used in the tests shall be Type I meeting the requirements of Sec 1019.

SECTION 1006 – AGGREGATE FOR SURFACING

Delete Sec 1006.2 and substitute the following: ***07/02***

1006.2 The aggregate shall comply with the following requirements for the grade specified in the contract:

Grade	Kind of Material	Percent Passing					
		Sieve Sizes					
		1 in. (25.0 mm)	3/4 in. (19.0 mm)	3/8 in. (9.5 mm)	No. 4 (4.75 mm)	No. 10 (2.00 mm)	No. 200 (75 µm)
A[b]	Gravel	100	80-100	….	60 [a]	10-35	0-10
B[b]	Crushed Stone	100	….	65 [a]	….	5-25	….
C	Chat	100	….	….	80 [a]	45 [a]	….
D	Gravel	….	100	….	75 [a]	10-40	….
E	Gravel	….	100	….	75 [a]	10-40	0-5
F	Crushed Stone	….	100	75 [a]	….	10-30	….
G	Crushed Stone or Gravel	….	100	75 [a]	….	0-15	….

[a]Indicates maximum permitted.
[b]Type 1 or 2 Aggregate for Base may be used, except all material shall be in accordance with Sec 1007.

SECTION 1015 – BITUMINOUS MATERIAL

Delete Sec 1015.5 and substitute the following: ***07/02***

1015.5 Application Temperatures for Bituminous Materials.

Bituminous Material	Temperature, Degrees Fahrenheit (Celsius)			
	Spraying		Mixing	
	Min	Max	Min	Max
Asphalt Binder				
PG 46-28	260 (125)	325 (165)	----	----
All Other Grades	285 (140)	350 (175)	275 (135)	350 (175)
Liquid Asphalt RC-MC Grade				
30	70 (20)	150 (65)	50 (10)	110 (45)
70	100 (40)	180 (80)	90 (30)	140 (60)
250	150 (65)	220 (105)	130 (55)	170 (75)
800	180 (80)	260 (125)	170 (75)	210 (100)
3000	210 (100)	290 (145)	200 (95)	240 (115)
Asphalt Emulsions				
RS-1	70 (20)	140 (60)	----	----
RS-2	125 (50)	185 (85)	----	----
SS-1	70 (20)	160 (70)	70 (20)	160 (70)
SS-1h	70 (20)	160 (70)	70 (20)	160 (70)
CRS-1	125 (50)	185 (85)	----	----
CRS-2	125 (50)	185 (85)	----	----
CSS-1	70 (20)	160 (70)	70 (20)	160 (70)
CSS-1h	70 (20)	160 (70)	70 (20)	160 (70)
EA-90P	130 (55)	180 (80)	----	----
CRS-2P	130 (55)	180 (80)	----	----

Application temperatures of other grades of emulsions will be as specified in the contract.

The spraying temperature for non-modified PG 46-28 asphalt binder is 260 - 325 F (125 - 165 C) and for all other higher temperature non-modified performance grades is 285 - 350 F (140 - 175 C). The mixing and compaction temperatures for performance graded asphalt binder shall be determined by rotational viscosity testing as defined in AASHTO TP4.

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.

SECTION 1017 – GROUND GRANULATED BLAST FURNACE SLAG

Delete Sec 1017.2 and substitute the following: ***07/00***

1017.2 General. All GGBFS shall conform to the requirements of AASHTO M 302, Grade 100 or 120, except as herein specified. Only GGBFS from sources qualified in accordance with these specifications will be permitted.

Delete Sec 1017.4.1 and substitute the following: ***07/00***

1017.4.1 The bill of lading or delivery receipt for each shipment to MoDOT 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 MoDOT 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

Delete Sec 1018.2.1 and substitute the following: ***07/01***

1018.2.1 The available alkalis, as Na_2O, shall not exceed 1.5 percent. Loss on ignition shall not exceed 1.5 percent.

SECTION 1019 – CEMENT

Delete Sec 1019.2.1 and substitute the following: ***04/00***

1019.2.1 All blended hydraulic cement shall conform to the requirements for Type IP, I(PM), IS or I(SM) of AASHTO M 240 with the following modifications.

(a) Type IP or I(PM) cement shall be produced by intergrinding Portland-cement clinker and pozzolan or may be produced by blending Portland cement and pozzolan provided approved analytical procedures are provided.

(b) The pozzolan constituent of Type IP shall not exceed 20 percent by weight (mass) of the total Portland-pozzolan cement.

(c) Type IS or I(SM) cement shall be produced by intergrinding Portland cement clinker and granulated blast-furnace slag or may be produced by blending Portland cement and ground granulated blast furnace slag provided approved analytical procedures are provided.

(d) The slag constituent of Type IS or I(SM) shall not exceed 25 percent by weight (mass) of the total Portland-slag cement.

(e) The basis of acceptance shall be as described in Sec 1019.3 in addition to AASHTO M 240.

Delete Sec 1019.2.2 and substitute the following: ***10/00***

1019.2.2 Types I, II, IP, I(PM), IS or I(SM) cement shall be used for all general concrete construction except as herein specified or where other types of cement are permitted. If Type I is specified, Types II, IP, I(PM), IS, and I(SM) will be allowed, subject to any requirements for each type, unless otherwise specifically prohibited. Types IP, I(PM), IS or I(SM) shall not be used in concrete designed for high early strength. Type I or Type III Portland cement shall be used in high early strength concrete. Type III Portland cement may be used in any precast concrete. White Portland cement shall meet the requirements for Type I. Type IA, 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.

Delete Secs 1019.3.1.1 and 1019.3.1.2 and substitute the following: ***04/00***

1019.3.1.1 The following information shall be included in the request for qualification.

(a) An outline of the QC program from the quarry to the point where the product is relinquished to the purchaser. The QC program shall cover all tests required by the specification and include the testing frequency for each test.

(b) A copy of the most recent Cement and Concrete Reference Laboratory (CCRL) inspection report and the latest CCRL proficiency sample report. The CCRL inspection shall cover all tests required by the specification. Documentation showing satisfactory resolution of all inspection deficiencies shall be included.

(c) The physical layout of the plant, including the number and capacity of finish mills and silos and the type of cement stored in each silo.

(d) If blended IP, I(PM), IS or I(SM) cement is furnished, the following is also required. The layout of the blending system, from the Portland cement and pozzolan or slag silos to the point where the blended product is relinquished to the purchaser, shall be furnished along with the request for qualification. The supplier shall describe and have in place an analytical procedure that can be shown to be of sufficient accuracy to determine the pozzolan or slag content of the blend to within $\pm$ 1.0 percent of the true pozzolan or slag content. The analytical procedure, frequency of sampling and testing locations are subject to approval by MoDOT.

(e) A copy of a typical bill of lading with the required certification statement.

(f) A split sample of each type of cement proposed for use. Manufacturer test results for the split sample shall also be submitted.

1019.3.1.2 In order to maintain qualification, the following is required.

(a) Monthly QC test results covering the production of cement types proposed for use in MoDOT projects, including the high, low and average results for each type shall be forwarded to MoDOT, no later than two weeks following the end of the period covered by the report.

(b) A copy of the most recent CCRL inspection and proficiency sample reports and any deficiency resolutions shall be forwarded promptly to MoDOT.

(c) If blended IP, I(PM), IS or I(SM) cement is furnished, a target value for the percentage of pozzolan or slag in the blend shall be provided to MoDOT, and test results from the manufacturer shall not vary more than two percentage points from the target value. MoDOT shall be informed, in writing, prior to changing the target value. At no time shall the test results show a percentage of pozzolan in the blended IP or I(PM) greater than 20 percent or a percentage of slag in the blended IS or I(SM) greater than 25 percent.

(d) Quarterly split samples for each type of approved cement will be obtained by MoDOT for joint testing by the manufacturer. Manufacturer test results on the split samples shall be furnished to MoDOT when completed.

(e) All QC test results shall be available for a minimum of three years, for MoDOT review upon request.

(f) No cement out of specification shall be allowed into a silo destined for MoDOT projects.

SECTION 1020 – CORRUGATED METALLIC-COATED STEEL CULVERT PIPE, PIPE-ARCHES AND END SECTIONS

Delete Sec 1020.19.6 and substitute the following: ***01/02***

1020.19.6 In lieu of coupling bands, a bell and spigot joint system may be used as approved by Project Operations - Materials.

Delete Table XIII in Sec 1020 and substitute the following: ***10/00***

TABLE XIII	
Tensile Strength of Lock Seams	
Specified Sheet Thickness, Inch (mm)	**Pounds Force Per Inch (kN/mm) of Width, Minimum**
0.064 (1.63)	340 (60)
0.079 (2.01)	520 (91)
0.109 (2.77)	700 (122)
0.138 (3.50)	880 (154)
0.168 (4.27)	1200 (210)

SECTION 1026 – REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE

Delete Secs 1026.4 and 1026.5 and substitute the following: ***04/00***

1026.4 Reinforced Concrete. The reinforced concrete shall consist of a mixture of cement, mineral aggregates and water, in which steel has been embedded in such manner that the steel and the concrete act together.

1026.5 Cement. Cement shall conform to the requirements of Sec 1019. Fly ash or GGBFS may be used to replace cement in accordance with Sec 501.

SECTION 1033 – PRECAST REINFORCED CONCRETE MANHOLE AND DROP INLET SECTIONS

Delete Sec 1033 and substitute the following: ***04/00; 07/00***

SECTION 1033

PRECAST DRAINAGE UNITS

1033.1 Scope. These specifications cover precast reinforced concrete manhole and drop inlet sections and appurtenances such as grade rings, tops and special sections.

1033.2 Basis of 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 1033.3; 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 their freedom from defect. 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 conform to the requirements of Sec 1019. Fly ash or GGBFS may be used to replace cement in accordance with Sec 501.

1033.3.2 Fly Ash. Fly ash shall comply with the requirements of Sec 1018.

1033.3.3 Aggregates. Fine and coarse aggregate shall conform to the requirements of Sec 1005, except that requirements for gradation and percent passing the No. 200 (75 µm) sieve shall not apply.

1033.3.4 Steel Reinforcement. Reinforcement may consist of wire conforming to AASHTO M 32 or AASHTO M 225; or of wire fabric conforming to AASHTO M 55 or AASHTO M 221; or of bars conforming to AASHTO M 31.

1033.3.5 Mixture. The aggregates shall be sized, graded, proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water, as will produce a homogeneous concrete mixture of such quality that the manhole and drop inlet sections will conform to the test and design requirements. Admixtures or blends may be used with the approval of the engineer. In no case, however, shall the proportion of Portland cement in the mixture be less than 564 pounds per cubic yard (335 kg/m^3) of concrete. Precast concrete manhole and drop inlet sections may also be constructed of Class B or B-1 concrete. 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 The minimum compressive strength of the concrete shall be 4000 pounds per square inch (28 MPa). The minimum wall thickness for manhole sections shall be one-twelfth of the internal diameter of the riser or largest cone diameter. Wall thickness for rectangular drop inlets shall be as shown on the plans.

1033.4.2 The circumferential reinforcement in manhole sections may consist of either one or two lines of steel. The total area of reinforcement per vertical or linear foot (meter) shall not be less than 0.0025 times the inside diameter in inches (0.2125 times the inside diameter in millimeters), or in any case, not less than 0.12 square inch per linear foot (255 mm^2/m).

1033.4.3 The quantity of steel reinforcement for rectangular drop inlets shall be as shown on the plans.

1033.4.4 Flat slab tops shall be of the thickness shown on the plans and shall be reinforced with a layer of steel with a minimum area of 0.12 square inch per linear foot (255 mm^2/m) in both directions. Openings in flat slab tops shall be additionally reinforced with a minimum of the equivalent of 0.20 square inch (133 m^2) of steel at 90 degrees. Straight rods used to reinforce openings shall have a minimum length equal to the diameter of the opening plus 2 inches (50 mm).

1033.4.5 The circumferential reinforcement in grade rings shall have an equivalent area of not less than 0.07 square inch per linear foot (150 mm^2/m), or in any case, not less than 0.024 square inch (15 mm^2) in any one grade ring.

1033.5 Modified or Special Designs. The manufacturer may request approval of designs, prior to manufacture, other than those described in these specifications. Special or modified designs shall be submitted to the engineer, in writing and shall fully describe any deviations from these specifications. 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.

1033.6 Placement of Reinforcement.

1033.6.1 For manholes, if one line of circular reinforcement is used, the reinforcement shall be placed in the center one-third of the wall thickness. If two lines of circular reinforcement are used, each line shall be so placed that the protective covering over the circumferential reinforcement in the wall of the section shall be one inch (25 mm). Either the tongue or groove of the joint shall contain circumferential reinforcement equal in area to that of a single line within the wall of the section. The location of the reinforcement shall be subject, however, to the permissible variations in dimensions specified in Sec 1033.10.5.

1033.6.2 Placement of reinforcement in rectangular drop inlets shall be as shown on the plans.

1033.6.3 In flat slab tops the layers of reinforcement shall be placed near the bottom surface so that the protective cover over the reinforcement shall be one inch (25 mm). The exposure of the ends of the reinforcement will not be a cause for rejection.

1033.6.4 Reinforcement of a given total steel area may be composed of two layers if the layers are not separated by more than the thickness of one cross member plus 1/4 inch (6 mm). The two layers shall be tied together to form a single rigid cage. All other specification requirements such as laps, welds and tolerances of placement in the wall of the manhole, risers and tops, shall apply to this method of fabricating a line of reinforcement.

1033.6.5 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 a cause for rejection.

1033.6.6 If splices are not welded, the reinforcement shall be lapped not less than 20 diameters for deformed bars and 40 diameters for plain bars and cold-drawn wire. The spacing center to center of adjacent rings of circumferential reinforcement in a cage shall not exceed 6 inches (150 mm) for manhole risers and conical tops.

1033.7 Joints. The reinforced concrete riser sections, excepting grade rings, shall be so formed that when the risers and top are assembled they will make a continuous and uniform structure compatible with the tolerance specified in Sec 1033.10.3. The joints shall be of such design as will permit placement without appreciable irregularities in the interior wall surface.

1033.8 Manufacture.

1033.8.1 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.

1033.8.2 Curing. 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.

1033.8.2.1 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 the requirements of Sec 502.12.1. 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 thus exposed shall be cured as directed by the engineer.

1033.8.3 Lift Holes. Lift holes shall conform to the requirements of Sec 1026.17. Lifting hooks or bars may be cast into the sections, if approved by the engineer.

1033.8.4 Forms. Forms shall be mortar-tight and of sound material adequate to prevent distortion during placing and curing of concrete. Forms shall be reasonably smooth and free of loose knots, holes and other defects.

1033.8.5 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 (2 C). No concrete shall be placed when the ambient temperature is below 35 F (2 C).

1033.9 Physical Test Requirements.

1033.9.1 Concrete Test Requirements. The engineer may require compression test specimens in the quantity of 5 percent of the total number of sections for each contract, but not to exceed two cylinders for each day's production. 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. If cores are taken for compression tests they shall be 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.

1033.9.2 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 drop inlet sections or, at the option of the manufacturer, on cores drilled from the wall of the section. If cylinders are tested, they shall be tested in accordance with the requirements of AASHTO T 22. The average compressive strength of all cylinders tested shall be equal to or greater than the design strength of the concrete. If compression test cylinders are being used, the manufacturer shall furnish a sufficient number of molds of a type meeting the approval of the engineer. If cores are obtained from the wall of the sections, they shall be cut and tested in accordance with the requirements of AASHTO T 280. 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. If the cores cut from a section meet the strength test requirement, the core holes shall be plugged and sealed by the manufacturer in a manner such that the section will meet all of the test requirements of this specification. Precast units so sealed shall be considered as satisfactory for use.

1033.9.3 Absorption Test Requirements. The engineer may require samples for absorption tests if concrete other than Class B or B-1 is used. The absorption of a specimen from the wall of a section, as determined in accordance with the requirements of AASHTO T 280 shall not exceed 9 percent of the dry weight (mass). 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 (5800 mm^2) as measured on one surface of the wall, have a thickness equal to the wall and be free of visible cracks. If the initial absorption specimen from a section fails to conform to this specification, the absorption test shall be made on another specimen from the same section and the results of the retest shall be substituted for the original test results.

1033.9.4 Retests. If not more than 20 percent of the concrete test specimens fail to pass the requirements of this specification, the manufacturer may cull stock and may eliminate whatever quantity of sections desired and shall so mark them that they will not be shipped. The required tests will be made on the balance of the order and the sections will be accepted if they conform to the test requirements.

1033.9.5 Test Equipment. Each manufacturer furnishing precast units under these specifications shall furnish all facilities and personnel necessary to carry out the tests described in Sec 1033.9.2 and 1033.9.3.

1033.10 Permissible Variations in Dimensions.

1033.10.1 The internal dimensions of precast units shall not vary more than one percent or 3/8 inch (10 mm), whichever is greater.

1033.10.2 The wall thickness shall not be less than that specified in Sec 1033.4.1 or as shown on the plans by more than 5 percent or 3/16 inch (5 mm), whichever is greater. A wall thickness greater than that specified in Sec 1033.4.1 or as shown on the plans will not be cause for rejection.

1033.10.3 Variations in lengths of two opposite sides of precast units shall not be more than 5/8 inch (16 mm).

1033.10.4 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 (25 mm) from the design dimensions.

1033.10.5 Position and Area of Reinforcement.

1033.10.5.1 Position. For sections with a 4-inch (100 mm) thickness or less, the maximum variation in the position of the reinforcement from that specified in Sec 1033.6 shall be 10 percent of the thickness or 1/4 inch (6 mm), whichever is the greater. For sections with a thickness greater than 4 inches (100 mm) the maximum variation shall be 10 percent of the thickness or 5/8 inch (16 mm), whichever is the lesser. The cover over the reinforcement shall not be less than 3/4 inch (19 mm).

1033.10.5.2 Area. Steel areas up to 0.005 square inch per linear foot (10 mm^2/m) less than that specified will be considered as meeting the required steel area.

1033.11 Steps. Steps for precast manholes and drop inlets shall be in accordance with Sec 604.10 and as shown on the plans. Steps in riser and conical top sections shall be aligned in each section so as to form a continuous ladder with rungs equally spaced vertically in the assembled manhole at a maximum distance of 16 inches (400 mm). Steps shall be embedded in the riser or conical top section wall a minimum distance of 3 inches (75 mm). The rung or cleat shall project a minimum clear distance of 4 inches (100 mm) from the wall of the riser or cone section measured from the point of embedment.

1033.12 Finish. Precast units shall be substantially free of fractures, large or deep cracks and surface roughness. The planes of the ends of the sections shall be perpendicular to their longitudinal axis, within the limits of the variations specified in Sec 1033.10.3.

1033.13 Repairs. Precast units may be repaired, if necessary, because of occasional imperfections in manufacture or accidental injury during handling and will be acceptable if, in the judgment of the engineer, the repairs are sound, properly finished and cured and the repaired manhole sections conform to the requirements of these specifications. Filling of form tie cavities and repair of other defects shall be in accordance with Sec 703.3.15.

1033.14 Inspection and Rejection.

1033.14.1 Inspection. The quality of material, the process of manufacture and the finished precast units shall be subject to inspection and approval by the engineer.

1033.14.2 Rejection. Precast units shall be subject to rejection for failure to conform to any of the specified requirements. In addition, individual sections may be rejected because of any of the following:

(a) Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

(b) Defects that indicate imperfect proportioning, mixing and molding.

(c) Surface defects indicating honeycombed or open texture.

(d) Damaged or cracked ends where such damage would prevent making a satisfactory joint.

(e) Any continuous crack having a surface width of 0.01 inch (0.3 mm) or more and extending for a length of 12 inches (300 mm) or more, regardless of position in the section wall.

1033.15 Marking. The following information shall be clearly marked on the inside of each precast unit:

(a) MH for manholes or DI for drop inlets. Other units do not need a designation.

(b) Date of manufacture.

(c) Name or trademark of the manufacturer.

Marking shall be indented into the section or shall be painted thereon with waterproof paint.

SECTION 1034 – REINFORCED CONCRETE ELLIPTICAL CULVERT, STORM DRAIN AND SEWER PIPE

Delete Sec 1034.1 and substitute the following: ***04/00***

1034.1 Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe. This pipe shall conform to the requirements of AASHTO M 207, except material shall meet the requirements in Sec 1026.

SECTION 1035 – REINFORCED CONCRETE ARCH CULVERT, STORM DRAIN AND SEWER PIPE

Delete Sec 1035.1 and substitute the following: ***04/00***

1035.1 Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe. This pipe shall conform to the requirements of AASHTO M 206, except material shall meet the requirements in Sec 1026.

SECTION 1037 – SHEAR CONNECTORS

Delete Sec 1037.5.1 and substitute the following: ***01/02***

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 (13 to 19 mm) 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.

SECTION 1040 – GUARDRAIL, END TERMINALS, CRASH CUSHIONS, ONE-STRAND CABLE – ACCESS RESTRAINT AND GUARD CABLE MATERIAL

Delete Sec 1040 and substitute the following: ***04/02***

SECTION 1040

GUARDRAIL, END TERMINALS, CRASH CUSHIONS, ONE-STRAND CABLE - ACCESS RESTRAINT AND GUARD CABLE MATERIAL

1040.1 Scope. These specifications cover guardrail, end terminals, crash cushions, one-strand cable - access restraint, guard cable, end terminals, crash cushions and all appurtenances required for installation.

1040.2 Posts and Blocks. Within any continuous run of guardrail, only one type of post and one type of block shall be used, except as shown in the plans or as approved by the engineer.

1040.2.1 Wood Posts and Blocks. Wood posts and blocks for guardrail and guard cable shall be in accordance with of 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 ASTM A 36, shall be of the dimensions and weights (masses) 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 in the standard plans. The blocks shall be a solid, homogeneous product with a uniform texture and shall have no cracking, chipping, flaking, peeling or splintering after fabrication. The blocks shall have no more than five voids larger than 5/8 inch (16 mm) and none larger than 3/4 inch (19 mm) on any cut face. The blocks shall be of new stock unless the contract provides for relocation of existing units or units to be furnished by others. The blocks shall meet all applicable requirements of NCHRP 350 and meet approval by Project Operations.

1040.2.3.1 Approval. Prior to approval and use of the plastic guardrail blocks, the manufacturer shall submit to Project Operations, the manufacturers name, the product brand name or model number, a copy of the NCHRP 350 test results, a copy of the FHWA acceptance letter, a Material Safety Data Sheet, 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 shown on the plans. Guardrail beams shall be galvanized in accordance with the requirements for Type 1 or Type 2. The classes and types of guardrail beams allowed are as follows:

(a) Class A - 12 Gage - base metal nominal thickness, 0.105 inch (2.67 mm).

(b) Class B - 10 Gage - base metal nominal thickness, 0.135 inch (3.43 mm).

(c) Type 1 - Zinc coated, 1.80 ounces per square foot (550 g/m^2), minimum single-spot.

(d) Type 2 - Zinc coated, 3.60 ounces per square foot (1100 g/m^2), minimum single-spot.

1040.3.1 Base Metal. The beam elements shall consist of sheet made of open hearth, electric furnace or basic oxygen steel.

1040.3.1.1 The mechanical properties of the base metal for beams shall conform to the following tensile requirements:

a) Yield Point, minimum, 50,000 psi (345 MPa).

b) Tensile Strength, minimum, 70,000 psi (483 MPa).

c) Elongation, 2-inch (50 mm) minimum, 12 percent.

1040.3.1.2 Test specimens for mechanical properties shall be prepared and tested in accordance with ASTM A 924.

1040.3.2 Sheet or Beam Thickness.

1040.3.2.1 The thickness for the finished beam or sheet shall be in accordance with Table I.

TABLE I			
Sheet or Beam Thickness			
Class of Beam	**Type of Coating**	**Thickness, in. (mm)**	**Tolerance Under Specified Thickness, in. (mm). No limit for over thickness.**
A	1	0.108 (2.74)	0.009 (0.23)
	2	0.111 (2.82)	0.009 (0.23)
B	1	0.138 (3.51)	0.010 (0.25)
	2	0.141 (3.58)	0.010 (0.25)

1040.3.2.2 For fabricated beams, thickness measurements will be made on tangent portions of the cross-section.

1040.3.3 Sheet Width. The beam elements shall be formed from sheets having nominal widths of 19 inches (483 mm) for W beams and 29 1/2 inches (749 mm) for thrie beams. A tolerance of minus 1/8 inch (3 mm) from the nominal width will be permissible.

1040.3.4 Galvanized Beams.

1040.3.4.1 The beams may be galvanized before or after fabrication. The zinc used for the coating shall be Prime Western Spelter or better in accordance with AASHTO M 120.

1040.3.4.2 The weight (mass) of coating shall be in accordance with Table II. The weight (mass) of coating is the total quantity of galvanizing on both sides of a sheet or beam, expressed as ounces per square foot (grams per square meter) of sheet.

TABLE II	
Weight (Mass) of Coating	
Type	**Check Limit Single-Spot Test oz/ft^2 (g/m^2), min.**
1	1.80 (550)
2	3.60 (1100)

1040.3.4.3 The sheets or beams shall be of prime finish, that is, free from injurious defects such as blisters, flux and uncoated spots. Uncoated edges resulting from shearing or punching will be acceptable.

1040.3.4.4 The coating shall be smooth, free of beading or sharp projections along the edges, and shall adhere to the surface of the metal.

1040.3.4.5 The test specimen size and method of tests for determining the weight (mass) of coating shall be in accordance with AASHTO T 65. At the option of the engineer, material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

1040.3.5 Connections and Splices. All beam connections or splices shall be formed with oval shoulder button-headed bolts to minimize projections on the traffic face of guardrail. Bolts and nuts shall be in accordance with ASTM A 307, and shall be galvanized in accordance AASHTO M 232, or may be mechanically galvanized in accordance with AASHTO M 232, Class C.

1040.3.6 Back-up Plates. Back-up plates shall consist of one-foot (305 mm) sections of beams and shall be of the same class and type specified for the full length beams.

1040.3.7 End Sections. End sections, buffer ends, end shoes and terminal connectors shall be formed of material of a class and type the same as or superior to that used for the beam to which they are attached.

1040.3.8 Fabrication. The beams, end sections, buffer ends, end shoes and terminal connectors shall be shaped and punched as shown on the plans. They 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 (46 m) or less shall be shop curved to the approximate curvature of the installation.

1040.3.9 Marking.

1040.3.9.1 Each beam element shall be identified by the following:

(a) Name or Brand of Manufacturer.

(b) Identification Symbols or Code for Heat Number and Coating Lot.

(c) AASHTO Specification Number.

(d) Class and Type.

1040.3.9.2 If approved by the engineer, the AASHTO specification number may be omitted, and other designations for Class and Type may be used.

1040.3.9.3 Markings shall not be placed at such location that they will be obscured after erection, or in a manner that the brand will be conspicuous to any traffic. Markings placed on the traffic face of the beam shall be placed in the valley of the center corrugation and shall be die imprinted with letters and numerals not exceeding one-half inch (13 mm) high.

1040.3.9.4 Marking material shall be such as to resist obliteration during storage, transportation and erection.

1040.3.9.5 Markings for end sections, buffer ends, end shoes and back-up plates may be on durable tags securely attached to each section or to each bundle. Markings shall include name or brand of manufacturer, Class and Type. Heat numbers and coating designations are not required.

1040.3.10 Basis of Acceptance.

1040.3.10.1 All material shall be subject to inspection and sampling at the fabricating plant or warehouse, or after delivery to the site of construction. The contractor or supplier shall provide equipment and personnel required to obtain samples as directed by the engineer.

1040.3.10.2 Acceptance by Sampling. The engineer may take one piece of guardrail beam, a back-up plate, an end section, a buffer end and an end shoe from each 200 pieces in a lot, or from each lot if less than 200 pieces are included therein, for determination of compliance with specification requirements. If one piece fails to meet requirements, two other pieces shall be tested. If either of these pieces fails to conform to the requirements of this specification, the lot of material represented by these samples will be rejected. A lot shall be considered that quantity of material, offered for inspection at one time, which bears the same heat and coating identification.

1040.3.10.3 Acceptance by Brand Registration and Guarantee.

1040.3.10.3.1 By mutual agreement between the fabricator and engineer, acceptance may be based upon a Brand Registration and Guarantee filed with Project Operations by the fabricator. For acceptance of a brand, the fabricator shall furnish a Brand Registration and Guarantee meeting the approval of the engineer and showing the brand name or designation, the manner in which the brand name or designation will appear on the fabricated beams, the typical mechanical properties, chemical composition if specified, the class and type of guardrail, and other specified properties. The fabricator shall also guarantee that as long as material is furnished under that brand and designation, the material will conform fully to the requirements of the specifications and shall be replaced without cost to the Commission when found not in conformity with any of the specified requirements. The Brand Registration and Guarantee shall be sworn to for the fabricator by a person having legal authority to bind the company. Upon approval of a Brand Registration and Guarantee, that brand will be accepted without further certification. If, in subsequent actual field use, there is evidence of misbranding, as determined by random sampling and detection of inadequate tensile strength, yield strength, elongation, improper chemical composition, inadequate or improper coating, deficient thickness or improper fabrication, the material will be rejected and approval for further use withdrawn until subsequently reapproved. Samples for tests of any material offered for use may be taken at any time deemed desirable by the engineer.

1040.3.10.3.2 The manufacturer or fabricator shall make such tests and measurements as necessary to ensure that the material produced complies with all specification requirements. These tests and measurements shall be so identified by the identification symbols or code used on the beam that the manufacturer can produce specific reports showing these test results. Copies of reports of these tests shall be kept on file and shall be submitted to the engineer upon request.

1040.3.10.3.3 The brand shall be removed or obliterated by the manufacturer or fabricator on all material where control tests, as outlined herein, do not show conformance to this specification.

1040.4 End Terminals and Crash Cushions

1040.4.1 Approval. Approval of end terminal and crash cushion units may be requested by submitting proof of equivalent crash test results as described in Sec 606.30, shop drawings, certification, and any additional required information to the engineer. Approval shall be received prior to the fabrication and installation of any units.

1040.5 End 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 3/4 inch (19 mm) in diameter, Type II, Class A in accordance with AASHTO M 30.

1040.5.3 Approval. Cable assembly and anchor plate shall be subject to approval by the engineer and shall have a minimum breaking strength of 20 tons (178 kN).

1040.6 Cable and Fittings.

1040.6.1 One-Strand Cable - Access Restraint.

1040.6.1.1 Cable. Cable shall be zinc coated steel wire strand; 1/2 inch (12.7 mm) in diameter; seven wire strand; Common, Siemens-Martin 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 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, 3/4-inch (19 mm) 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 (111 kN) 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 (80 kN/m), plus or minus 0.06 pounds per inch (10 kN/m) and permit 6 inches (150 mm) of travel, plus or minus 1 inch (25 mm). All threaded parts on compensating cable end assemblies shall be in accordance with ASTM F 568 Class 4.6, 3/4-10 threads. Socket baskets shall be designed for use with the cable anchor wedge as shown on the plans. Cable guardrail 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 its 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 M111. 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 3/4-inch (8 mm), 25,000-pound (111 kN) 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 (80 kN), plus or minus 0.03 pounds per inch (10 kN/m), and permit 6 inches (150 mm) of travel, plus or minus 1 inch (25 mm). All parts except cable wedge shall be hot-dip zinc coated in accordance with AASHTO M 232 or AASHTO M 298.

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 1000 pounds (2.0 to 4.5 kN) 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 the following table.

Table III Certification Requirements			
Item	**Galvanizing Standard**	**Steel Grade**	**Other**
Wood Post and Blocks	-	-	1
Posts, Plates and Brackets	AASHTO M111	ASTM A 36	2
Plastic Blocks	-	-	7
Guardrail Beam	Sec 1040.3	Sec 1040.3	2, 3
Bolts, Nuts and Washers	AASHTO M 232	ASTM A 307	
End Terminals and Crash Cushions Units	-	-	6
End Anchors Tubes	AASHTO M 111	ASTM A 500/ASTM A 501	
One-Strand Cable - Access Restraint Cable Hardware	AASHTO M 30 AASHTO M 232	AASHTO M 30 AASHTO M 102/ ASTM A 220	2 2
Three Strand Guard Cable Cable Hardware Cast Steel Components Malleable Iron Castings Anchor Brackets Cable Brackets Hook and Hex Bolts Hook Nuts Hooked Anchor Studs	AASHTO M 232 AASHTO M 232 AASHTO M 232 AASHTO M 111 AASHTO M 111 AASHTO M 232 AASHTO M 232 AASHTO M 232	AASHTO M 30 & AASHTO M 269 AASHTO M 102/ ASTM A 220 AASHTO M 103 ASTM A 47 AASHTO M 270 ASTM A 36 ASTM A 307 ASTM A 563 AASHTO M 314	2 4 4 4 5 4

1. Certification shall state that the material is in accordance with Sec 1050 and shall include a listing of the materials supplied, and shall have a certified test report as detailed in Section 7.2 of AWPA Standard M2 attesting to complete compliance with this specification.
2. Certification shall include, or have attached, specific results of laboratory tests for physical and chemical properties from samples representative of the material.
3. Certification will not be required if the manufacturer complies with Sec 1040.3.10.3.
4. All threaded parts of compensating cable end assemblies and hooked anchor studs shall be in accordance with ASTM F 568.
5. All fittings for cable bracket, except the cable wedge, shall be in accordance with AASHTO M 232 or AASHTO M 298.
6. Certification shall state the name of the manufacturer and that the units furnished are identical in materials and design as those tested for performance in accordance with Sec 606.30.
7. 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.

1040.8 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. Any galvanized material on which the spelter coating has been damaged will be rejected or may, with the engineer's approval, be repaired by the zinc alloy stick method in accordance with Sec 712.

SECTION 1042 – HIGHWAY SIGN MATERIAL

Delete Sec 1042 and substitute the following: ***01/01; 01/02; 07/02***

SECTION 1042

HIGHWAY SIGN MATERIAL

1042.1 Scope. These specifications cover the material used in signs and fastening devices, and the fabrication of the signs.

1042.2 Material. Material shall be of new stock and shall conform to the following unless otherwise shown on the plans.

1042.2.1 Signs.

Item	Specification
Aluminum Flat Sheets	ASTM B 209, 6061-T6 or 5052-H38
Aluminum Extruded Sign Panels	ASTM B221, 6063-T6

1042.2.2 Sign Appurtenances.

Item	Specification
Aluminum Post Clip	ASTM B 108, 356-T6
Aluminum Bolts	ASTM B 211, 2024-T4 or 6061-T6
Aluminum Nuts	ASTM B 211, 2024-T4, 6061-T6, 6262-T9 or 2017-T4
Aluminum Flat Washers	ASTM B 209, or Alclad 2024-T4 or 2024-T4
Aluminum Lock Washers	ASTM B 211, 7075-T6
Aluminum Lock Nuts (Nylon Insert)	ASTM B 211, 2017-T4
Aluminum Edge Molding	ASTM B 221, 6063-T6
Stainless Steel Bolts, Nuts, Screws and Washers	ASTM A 320 or SAE J405D, Austenitic Steel, Min Yield 30,000 psi (206 MPa)
Vulcanized Fiber Washers Commercial Grade	ASTM D710 Gray

1042.2.3 A manufacturer's 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 inspection of the material. The contractor shall furnish the engineer the fabricator's certification in accordance with Sec 903.3.5.2.

1042.2.4 Structural signs shall be fabricated of minimum 0.081 inch (2.1 mm) extruded aluminum panels and mounted as shown on the plans. Maximum allowable deviation from flatness shall not exceed 0.010 inch per inch (0.25 mm per 25 mm) width of the panel. Shop drawings for approval of the engineer will be required for any variations in the assembly or mounting details.

1042.2.5 Flat sheet signs shall be fabricated as shown on the plans from sheet aluminum of the specified thickness. Flat sheet signs shall have no holes except those drilled or punched for proper mounting.

1042.2.6 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 (9.5 mm) bolts and have a minimum outside diameter of 3/4 inch (19 mm), and a nominal thickness of 1/16 inch (1.5 mm).

1042.2.7 Reflective Sheeting. Reflective sheeting shall have a precoated pressure sensitive adhesive or a tack free heat activated adhesive backing, neither of which shall require additional adhesive coats on the reflective sheeting or application surface. The protective liner attached to the adhesive shall be easily removed by peeling without

soaking in water or other solvents. The adhesive shall form a durable bond to clean substrates and shall adhere securely under all atmospheric conditions of field exposure. Reflective sheeting applied to cleaned aluminum test panels shall adhere securely after 48 hours of aging, at temperatures of -20 F to 150 F (-29 to 65 C). The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when struck by foreign objects. Reflective sheeting shall have sufficient strength and flexibility so that the sheeting can be handled, processed and applied according to the manufacturer's recommendations without appreciable stretching, tearing, cracking or other damage. The sheeting surface shall be readily screen processed and compatible with recommended transparent and opaque screen process colors. The reflective 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 brightness and durability.

1042.2.7.1 Type 1 reflective sheeting shall meet the requirements of ASTM D 4956, Type I, Class 1 or 2, except it shall be enclosed lens glass-bead sheeting.

1042.2.7.2 Type 3 reflective sheeting shall meet the requirements of ASTM D 4956, Type III, Class 1 or 2, except it shall be encapsulated glass-bead sheeting.

1042.2.7.3 Type 7 reflective sheeting shall meet the requirements of ASTM D 4956, Type IV, Class 1 or 2, except as noted herein.

1042.2.7.3.1 Type 7 reflective sheeting shall meet or exceed the minimum coefficient of retroreflection requirements as shown in Table I, expressed as candelas per footcandle per square foot (candelas per lux per square meter).

TABLE I
Type 7 Reflective Sheeting
Minimum Coefficient of Retroreflection

Observation Angle, Degrees	Entrance Angle, Degrees	White	Yellow	Red	Green	Blue	Orange	Brown
0.2	-4	430	350	110	45	20	250	24
0.2	+30	235	190	48	24	11	110	10
0.5	-4	200	160	45	20	9.8	100	8
0.5	+30	135	85	26	10	5	50	3

1042.2.7.3.2 Type 7 reflective sheeting shall meet the luminance factor (daytime luminance) requirements as shown in Table II.

Table II

Color	Reflectance Limits (%Y) Y	
	Min	Max
Whites**	40	--
Red	3.0	15
Orange	14	30
Yellow	24	45
Green	3.0	15
Brown	1.0	9.0
Blue	1.0	10

**Silver white is an acceptable color designation.

1042.2.7.4 For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficient of retroreflection (Ra) shall not be less than 70 percent of the original values for the corresponding color.

1042.2.7.5 Reflective sheeting, except for construction signs, shall be submitted by the manufacturer to the National Transportation Product Evaluation Program (NTPEP) for two years of 45-degree south-facing outdoor exposure. Reflective sheeting for construction 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 MoDOT review. For all NTPEP test decks, reflective sheeting shall have a coefficient of retroreflection not less than 50 percent of the original reading for Type 1 or 80 percent of the original reading for Type 3 and Type 7.

1042.2.7.5.1 Preliminary approval will be based upon satisfactory NTPEP test results for reflective sheeting and additional verification testing for reflectance and chromaticity as required.

1042.2.7.5.2 Continued approval will be based upon satisfactory field performance.

1042.2.8 Fluorescent Reflective Sheeting. Fluorescent reflective sheeting shall be in accordance with Sec 1042.2.7 and ASTM D 4956, Type IV, Class 1, except as noted herein.

1042.2.8.1 Coefficient of Retroreflection. Reflective sheeting shall meet or exceed the minimum coefficient of retroreflection requirements as shown in the following table, expressed as candelas per footcandle per square foot (candelas/lux/m^2). Coefficient of Retroreflection values will be the mean of test rests obtained from readings taken with orientation angles of 0 degrees and 90 degrees.

Reflective Sheeting - Minimum Coefficient of Retroreflection, Ra				
Observation Angle, Degrees	**Entrance Angle, Degrees**	**Orange**	**Yellow Green**	**Yellow**
0.2	-4	200	325	240
0.2	+30	85	205	150
0.5	-4	80	235	165
0.5	+30	50	110	75

1042.2.8.2 Color Specification Limits and Luminance Factor. Fluorescent reflective sheeting shall meet the color specification limits (daytime) and luminance factor (daytime) requirements shown below.

Fluorescent Reflective Sheeting Color Specification Limits (Daytime) - Luminance Factor, Y%										
	1		**2**		**3**		**4**		**Luminance Factor (Y)**	
	x	**y**	**x**	**y**	**x**	**y**	**x**	**y**	**Min**	**Max**
Orange	.583	.416	.523	.397	.560	.360	.631	.369	28	---
Weathered	.583	.416	.523	.397	.560	.360	.631	.369	20	45
Yellow Green	.387	.610	.460	.540	.421	.486	.368	.539	60	---
Weathered	.387	.610	.460	.540	.421	.486	.368	.539	50	---
Yellow	.498	.412	.557	.442	.479	.520	.438	.472	40	---

Note: The four pairs of chromaticity coordinates will determine the acceptable color in terms of the CIE 1931 Standard Colorimetric System measured with CIE Standard Illuminant D65.

1042.2.8.3 Specular Gloss. Fluorescent reflective sheeting shall have a specular gloss of not less than 50.

1042.2.8.4 Reflective Sheeting for Work Zones. Fluorescent Orange reflective sheeting for work zones shall be submitted for one year of exposure on NTPEP test decks.

1042.2.8.5 Manufacturer and Brand Name Approval. Prior to approval and use of material, the manufacturer shall submit to Project Operations NTPEP test results from all test decks and certification showing specific test results that the material are in accordance with this specification. In addition, the manufacturer shall submit to Project Operations samples representing the reflective sheeting tested by NTPEP, and 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 reflective sheeting submitted. Samples of reflective sheeting shall be a minimum of 13 x 13 inches (330 x 330 mm).

1045.2.8.5.1 Preliminary approval will be based upon satisfactory NTPEP test results for reflective sheeting and additional verification testing for reflectance and chromaticity as required.

1045.2.8.5.2 Continued approval will be based upon satisfactory field performance.

1042.2.9 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 continuous stroke width with smooth edges and shall present a flat surface free of warp, blisters, wrinkles, burrs and splinters. Units of the sign message of the type shown on the plans shall meet the requirements for the specified type. Type L-1 and L-3 characters shall not be intermixed on a single sign face unless otherwise shown on the plans or as approved by the engineer.

1042.2.9.1 Type L-1, Screen Processed Characters. The letters, numerals, arrows, symbols and borders shall be applied to the background of the sign by direct or reverse screen process. Messages and borders of a color darker than the sign field shall be applied to the reflective sheeting by 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 silk screen process shall be of the type to produce the desired color and durability when applied on reflective sheeting. Silk screen inks shall be used in accordance with the manufacturer's recommendations. The ink shall produce the desired color when applied on reflective sheeting background and shall dry within 8 hours to a good film without running, streaking or sagging. The screening shall be done in a manner which results in a uniform color and tone, with sharply defined edges of legend and border, and without blemishes on the sign field that will affect intended use. Signs after screening shall be air-dried or baked 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.

1042.2.9.2 Type L-3, 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 instructions of the manufacturer of the sheeting.

1042.2.9.3 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 (3 mm).

Nominal Height, in. (mm)	Variation in Height, in. (mm)	Variation in Width, in. (mm)
4 thru 12 (100 thru 300)	-1/8 to +3/8 (-3 to +9.5)	-1/4 to +1/4 (-6 to +6)
Over 12 (Over 300)	-1/8 to +3/8 (-3 to +9.5)	-3/8 to +3/8 (-9.5 to +9.5)

The design height of rounded letters or numerals shall be 1/64 inch per inch (0.4 mm per 25 mm) 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.

1042.2.10 Reflectors used in delineators shall consist of a clear and transparent plastic face, herein referred to as the lens, and an opaque back fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit permanently sealed against dust, water and water vapor. The reflector lens shall be made of methyl methacrylate. The lens shall consist of a smooth front surface free from projections or indentations, other than for identification, and a rear surface bearing a prismatic configuration such that it will effect internal reflection of light. Fifty samples of each size will be selected by the engineer at random from each shipment for the various tests. Sample size and acceptance practice will be the same regardless of the size of the shipment unless otherwise specifically permitted by the engineer.

(a) Reflectors shall have a minimum coefficient of luminous intensity as shown in the following table, expressed as candelas per footcandle (lux) in accordance with MoDOT Test Method T8. A white or pastel acrylic opaque plastic back will not be required if the lens is permanently and durably sealed against dust, water and water vapor in a manner approved by the engineer.

ENGLISH				
Observation Angle, Degrees	**Entrance Angle, Degrees**	**Minimum Coefficient of Luminous Intensity**		
		Crystal *(White)	**Amber**	**Red**
1/10	0	115	70	30
1/10	20	45	25	12
1/3	0	50	30	12
1/3	20	20	12	5

METRIC				
Observation Angle, Degrees	**Entrance Angle, Degrees**	**Minimum Coefficient of Luminous Intensity**		
		Crystal *(White)	**Amber**	**Red**
1/10	0	10.7	6.5	2.8
1/10	20	4.2	2.3	1.1
1/3	0	4.7	2.8	1.1
1/3	20	1.9	1.1	0.5

(b) The color of the reflector lens shall be as shown on the plans. Failure to meet the coefficient of luminous intensity minimum shall constitute failure of a reflector and failure of more than two reflectors of the 50 subjected to test shall be cause for rejection of the lot.

(c) When tested in accordance with MoDOT Test Method T68, the reflectors shall show no evidence of water or water vapor inside the reflector. Any evidence of water or water vapor in a reflector shall constitute failure. Failure of more than two reflectors shall be cause for rejection of the lot.

(d) When tested in accordance with MoDOT Test Method T68, the reflectors shall show no significant change in shape or general appearance. Failure of one sample shall be cause for rejection of the lot.

1042.3 Sign Fabrication. A sign shall consist of aluminum flat sheets or extruded panels reflectorized 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 as shown on the plans. Signs with an area of 30 square feet (3 m^2) or more are structural (ST) and shall be fabricated with extruded panels. Signs with an area of less than 30 square feet (3 m^2) are sheet (SH) signs and shall be fabricated with flat sheet.

1042.3.1 The signs shall be reflectorized as follows.

1042.3.1.1 All aluminum substrate shall be given a chromate conversion coating conforming to the requirements of 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 directions of the manufacturer. 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 with clean mechanical devices or workers with clean gloves. Panels shall be stored in a dry, clean area free from dust, acid fumes or vapors. Where aluminum is shipped to a secondary location for reflectorizing, adequate precautions shall be taken to ensure that the material arrives at destination uncontaminated.

1042.3.1.2 Reflective 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 Reflective sheeting splices on structural signs shall be kept to a minimum. Only sheeting manufacturer's rolled overlap splices shall be used with no more than one allowed per panel. Reflective sheeting shall be placed horizontally on the individual extruded panels with approximately 3/8 inch (9 mm) overlap on each edge. No

reflective sheeting will be permitted over the butt joints of adjacent extruded panels. The sign panels shall be clear coated or edge sealed after application of the reflective sheeting, if recommended by the sheeting manufacturer. The completed sign shall have good color matching of reflective sheeting and be free from cracks, tears, blisters, bubbles and wrinkles.

1042.3.1.4 Reflective sheeting applied to standard flat sheet signs shall have no splices except on signs where the smallest dimension is greater than 4 feet (1200 mm). One vertical overlap splice approximately 1/4 inch (6 mm) wide will be acceptable on standard flat sheet signs where the smallest dimension is greater than 4 feet (1200 mm). 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 shall be clear coated or edge sealed after application of the reflective 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 cracks, tears, blisters, bubbles and wrinkles.

1042.3.2 Nuts on panel bolts shall be torqued to 220 - 230 inch-pounds (25 - 26 N-m).

1042.3.3 Periodic shop inspection of sign fabrication will ordinarily be made at the fabricating shop, but in some cases may be waived and complete inspection made when the fabricated signs are delivered to the site of the work. The engineer shall be notified well in advance of beginning of shop work so adequate arrangements may be made for inspection. It is understood that whether or not shop inspection is made, workmanship and material which do not conform to the requirements of the specifications and recognized good practice may be rejected at any time prior to acceptance of the work.

1042.3.3.1 The contractor will be charged with transportation costs of sign inspectors for trips made from Jefferson City to points to which they must travel for shop inspection work. The routine shop inspection work will include inspection and sampling of material, inspection of treatment and fabrication processes, and of any signs completed at time of inspection. In general, two round trips for one inspector will be required. Transportation costs will be deducted by the Commission from monies due the contractor.

SECTION 1043 – FENCE MATERIAL

Delete Secs 1043.2.6.1-1043.2.6.6 and substitute the following: ***01/00***

1043.2.6.1 Zinc Coated Steel Members. Zinc coated steel members shall comply with the requirements of ASTM F 1043, heavy industrial fence Group IA, with Type A interior and exterior coating, and the standard plans.

1043.2.6.2 Zinc Plus Organic Coated Steel Members. Zinc plus organic coated steel members shall comply with the requirements of ASTM F 1043, heavy industrial fence Group IC, with Type B or D interior coating and Type B exterior coating, and the standard plans.

1043.2.6.3 Aluminum Alloy Members. Aluminum alloy members shall comply with the requirements of ASTM F 1043, heavy industrial fence Group IB, and the standard plans.

Delete Sec 1043.9.2 and Table 1 and substitute the following: ***10/00***

1043.9.2 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.

TABLE I		
Wire Size and Height of Fabric		
Specified Diameter[a]		Height of Fabric,
in. (mm)	Gage	In. (mm)
0.120 (3.048)	11	36, 42 (914, 1068)
0.148 (3.759)	9	48, 60 (1219, 1524)
0.192 (4.877)	6	72-144 (1829- 3658)

[a] See Sec 1043.2.1.3 for definition of specified diameter and tolerances.

TABLE II				
Breaking Load of Wire				
Specified Diameter		Breaking Load, min., lbf (N)		
in. (mm)	Gage	Zinc Coated and Aluminum Coated	Aluminum Alloy	PVC Coated[a]
0.120 (3.05)	11	850 (3780)	610 (2713)	850 (3780)
0.148 (3.76)	9	1290 (5738)	930 (4136)	1290 (5738)
0.192 (4.88)	6	2170 (9652)	1560 (6939)	2170 (9652)

[a] The PVC coating may be mechanically or chemically removed prior to testing, if desired.

TABLE III			
PVC Coated Wire Coating Thickness and Weight (Mass)			
		PVC Thickness, Range	
Specified Diameter of Metallic Coated Core Wire[a] in. (mm)	Weight (Mass) of Zinc or Aluminum Coating of Uncoated Wire Surface, min., oz/ft^2(g/m^2)	Bonded Coatings in. (mm)	Extruded or Extruded and Bonded Coatings, in. (mm)
0.120 (3.05)	0.30 (91.5)	0.006 - 0.010 (0.15 - 0.25) All Gages	0.015 - 0.025 (0.38 - 0.64) All Gages
0.148 (3.76)	0.30 (91.5)		
0.192 (4.88)	0.40 (122.1)		

[a] The PVC coating shall not be used when determining wire size.

TABLE IV			
Miscellaneous Aluminum Alloy Fittings and Hardware			
		Aluminum Alloy	
Item	Type of Material	Alloy & Temper	ASTM Designation
Rail and Brace Ends, Post Tops and Turnbuckles	Castings	356.0-T6 712.0-T5, 713.0-T5, A360.0, 360.0, 413.0	B26, B85, B108
Gate Hinges, Barbed Wire Extension Arms and Other Fittings	Castings	Same as above	----
Stretcher Bars and Bands	Bar	6063-T6	B 221
Truss or Brace Rods		6061-T6	B 221
Flat Band Ties	Sheet	3003-H14	B 209
Bolts		2024-T4	F 468
Nuts		6061-T6	F 467

SECTION 1045 – PAINT FOR STRUCTURAL STEEL

Delete Sec 1045 and substitute the following: ***10/00; 01/01; 10/01; 04/02***

SECTION 1045

PAINT FOR STRUCTURAL STEEL

1045.1 Paint and Paint Material.

1045.1.1 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 that they will have good application, covering

and leveling properties; and shall dry within the specified period to a good film without running, streaking or sagging. If tinted paint is specified, the tinting material shall be thoroughly and uniformly incorporated within the body of the paint to form a shade which shall match that of a sample submitted for the purpose. Any paint which has livered or in any way hardened or thickened in the container, or in which the pigment has settled out so that the paint cannot be readily broken up with a paddle to a smooth uniform paint of good application consistency, will be rejected. The grinding equipment used in the manufacture of the paint shall meet the approval of the engineer. In no case will the use of a colloid mill, steel ball mill or high speed mill be permitted.

1045.1.1.1 All percentages and proportions are on a weight (mass) basis unless otherwise stated.

1045.1.2 Sampling. Each batch or lot of pigment and vehicle constituents for mixed paints shall be sampled and approved prior to being incorporated into a paint mixture when requested by Project Operations. 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.

1045.1.3 Packaging. All containers shall be approved by the engineer as to type and weight (mass) and shall be free of physical defects. The lining of the container shall not react with the paint. All containers shall be cleaned of any paint spilled during filling operations. Except when supplied in containers of less than five gallons (19 L), all mixed paint shall be packaged in strong, substantial 24-gage (0.6 mm) or heavier, new metal containers having lug-type replaceable tops. They shall bear a label on which shall be clearly shown the name of the manufacturer, the kind of paint, the lot number, date of manufacture and net weight (mass) of contents. The lot number and date of manufacture shall be stamped, stenciled, or painted directly onto the container using a weatherproof, durable material.

1045.1.3.1 Multiple-component paint shall be packaged in multiple-compartment containers or in separate containers. The components shall be packaged in such proportions that the pigment, mixed with the vehicle and activator, if used, will yield one or five gallons (4 or 19 L) of mixed paint. Each container shall bear a label on which shall be clearly shown the name of the manufacturer or brand name of paint, the lot number, date of manufacture, shelf life and, in the case of organic zinc silicate paint, the individual net weights (masses) of pigment and vehicle. The lot number and date of manufacture shall be stamped, stenciled, or painted directly onto the container using a weatherproof, durable material. The label on the vehicle container shall also include complete instructions for use of the paint.

1045.1.4 Determination of Quantities. Quantities of paint shall be determined by volume. One gallon (liter) shall equal 231 cubic inches (0.001 m^3) at 77 F (25 C).

1045.2 Blank.

1045.3 Blank.

1045.4 Blank.

1045.5 High Solids Inorganic Zinc Silicate Coating.

1045.5.1 Description. High solids inorganic zinc coating shall be a solvent base multiple component material which, when mixed and applied in accordance with the requirements of Sec 712, cures without the use of a separate curing solution. High solids inorganic zinc coating shall comply with the requirements of AASHTO M 300, Type IA. The volatile organic compound (VOC) content shall not exceed 3.50 pounds/gallon (420 g/L). If thinning is necessary for application, the maximum VOC shall not exceed 3.50 pounds/gallon (420 g/L).

1045.5.2 Manufacturer and Brand Name Approval. Prior to approval and use of high solids inorganic zinc, the manufacturer shall submit to Project Operations 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 also contain the exact ratio, by weight (mass), 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 by 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 Project Operations.

1045.6 High Solids Epoxy System G Intermediate Coating.

1045.6.1 Description. The coating shall be a two-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.

1045.6.2 Pigment. The pigment shall be a minimum of 43 percent by weight (mass) of the coating.

1045.6.3 Vehicle. The vehicle shall be a maximum of 57 percent by weight (mass). The vehicle shall consist of an epoxy resin.

1045.6.4 Mixed Coating.

Color – Provide a contrast with the primer and the finish coat.

Weight (Mass) per Gallon (Liter), lbs (kg), min, ASTM D 1475	10.0 (1.20)
Solids, percent by weight (mass) ASTM D 1644 for 72 hours at 100 F (37.8 C) min.	79
Pigment, percent by weight (mass), min., Federal Test Method 4021	43
Viscosity, Krebs-Stormer, 77 F (25 C) KU	80-130
Volatile Organic Content*, max., lb/gal (g/L)	3.50 (420)
Fineness of Grind, Hegeman Gage, min.	4
Sag Resistance, Leneta Anti-Sag Meter, mils (μm) wet, min.	8 (203)
Pot Life at 70 F (21 C), hours, min.	4
Dry to Touch, hours, max.	3
Dry to Handle, hours, max.	6

*Maximum when thinned for application.

1045.6.5 Manufacturer and Brand Name Approval. Prior to approval and use of the specified coating system, the manufacturer shall submit to Project Operations a one-gallon (4 L) 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 23 Method 1, Type EH (Carbon Arc), 4000 hours. ASTM G 26, Method 2, Xenon Arc or G 53 QUV (Fluorescent UV-Condensation Type using Type A lamps) may be used as an alternate to Carbon Arc.

1045.6.5.1 All coats of the system to be tested shall be applied to steel test panels which 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 color(s) for which approval is being requested. After 4000 hours testing for accelerated weathering resistance, each color of the finish coat shall show a difference in color of no greater than 3.0 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 Project Operations.

1045.6.5.2 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 MoDOT.

1045.7 Polyurethane System G Finish Coating.

1045.7.1 Description. The coating shall be a two-component, aliphatic acrylic polyurethane suitable for use over Sec 1045.6, 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 Pigment. The pigment shall be a minimum of 29 percent for gray and a minimum of 24 percent for brown by weight (mass) of the total coating. The pigment shall consist of titanium dioxide, color retentive tinting pigments, extender pigments and UV stabilizers.

1045.7.3 Vehicle. The vehicle shall be a maximum of 71 percent for gray and a maximum of 76 percent for brown by weight (mass) of the total coating. The vehicle shall consist of an aliphatic acrylic polyurethane.

1045.7.4 Mixed Coating.

Color, Federal Standard 595b

	Gray 26373	**Brown** 30045
Weight (Mass) per Gallon (Liter), lbs (kg), min., ASTM D 1475	10.0 (1.20)	9.3 (1.14)
Solids, percent by weight (mass) ASTM D 1644 for 72 hours at 100 F (37.8 C), min.	74	71
Solids by Volume, min, ASTM D 2697	63	58
Pigment, percent by weight (mass), min., Federal Test Method 4021	29	24
Viscosity, Krebs-Stormer, 77 F (25 C), KU	65-96	65-96
Volatile Organic Content*, lb/gal (g/L), max.	3.50 (420)	3.50 (420)
Fineness of Grind, Hegeman Gage, min.	6	6
Sag Resistance, Leneta Anti-Sag Meter, mils (µm) wet, min.	8 (203)	8 (203)
Pot Life at 70 F (21 C), hours, min.	4	4
Dry to Touch, hours, max.	4	4
Dry to Handle, hours, max.	8	8

*Maximum when thinned for application.

1045.7.5 Manufacturer and Brand Name Approval. Manufacturer and brand name approval shall be in accordance with Sec 1045.6.5.

1045.8 Waterborne Acrylic System H Intermediate and Finish Coating.

1045.8.1 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 coating shall cure to a tough, abrasion resistant surface which 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.

1045.8.2 Pigment. The pigment shall be a minimum of 18 percent for gray and a minimum of 15 percent for brown by weight (mass) of the total coating. The pigment shall consist of titanium dioxide, color retentive tinting pigments and extender pigment.

1045.8.3 Vehicle. The vehicle shall be a maximum of 82 percent for gray and a maximum of 85 percent for brown by weight (mass) of the total coating. The vehicle shall consist of acrylic resin suitable for use in exterior coatings.

1045.8.4 Mixed Coating.

Color - Intermediate Coat
Provide a contrast between primer and finish coat.

Color - Finish Coat
Federal Standard 595b

	Gray 26373	**Brown** 30045
Weight (Mass) per Gallon (Liter), lbs (kg), min., ASTM D 1475	10.0 (1.20)	9.3 (1.11)
Solids, percent by weight (mass), min., ASTM D 2369	42	42
Solids, percent by volume, min., ASTM D 2697	34	34
Pigment, percent by weight (mass), min., ASTM D 3723	18	15
Percent Non-volatile Vehicle, by weight (mass) of coating, min.	22	28
Viscosity, Krebs-Stormer, 77 F (25 C), KU	80-100	80-100
Volatile Organic Content, lb/gal (g/L), max.	3.50 (420)	3.50 (420)
Fineness of Grind, Hegeman Gage, min.	7	7
Sag Resistance, Leneta Anti-Sag Meter, mils (µm) wet, min.	8 (203)	8 (203)
Dry to Handle, hours, max.	2	2

1045.8.5 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 1045.6.5.

Amend Sec 1045 to include the following: ***04/02***

1045.9 Aluminum Epoxy-Mastic Primer.

1045.9.1 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 allowed for use in contact with fresh concrete. The epoxy-mastic shall be a two-component, modified epoxy-primer containing metallic-aluminum flake.

1045.9.2 Pigment. The primary pigment shall be metallic-aluminum.

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 coating shall be supplied as a two-component material with a 1:1 volume mix ratio, and 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 (127 µm) dry film thickness without runs or sags.

1045.9.4.2 The mixed coating properties shall be as follows:

Item	Requirement
Shelf Life, months, min.	12
Weight per gallon,lb,min. 77 F (25 C) (Mass per liter, kg, min.)	10.5 (1.26)
Solids, percent by weight (mass), min.	88[a]
Pot life, 75 F (24 C), hours, min.	2
Dry to touch, hours, max.	24
Dry hard, days, max.	5[b]
Volatile Organic Content, lb/gal (g/L), max.	3.50 (420)

[a] When tested in accordance with ASTM D 1644, Method A for 72 hours at 100 F (37.8 C).

[b] When air-cured at a temperature of 75 F (24 C) or above to a hard, tough film by evaporation of solvent and chemical reaction.

1045.9.5 Resistance Tests. Test panels of steel meeting the requirements of ASTM D 609 and having dimensions of 2 inches x 5 inches x 1/8 inch (50 mm x 125 mm x 3 mm) 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 thirty days or until uniform rusting occurs. They shall then be hand cleaned with a wire brush in accordance with SSPC-SP2-82. A 6-mil (152 µm) dry coating of the epoxy-mastic shall then be applied in one coat in accordance with the manufacturer's current printed instructions. 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.

1045.9.5.1 Fresh Water Resistance. Panels shall be scribed down to base metal with an "X" of at least 2 inch (50 mm) legs and shall be immersed in fresh tap water at 75 ± 5 F (24 ± 2 C). The panels shall show no rusting, blistering, or softening beyond 1/16 inch (2 mm) from the scribe mark, when examined after thirty days. Discoloration of the coating will be allowed.

1045.9.5.2 Salt Water Resistance. Panels shall be scribed down to base metal with an "X" of at least 2 inch (50 mm) legs and immersed in 5 percent sodium chloride at 75 ± 5 F (24 ± 2 C). The panels shall show no rusting, blistering, or softening beyond 1/16 inch (2 mm) from the scribe mark upon examination after seven, fourteen and thirty days. Discoloration of the coating will be allowed. The sodium chloride solution shall be replaced with fresh solution after each examination.

1045.9.5.3 Weathering and Salt Fog Resistance. Panels shall be tested in the weatherometer in accordance with ASTM G 53 QUV (Fluorescent UV-Condensation Tape using Type A Lamps) for 300 hours using a test cycle consisting of 4 hours light followed by 4 hours condensation. After this period, the panels shall be removed and scribed with an "X" of at least 2 inch (50 mm) legs down to base metal. The test panels shall then be tested in accordance with ASTM B 117. After 1000 hours of continuous exposure, the coating shall show no loss of bond, nor shall it show rusting or blistering beyond 1/16 inch (2 mm) from the center of the scribe mark.

1045.9.6 Packaging and Labeling. The epoxy-mastic coating shall be packaged in two containers. The components shall be prepackaged such that mixing at a 1:1 ratio, by volume, utilizes a complete container of each component. Each container shall be labeled in accordance to Sec 1045.1.3.1. The label on the vehicle container shall also include complete instructions for the use of this paint. The container shall be coated on the inside, if necessary, to prevent attack by the paint components.

1045.9.7 Field Application.

1045.9.7.1 The epoxy-mastic shall be applied over an SSPC-SP2, SSPC-SP3 or SSPC-SP6 surface preparation, including removal of all rust scale, loose rust, loose mill scale and loose or non-adherent paint. Oil and grease shall be removed in accordance with SSPC-SP1 Solvent Cleaning.

1045.9.7.2 The epoxy-mastic shall be applied by spray, brush or roller in accordance with the manufacturer's printed instructions except as herein modified. The contractor shall furnish the engineer a complete set of the manufacturer's printed instructions at least two weeks prior to beginning surface preparation.

1045.9.7.3 The epoxy-mastic shall not be applied when either the temperature of the metal or the air is below 50 F (10 C), the temperature is expected to drop to 40 F (5 C) or below before the coating has cured, or the steel surface temperature is at or below 5 F (-15 C) above the dew point as determined in accordance with MoDOT Test Method T 38.

1045.9.7.4 The epoxy-mastic shall be applied in one coat to a 5-mil (127 µm) dry film thickness.

1045.9.8 Approval and Prequalification.

1045.9.8.1 Manufacturer and Brand Name Approval. Prior to approval and use of the epoxy-mastic primer, the manufacturer shall submit to Project Operations a one-gallon (4 L) 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 also 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 which have undergone each required resistance test. The set of panels submitted shall include one untested control panel that has been prepared according to Sec. 1045.9.5. Upon approval by Project Operations of this certified test report, further resistance tests will not be required, except as hereinafter noted, of that manufacturer for that brand name of epoxy-mastic primer. 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.

1045.9.8.2 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 upon results of tests made on samples of the material. The engineer will sample and test each lot of each component prior to approval or use of the material.

1045.10 Gray Epoxy-Mastic Primer.

1045.10.1 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 two component modified epoxy containing gray pigmentation and shall comply with the requirements specified herein.

1045.10.2 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.

1045.10.3 Vehicle. The vehicle shall be an epoxy type. The curing agent shall have suitable insensitivity to moisture to allow trouble-free application.

1045.10.4 Mixed Coating.

1045.10.4.1 The provisions of Secs 1045.9.4.1 shall apply.

1045.10.4.2 The mixed coating properties shall be as follows:

Item	Requirement
Color, Federal Standard 595b	Gray 26373
Weight per gallon,lb,min. 77 F (25 C) (Mass per liter, kg, min.)	11.0 (1.32)
Solids, percent by weight (mass), min.	88[a]
Pigment, percent by weight (mass), min.	40
Viscosity, (Krebs-Stormer, 25 C) KU	90 - 120
Volatile Organic Content, lb/gal(g/L), max.	3.50 (420)
Pot life, 75 F (24 C), hours, min.	2
Dry to touch, hours, max.	24
Dry hard, days, max.	7[b]
Shelf Life, months, min.	12

[a]When tested in accordance with ASTM D 1644, Method A for 72 hours at 100 F (37.8 C).

[b]When air-cured at a temperature of 75 F (24 C) or above to a hard, tough film by evaporation of solvent and chemical reaction.

1045.10.5 Resistance Tests. Test requirements and approval criteria shall be in accordance with Sec 1045.9.5.

1045.10.6 Packaging and Labeling. Packaging and labeling shall be in accordance with Sec 1045.9.6.

1045.10.7 Field Application. Field application shall be in accordance with Sec 1045.9.7.

1045.10.8 Approval and Prequalification.

1045.10.8.1 Manufacturer and Brand Name Approval. Manufacturer and brand name approval shall be in accordance with Sec 1045.9.8.1.

1045.10.8.2 Final Acceptance. Final acceptance will be in accordance with Sec 1045.9.8.2.

SECTION 1046 – PIPE LINER

Amend Div 1000 to include the following: ***04/01***

SECTION 1046

PIPE LINER

1046.1 Scope. This specification covers material requirements for pipe liner.

1046.2 Material.

1046.2.1 Type I Pipe Liner. Type I pipe liner shall be polyethylene (PE) pipe and shall comply with the requirements of ASTM F 714 (Max. DR 32.5).

1046.2.2 Type II Pipe Liner. Type II pipe liner shall be PE pipe, shall comply with ASTM D1248, Type III, Category 5, Class C, Grade P34 and shall have approved dimensions as kept on file with Project Operations-Materials.

1046.2.3 Type III Pipe Liner. Type III pipe liner shall be PE pipe and shall comply with the requirements of ASTM F894 open profile, Class RSC 100 or RSC 160.

1046.2.4 Type IV Pipe Liner. Type IV pipe liner shall be polyvinyl chloride (PVC) pipe and shall comply with ASTM F 949, except that the PVC pipe and fittings shall be made of 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 meeting the requirements of 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. The marking shall be such that it will not be obliterated during handling, shipment or placement.

1046.4 Certification and Acceptance. The contractor shall furnish a manufacturer's certification to the engineer, stating that the pipe liner was manufactured and tested in accordance with the listed specifications and was found to meet the requirements of these specifications. 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 free access to the manufacturing plant or intermediate distribution point for inspection, and every facility shall be extended for this purpose. Any pipe liner which has been previously rejected and included in a later lot will be considered sufficient cause for rejection of the entire lot. A lot is 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 must comply in all respects or the entire shipment will be rejected.

SECTION 1047 – CORRUGATED POLYETHYLENE CULVERT PIPE

Delete Sec 1047.7 and substitute the following: ***01/02***

1047.7 Jointing Systems. Field joints of corrugated polyethylene 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. Corrugations in the bands shall have the same configuration as the corrugations in the pipe ends being connected. The design of any field jointing system shall be submitted to Project Operations - Materials for approval prior to use.

SECTION 1048 – PAVEMENT MARKING MATERIAL

Delete Sec 1048 and substitute the following: ***04/00; 07/02***

SECTION 1048

PAVEMENT MARKING MATERIAL

1048.1 Scope. This specification covers preformed pavement marking tape, thermoplastic pavement marking material, preformed removable pavement marking tape and preformed temporary pavement marking tape.

1048.2 Type 1 Preformed Marking Tape.

1048.2.1 Type 1 preformed marking tape shall be capable of being laid into new, dense and open graded asphalt wearing surfaces during the final roller operation. After application the tape shall be immediately ready to receive traffic.

1048.2.2 Composition. The tape shall consist of a mixture of polymeric material, pigments and glass beads distributed throughout the cross-sectional area with a reflective layer of glass beads embedded in the top surface. The tape shall be sufficiently flexible so as to conform to the roadway without cracking or breaking.

1048.2.3 Dimensions. The tape without adhesive shall have a minimum thickness of 60 mils (1.5 mm). A patterned surface is allowable but shall have a minimum thickness of 60 mils (1.5 mm) over at least 50 percent of its surface. The tape shall have a nominal width of 4 inches (100 mm) and the edges shall not be tapered.

1048.2.4 Adhesive. The tape shall be supplied with a precoated factory-applied adhesive for immediate application to asphalt pavement without the use of heat, solvent or other adhesive operations. The tape and adhesive shall be of a type that water used on the compaction roller will not be harmful to successful application.

1048.2.5 Reflectance. The tape shall be readily visible when exposed to automobile headlights at night and shall have a minimum specific luminance as shown in the following table, expressed as millicandelas per footcandle (lux) per square foot (square meter). The tape shall be applied to an 8 inch by 36-inch (200 x 900 mm) panel in a longitudinal orientation and measured in accordance with MoDOT Test Method T8 at 86 degrees entrance angle. The reflected color shall be white or yellow as required for the specified application.

Observation Angle	White	Yellow
0.2 degree	550	410
0.5 degree	380	250

1048.2.6 Approval. To obtain approval of Type 1 preformed marking tape, the manufacturer shall submit material and application specifications, samples of the tape, and a history of satisfactory use as a pavement marking tape to the engineer for testing and evaluation. The quantity, types and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.2.6.1 For acceptance on the project, the contractor shall furnish to the engineer a manufacturer's certification in triplicate stating the manufacturer and trade name, and certifying that the material furnished is of the same composition as originally prequalified and in no way has been altered or changed.

1048.3 Extruded Thermoplastic Marking Material.

1048.3.1 Thermoplastic Compound.

1048.3.1.1 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. The pre-mix beads shall be uncoated and shall be in accordance with AASHTO M 247, Type 1.

1048.3.1.2 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 - passing 3/8 inch (9.5 mm) and retained on 1/4 inch (6.3 mm) sieve
(b) Medium Grind - passing No. 8 (2.36 mm) and retained on No. 20 (850 µm) sieve
(c) Fine Grind - passing No. 30 (600 µm) sieve

1048.3.2 Primer. Primer, if required, shall be as recommended by the manufacturer of the thermoplastic material.

1048.3.3 Sampling and Testing.

1048.3.3.1 The engineer shall have free access to the material and all facilities for the purpose of inspection. A sample will be taken from each lot of thermoplastic marking material presented for inspection. A lot is defined as 22,000 pounds (10,000 kg), or fraction thereof, presented for inspection at one time regardless of the number of composition batches in the lot. A sample will consist of one 50-pound (23 kg) sample of material packaged in accordance with Sec 1048.3.5. The engineer reserves the right to sample at the point of manufacture, at intermediate points of storage, or at destination.

1048.3.3.2 The thermoplastic material shall be tested in accordance with AASHTO M 249 and AASHTO T 250, as applicable.

1048.3.4 Certification and Acceptance.

1048.3.4.1 The contractor shall furnish a manufacturer's certification in triplicate to the engineer, for each lot furnished, certifying that the material supplied conform to all requirements specified. The certification shall include or have attached typical results of required tests.

1048.3.4.2 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.

1048.3.5 Packaging and Marking.

1048.3.5.1 Thermoplastic material may be furnished as blocks approximately 12 x 37 x 2 inches (300 x 950 x 50 mm) or as granular material in bags. Either unit shall weigh (have a mass of) approximately 50 pounds (23 kg).

1048.3.5.2 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 (mass) of contents, and the temperature to which the material shall be heated for application. Granular thermoplastic material may be packaged in thermally degradable bags which 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.

1048.3.6 Drop-On Glass Beads. Drop-on glass beads shall be in accordance with Sec 1048.6.1.

1048.4 Preformed Removable Pavement Marking Tape. Preformed removable tape shall be capable of being removed manually either by hand or with a roll up device and shall leave no objectionable or misleading image after removal.

1048.4.1 Color. The tape shall be white or yellow as required for the specific application.

1048.4.2 Reflectivity. Tape shall be readily visible when exposed to automobile headlights at night and shall have a minimum specific luminance as shown in the following table, expressed as millicandelas per footcandle (lux) per square foot (square meter). The tape shall be applied to an 8 x 36 inch (200 x 900 mm) panel in a longitudinal orientation and measured in accordance with MoDOT Test Method T8 at 86 degrees entrance angle. The reflected color shall be white or yellow as required for the specified application.

Observation Angle	White	Yellow
0.2 degree	1750	1300
0.5 degree	1250	800

1048.4.3 Adhesive. Tape shall have a pre-coated pressure sensitive adhesive that requires no activation procedures. The adhesive shall be resistant to oil, chemicals, acids, solvents and water.

1048.4.4 Dimensions. The tape shall have a minimum thickness of 15 mils (380 µm) and shall have a nominal width of 4 inches (100 mm). Following application, the tape shall remain conformed to the texture of the pavement.

1048.4.5 Durability. The tape shall be weather-resistant and show no appreciable fading, lifting, or shrinkage during its 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.

1048.4.6 Appearance. The tape as applied shall be in good condition, free of cracks and with edges straight and unbroken.

1048.4.7 Approval.

1048.4.7.1 Prior to approval and use of preformed removable tape, the manufacturer shall submit material and application specifications and samples of the tape for testing and evaluation. The quantity, types and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.4.7.2 Preformed removable tape appearing on the prequalified list may be accepted for use on the basis of brand name, color and width as shown in the prequalified list, so long as satisfactory performance is obtained in the field.

1048.5 Preformed Short Term Pavement Marking Tape.

1048.5.1 Color. The tape shall be white or yellow as required for the specific application.

1048.5.2 Reflectivity. The tape shall be readily visible when exposed to automobile headlights at night and shall have a minimum specific luminance as shown in the following table, expressed as millicandelas per footcandle (lux) per square foot (square meter). The tape shall be applied to an 8 x 36 inch (200 x 900 mm) panel in a longitudinal orientation and measured in accordance with MoDOT Test Method T8 at 86 degrees entrance angle. The reflected color shall be white or yellow as required for the specified application.

Observation Angle	White	Yellow
0.2 degree	1350	800
0.5 degree	750	500

1048.5.3 Adhesive. Tape shall have a pre-coated pressure-sensitive adhesive that requires no activation procedures. Adhesive shall be resistant to oil, chemicals, acids, solvents and water.

1048.5.4 Dimensions. Tape shall have a minimum thickness of 15 mils (380 µm) and shall have a nominal width of 4 inches (100 mm). Following application, the tape shall remain conformed to the texture of the pavement.

1048.5.5 Durability. The tape shall be weather resistant and show no appreciable fading, lifting, or shrinkage during its 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.

1048.5.6 Appearance. The tape as applied shall be in good condition, free of cracks and with edges straight and unbroken.

1048.5.7 Approval.

1048.5.7.1 Prior to approval and use of preformed short term marking tape, the manufacturer shall submit material and application specifications and samples of the tape for testing and evaluation. The quantity and type of tape submitted shall be at the discretion of the engineer. In addition, the manufacturer shall submit a certification stating that the material conforms to all of the requirements of these specifications. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.5.7.2 Preformed short term marking tape appearing on the prequalified list may be accepted on the basis of brand name and color as shown on the prequalified list, so long as satisfactory performance is obtained in the field.

1048.6 Drop-On Glass Beads.

1048.6.1 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, except as follows.

1048.6.1.1 Roundness. Type 1 beads shall have a minimum of 70 percent true spheres when tested in accordance with ASTM D 1155.

1048.6.1.2 Silica Content. Beads shall be made of glass containing no less than 58.0 percent silica (SiO_2) when tested in accordance with ASTM C 169, Procedures for Referee Analysis.

1048.6.1.3 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 T70.

1048.6.1.4 Calcium Chloride Resistance. The beads shall show no readily discernible dulling when tested in accordance with MoDOT Test Method T70.

1048.6.1.5 Sodium Sulfide Resistance. The beads shall show no readily discernible darkening or dulling when tested in accordance with MoDOT Test Method T70.

1048.6.2 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:

1048.6.2.1 Coating. The beads shall be coated to ensure satisfactory embedment and adhesion when applied to uncured traffic marking material. Embedment coating shall be tested in accordance with MoDOT Test Method T70.

1048.6.2.2 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 (determined visually). The remaining sieve fractions shall be determined visually per aspect ratio using microfiche reader to be no less than 75 percent rounds. The tests shall be in accordance with Federal Lands Highway Test Method T520-93.

1048.6.2.3 Gradation. Type L beads shall meet the following gradation requirements when tested in accordance with ASTM D 1214.

Sieve Size	Percent Passing
12 (1.7 mm)	100
14 (1.4 mm)	95 - 100
16 (1.18 mm)	80 - 98
18 (1.00 mm)	10 - 42
20 (850 µm)	0 - 7
25 (710 µm)	0 - 2

1048.6.2.4 Silica Content. Beads shall be made of glass containing no less than 58.0 percent silica (SiO_2) when tested in accordance with ASTM C 169.

1048.6.2.5 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 T70.

1048.6.2.6 Calcium Chloride Resistance. The beads shall show no readily discernible dulling when tested in accordance with MoDOT Test Method T70.

1048.6.2.7 Sodium Sulfide Resistance. The beads shall show no readily discernible darkening or dulling when tested in accordance with MoDOT Test Method T70.

1048.6.3 Intermix Beads. Intermix beads shall be uncoated and in accordance with AASHTO M 247, Type 1. Intermix beads shall be uniformly mixed throughout the thermoplastic material at the rate of not less than 30 to 35 percent by weight (mass) (retained on the No. 100 (150 µm) sieve) of the thermoplastic material.

1048.6.4 Certification and Acceptance of Glass Beads.

1048.6.4.1 The contractor shall furnish a manufacturer's certification in triplicate for each lot, certifying the beads conform to all requirements specified. The certification shall include or have attached specific results of tests on each lot furnished for roundness, refractive index, flow characteristics, coating type, and gradation. The certifications shall show the quantity and lot number.

1048.6.4.2 Acceptance of the beads will be based on the manufacturer's certification and upon the results of such tests as may be performed by the engineer.

1048.7 Temporary Raised Pavement Markers. The brand name and manufacturer shall be stamped or indelibly printed on each container.

1048.7.1 Type 1 Temporary Raised Pavement Markers. Markers shall consist of an L-shaped or T-shaped flexible polymer body with prismatic reflective tape on the top of both faces of the vertical section. The prismatic reflective faces shall be a minimum of 0.38 square inches (0.002 m^2) for each face. The marker base shall have affixed a pressure-sensitive adhesive, protected by a release paper, for application to the pavement surface. A protective sleeve which prevents contamination of the reflective faces during pavement surface treatment operations shall be affixed to each marker. The protective sleeve shall be easily removable after the work is complete.

1048.7.2 Type 2 Temporary Raised Pavement Markers. Markers shall consist of a plastic shell with prismatic reflective faces with a minimum of 0.38 square inches (0.002 m^2) of reflective surface for each face. If reflective faces are specified on both sides, they shall be 180 degrees opposed. The marker shall be fitted with a pressure-sensitive adhesive for application to a primed surface or may be applied to the pavement surface with a bituminous adhesive material. The markers shall be subject to approval by the engineer.

1048.7.3 Acceptance. Prior to approval and use of temporary raised pavement markers, the manufacturer shall submit to Project Operations samples of the markers and certified results showing that the markers conform to the requirements of this specification. Documentation shall include reflectivity test results for the typical reflector units being furnished. Upon approval of the markers, the brand name will be placed on the list of prequalified temporary raised pavement markers.

1048.8 Hot Spray Thermoplastic Material.

1048.8.1 Thermoplastic Compound

1048.8.1.1 Except where otherwise specified, tests shall be performed in accordance with AASHTO T 250.

1048.8.1.2 The thermoplastic material shall be formulated with alkyd resin and intermix beads for application by the hot spray process at 45 mil (1.15 mm) or 60 mil (1.50 mm) thickness.

1048.8.1.3 The thermoplastic material, when melted, ground to various finenesses, and tested as shown in Sec 1048.3.1.2, shall exhibit leachable lead and chromium levels no greater than 4.0 ppm.

1048.8.1.4 The binder shall consist of a mixture of synthetic alkyd resins, at least one of which is solid at room temperature. The total binder content of the thermoplastic compound shall be well distributed through the compound. The binder shall be free from all foreign objects or ingredients that would cause bleeding, staining or discoloration. The binder shall be 25 percent minimum by weight (mass) of the thermoplastic compound.

1048.8.1.5 Pigment.

1048.8.1.5.1 White. The pigment used for the white thermoplastic compound shall be a minimum 93 percent, pure titanium dioxide. The white pigment content shall be less than 10 percent by weight and shall be uniformly distributed throughout the thermoplastic compound.

1048.8.1.5.2 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.

1048.8.1.5.3 Filler. The filler shall be a white, calcium carbonate, silica, or an approved substitute. Any filler which is insoluble in 6 N hydrochloric acid shall be of such particle size as to pass a No. 100 (150 µm) sieve.

1048.8.1.6 Mixed Compound.

1048.8.1.6.1 Reflectance and Color. The mixed thermoplastic compound, after heating 2.2 pounds (1000 g) in an open, friction-top can for 4 hours ± 5 minutes at 375 ± 3 F (190.6 ± 2 C) and cooling at 77 F (25 C), shall meet the following requirements 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.

Color	Daylight Reflectance (Y)
White	75 percent min
Yellow[a]	42 to 59 percent

[a]Shall match Federal 595 Color No. 33538 and chromaticity limits as follows:

x	0.470	0.510	0.485	0.530
y	0.455	0.485	0.425	0.456

1048.8.6.2 Specific Gravity. The specific gravity of the thermoplastic material shall not exceed 2.15.

1048.8.6.3 Softening Point. After heating the thermoplastic as described in Sec 1048.8.1.5.1 and testing in accordance with ASTM E 28, the material shall have a minimum softening point of 180 F (82.2 C) as measured by the ring and ball method.

1048.8.6.4 Tensile Bond Strength. After heating the thermoplastic as described in Sec 1048.8.1.5.1, the tensile bond strength to unprimed, sandblasted Portland cement concrete block, 0.0625 inch (1.587 mm) thick film drawdown at 375 F (190.6 C), test at 75 ± 2 F (23.0 ± 1 C) shall exceed 180 psi (1.24 MPa) when tested in accordance with ASTM D 4796.

1048.8.6.5 Impact Resistance. After heating the thermoplastic as described in Sec 1048.8.1.5.1, the impact resistance shall be a minimum of 50 inch-pounds (5.65 N-m) with no cracks or bond loss when 0.0625 inch (1.587 mm) thick film drawdown is made at 375 F (190.6 C) on an unprimed, sandblasted Portland cement concrete block, male indentor 5/8 inch (15.875 mm), no female die, tested at 75 ± 2 F (23.9 ± 1 C) when tested in accordance with ASTM D 2794.

1048.8.6.6 Yellowness Index. The white thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with AASHTO T 250.

1048.8.7 Packaging.

1048.8.7.1 The thermoplastic material shall be packaged in suitable containers that will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 pounds (22 kg). Each container shall designate the color, type of binder, spray and user information. The label shall warn the user the material shall be heated in the range of 350 to 425 F (177 to 218 C).

1048.8.7.2 Each package shall be marked with the name of the manufacturer, type of material, month and year the material was packaged, and lot number. The letters and numbers shall be a minimum of 1/2 inch (12 mm) high.

SECTION 1049 – PRECAST CONCRETE BOX CULVERTS

Delete Sec 1049.2.2-1049.2.5 and substitute the following: ***04/00***

1049.2.2 Cement. Cement shall comply with the requirements of Sec 1019. Fly ash or GGBFS may be used to replace cement in accordance with Sec 501.

1049.2.3 Mixture. The aggregates 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 the approval of the engineer. In no case, however, shall the proportion of Portland cement in the mixture be less than 564 pounds per cubic yard (335 kg/m^3) of concrete.

1049.2.4 Admixtures. Admixtures may be used with the approval of the engineer.

SECTION 1050 – LUMBER, TIMBER, PILING, POSTS AND POLES

Delete Sec 1050.4 and substitute the following: ***10/01***

1050.4 Electric Substation, Service and Span Wire Assembly Poles.

1050.4.1 Electric Substation and Services Poles. These poles shall be of the length and class specified in the contract, and shall conform to the requirements of ANSI 05.1. They shall be of the species and type of preservative shown in Table I. The poles may be gained and drilled in the field after treatment. Areas exposed shall be treated as specified in Sec 1050.7, before cross-arms or equipment are mounted.

1050.4.2 Span Wire Assembly Poles. These poles shall be of the length specified in the contract and shall conform to the requirements of ANSI 05.1, Class IV unless otherwise specified. They shall be of the species and type of preservative shown in Table I. All poles shall have a minimum diameter of 6 3/4 inches (170 mm) 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.

SECTION 1051 – SLOTTED DRAIN

Delete Sec 1051.3.1 and substitute the following: ***01/02***

1051.3.1 Type B and Type C slotted drain grate assemblies shall be fabricated from 3/16 inch (4.76 mm) thick ASTM A 36 structural steel and shall conform to the details in the plans. The entire grate assembly shall be hot dip galvanized, prior to attachment to the pipe, in accordance with AASHTO M 111.

SECTION 1057 – MATERIAL FOR JOINTS

Delete Sec 1057.1.1 and substitute the following: ***10/01***

1057.1.1 Dowel Bars. Dowels for transverse joints shall meet the requirements for Plain Rounds of AASHTO M 31, AASHTO M 42 or AASHTO M 53. They shall be epoxy coated in accordance with Sec 1036 except the coating thickness shall be 5 mils (127 µm) minimum, the flexibility of coating requirement will not apply and the cut ends are not required to be coated. They shall be free of cutting burrs and other projections. Dowel supporting units shall conform to one of the types shown on the plans.

1057.1.1.1 The free end of the dowel bar for a length of at least 11 inches (280 mm) shall be coated with an approved graphite grease. Graphite grease shall contain a minimum of 25 percent graphite and shall be certified by the manufacturer or shown on the container label. The graphite grease shall be applied in a manner that will result in a thorough covering of that section of the bar with a thin uniform coating.

1057.1.1.2 In lieu of the graphite grease application, the dowel bar basket supplier may supply completed basket units pre-dipped in a Techtyl 506 bondbreaker solution. The material shall not be applied in a spray or field application. The resulting dry dowel bar coating shall be visually evident, firm, amber, waxy and translucent. The coating shall be uniformly applied without excessive drips or thickness. The units shall be protected from dust and abuse prior to use. 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 specifications. The dowel basket supplier shall provide a certification for the coating with each shipment, certifying the bondbreaker product name, manufacturer and date of coating application.

SECTION 1061 – ELECTRICAL CONDUCTORS

Delete Sec 1061.2 and substitute the following: ***10/01***

1061.2 Conductors. Except as noted, all conductors shall be soft drawn, Class B or C stranded copper wire meeting requirements of ICEA S-6-402, Part 2. Solid conductors may be used only for grounding where connected to a ground rod.

Delete Secs 1061.7 through 1061.9 and substitute the following: ***07/00; 10/00; 10/01***

1061.7 Multi-Conductor Cable. Multi-conductor cable for traffic signals shall be No. 12 AWG (4 mm^2) rated at 600 volts and plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice. This cable shall comply with the requirements of IMSA Specification No. 19-1.

1061.8 Induction Loop Detector Cable. Induction loop detector cable shall be single conductor No. 14 AWG (2.5 mm^2) wire, with Type XHHW insulation, marked as such, rated at 600 volts, encased in a 1/4 inch (6 mm) polyvinyl chloride or medium density polyethylene duct and plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice. This cable shall comply with the requirements of IMSA Specification No. 51-7.

1061.9 Loop Detector Lead-In Cable. Lead-in cable used between the detector and the controller shall be two-conductor, twisted, shielded No. 14 AWG (2.5 mm^2) wire rated at 600 volts and plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice. This cable shall comply with the requirements of IMSA Specification No. 50-2.

SECTION 1070 – WATER

Delete Sec 1070.1.1 and substitute the following: ***04/00***

1070.1.1 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 oil, acid, alkali salt, organic matter, vegetable matter or other deleterious substances. If required by the engineer or if the pH of the water is less than 4.5 or more than 8.5, the following requirements shall also be met. Autoclaved bars, made with the water and a cement which shows satisfactory soundness when mixed with distilled water, shall show an expansion not to exceed 0.5 percent. The time of set of cement pats made with the water shall vary not more than 10 percent from the setting time shown by pats made from the same cement and distilled water. 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 not 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.

SECTION 1071 – ASPHALT RELEASE AGENTS AND FIBER ADDITIVES

Delete Sec 1071.2.1.1 and substitute the following: ***04/00***

1071.2.1.1 The weight per gallon (mass per liter) shall be determined in accordance with AASHTO T 59, "Weight per Gallon of Emulsified Asphalt".

SECTION 1072 – DAMPPROOFING AND WATERPROOFING MATERIAL

Delete Sec 1072.2.2 and substitute the following: ***07/02***

1072.2.2 Creosote primer shall comply with the requirements of ASTM D 43.