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**DIVISION 1900
CULVERT, SEWER AND UNDERDRAIN PIPE**

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1901 - USES OF PIPE

SECTION 1901

USES OF PIPE

1901.1 GENERAL

TABLE 1901-1 displays the authorized applications and specification references for all types of pipe utilized by the KDOT. This table summarizes general applications for pipe. The Contract Documents should be consulted for specified uses. When a type of pipe is not specified in the Contract Documents, then any type of pipe permitted for the type of construction may be used.

TABLE 1901-1 - USES OF PIPE									
Type	AASHTO, ASTM or Specification Class	Type of Construction							Spec.
		Cross Road	Entrance	Storm Sewer	Under Drain (type)	Under Drain Outlet (type)	Sanitary Sewer	Erosion	
Reinforced Concrete (Arch)	A-II, A-III or A-IV	X	X	X					1902
Reinforced Concrete (Round)	II, III, IV or V	X	X	X					1902
Reinforced Concrete (Horizontal Elliptical)	HE-II, HE-III or HE-IV	X	X	X					1902
Cast Iron Soil Pipe							X		1903
Cast Iron or Ductile Iron Pressure Pipe	As shown on the Contract Documents						X		1903
Corrugated Steel (Circular or Arch)		X ²	X	X ²	F ¹	G ¹		X	1904 & 1905
Corrugated Steel (Bituminous Coated Arch)		X ²	X	X ²				X	1906
Corrugated Steel (Bituminous Coated Circular)		X ²	X	X ²				X	1906
Corrugated Aluminum (Circular or Arch)		X	X	X	F ¹	G ¹		X	1904 & 1905
Corrugated Aluminum (Bituminous Coated Arch)		X	X	X				X	1906
Corrugated Aluminum (Bituminous Coated Circular)		X	X	X				X	1906
Corrugated Steel Bituminous Coated Circular Fully Paved)		X ²	X	X ²					1906
Corrugated Aluminum (Bituminous Coated Circular Fully Paved)		X	X	X					1906
Corrugated Polyethylene Tubing					L ¹	E ¹			1907
Polyethylene (PE) Pipe		X ²	X	X ³					1908
Polyvinyl Chloride (PVC) Pipe		X ²	X	X ³	H ¹	K ¹	X		1909

¹The letter signified the under-drain type designation as shown in **DIVISION 800**.

²Consult the KDOT cross road pipe policy for locations in Kansas where the use of CSP, PE or PVC is prohibited. Contact the Bureau of Materials and Research for additional information.

³Not intended for use beneath paved travelways on routes maintained by KDOT.

1902 - QUALITY CONTROL PROGRAM FOR PRECAST CONCRETE PRODUCTS

SECTION 1902

QUALITY CONTROL PROGRAM FOR PRECAST CONCRETE PRODUCTS

1902.1 DESCRIPTION

This specification covers precast concrete pipe, end sections, inlets, manholes, boxes, and related concrete accessories. This specification does not apply to prestressed concrete beams.

1902.2 REQUIREMENTS

a. Materials.

(1) Use cement from a prequalified source that complies with **DIVISION 2000**. Make cement certifications available at the precast production site.

(2) Fly ash may be substituted for Types II or I/II Portland cement in concrete pipe at rates up to 25 percent. Use fly ash (for pipe only) from a source prequalified under **SECTION 2006**. The sources of cement, aggregates and fly ash must be prequalified for each plant by testing them together using Kansas Test Method KTMR-29, "Wetting and Drying Test of Steam Cured Reinforced Concrete Pipe with Fly Ash." If the mixture complies with the requirement, the producer and the KDOT plant inspectors will be notified in writing. Preliminary approval will be given for mixtures at 150 days based on satisfactory test performance of KTMR-29. If any of the sources of Cement, Fly Ash, or Aggregate are changed in the future, the test must be repeated using the same procedure before incorporating the new sources in the products. Testing may be waived if the same mixture of sources has been tested for another plant. Contact the Bureau of Materials and Research for information and to make arrangements for testing. Make these certifications available at the precast production site.

(3) Aggregates. Use aggregates that comply with "Aggregates for Concrete" as shown in **DIVISION 1100** of the Standard Specifications except that the gradation requirements do not apply. Also, update aggregate producer's certifications at 6-month intervals and when aggregate source changes are made. Make these certifications available at the precast production site.

(4) Use admixtures and blends from a prequalified source as specified in AASHTO M 170, AASHTO M 206 or AASHTO M 207, as applicable. The supplementary optional physical requirements of AASHTO M 295 apply for pozzolanic admixtures except as stated in 1902.2a(2). Make certifications for admixtures and blends available at the precast production site.

Regular admixtures that are tested using ASTM C 494 or ASTM C 1017 procedures are prequalified by complying with **DIVISION 1400**. Admixtures prequalified in this way are listed in prequalified list PQL-2.1, "List of Prequalified Admixtures for Water Reduction, Acceleration, Set Retardation and Plasticizing of Portland Cement Concrete."

Admixtures that are developed for zero slump concrete, and are not tested by admixture producers using ASTM C 494 or ASTM C 1017 procedures, are prequalified by submitting the material to the Engineer of Tests for evaluation and testing. Submit technical data sheets, test reports, material safety data sheets, an IR trace and a 1-quart sample. The admixture will be evaluated for long term durability similar to fly ash by testing it using Kansas Test Method KTMR-29, "Wetting and Drying Test of Steam Cured Reinforced Concrete Pipe with Fly Ash." If the mixture complies with the requirement, the producer and the KDOT plant inspectors will be notified in writing. Preliminary approval will be given for mixtures at 150 days based on satisfactory test performance of KTMR-29. Admixtures prequalified in this way are listed in prequalified list PQL-2.3, "List of Prequalified Admixtures for Zero Slump Concrete."

(5) Use steel reinforcement as specified in AASHTO M 170, AASHTO M 206 or AASHTO M 207, as applicable. Make certifications for steel reinforcement available at the precast production site. All steel components utilized in the products, reinforcing and structural must comply with **DIVISION 1600**.

b. Pipe. Supply pipe, either elliptical, arch or round, as designated in the Contract Documents and complying with either AASHTO M 170 for round pipe, AASHTO M 206 for arch pipe or AASHTO M 207 for elliptical pipe with the following additions or deletions:

(1) Classes of Pipe. Provide only Class II or stronger round pipe, Class HE-II or stronger elliptical pipe, or Class A-II or stronger arch pipe.

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(2) Sizes of pipe. The minimum diameters of round pipe and the minimum waterway areas of elliptical pipe and arch pipe will be shown in the Contract Documents. Pipe having larger diameters or waterway areas may be provided the Engineer approves any substitutions. The nominal waterway areas for various sizes of arch pipe are as shown in AASHTO M 206 and for various sizes of elliptical pipe are as shown in AASHTO M 207.

(3) Delete the permissible variations in internal diameter as shown in AASHTO M 170, M 206, or M 207 as applicable, and replace with the following:

For round pipe, the permissible variation in internal diameter is $\pm 1\%$ from the design diameter for the first 9 inches measured from the inside edge of each end of the pipe and $\pm 3\%$ from the design diameter for the remainder of the pipe.

For arch pipe, the permissible variation in internal diameter is $\pm 2\%$ from the rise and span as shown in Table 1 and Figure 1 of AASHTO M 206 for the first 9 inches measured from the inside edge of each end of the pipe and $\pm 3\%$ from the rise and span shown in Table 1 and Figure 1 of AASHTO M 206 for the remainder of the pipe.

For elliptical pipe, the permissible variation in internal diameter is $\pm 2\%$ from the rise and span as shown in Table 1 and 2 of AASHTO M 207 for the first 9 inches measured from the inside edge of each end of the pipe and $\pm 3\%$ from the rise and span shown in Table 1 and 2 of AASHTO M 207 for the remainder of the pipe.

(4) Lift Holes. One lift hole, not to exceed 4 inches in diameter, may be provided in each section of pipe. After placement, fill lift holes with a suitable concrete mortar, unless directed otherwise by the Engineer.

c. End Sections

(1) Fabricate beveled end sections from pipe complying with this specification for Class II, Class A-II or Class HE-II pipe, as applicable. Bevel to comply with the dimensions shown on the Contract Documents.

(2) Fabricate flared end sections complying with the concrete compressive strength, the absorption, the steel area and the workmanship requirements of this specification for Class II, Class A-II or Class HE-II pipe, as applicable.

(3) Two lift holes, not exceeding 4 inches in diameter, will be permitted in each section. After placement, fill lift holes with a suitable concrete mortar, unless directed otherwise by the Engineer.

d. Manholes, Inlets, and Boxes for Storm Water Drainage. Fabricate manholes, inlets, and boxes for storm water drainage complying with the KDOT approved shop drawings, including reinforcement, absorption, and concrete strength.

e. Manholes, Inlets, and Boxes for Sanitary Sewer Drainage. Fabricate manholes, inlets, and boxes for sanitary sewer drainage complying with the KDOT approved shop drawings and ASTM C 478.

1902.3 TEST METHODS

a. The following current test methods and property requirements, AASHTO or the ASTM equivalent are to be applied to procedures referenced in this specification.

(1) AASHTO T-22, "Compressive Strength of Cylindrical Concrete Specimens." Apply the single operator precision statement for field conditions from ASTM C-39.

(2) AASHTO T-23, "Making and Curing Concrete Test Specimens in the Field."

(3) AASHTO T-24, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."

(4) AASHTO T-119, "Slump of Hydraulic Cement Concrete."

(5) AASHTO T-121, "Weight per Cubic Foot, Yield and Air Content (Gravimetric) of Concrete."

(6) AASHTO T-126, "Making and Curing Concrete Test Specimens in the Laboratory."

(7) AASHTO T-196, "Air Content of Freshly Mixed Concrete by the Volumetric Method."

(8) AASHTO T-152, "Air Content of Freshly Mixed Concrete by the Pressure Method." Not applicable, without special calibration, in the following conditions:

- Slump ≤ 2 inches.
- A mid-range or high-range water-reducer is used.
- An air-entraining agent other than a vinsol resin is used.
- Non-plastic concrete such as commonly used in the manufacture of pipe and concrete masonry units.

(9) AASHTO T-231, "Capping Cylindrical Concrete Specimens."

(10) ASTM C-497, "Concrete Pipe, Manhole Sections, or Tile." (Suggested minimum amplitude of 5 mils.)

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(11) Kansas Test Method KTMR-29, "Wetting and Drying Test of Steam Cured Reinforced Concrete Pipe with Fly Ash."

b. Cylinders are to be 6Ø X 12-inch, however 4Ø X 8-inch cylinders may be approved by the KDOT provided reliable correction factors are developed. Include both uncorrected and corrected data in the quality control summary reports.

c. Compressive strength testing of a minimum of two 28-day laboratory cured cylinders is required for each mix design of a producer. The five lot moving average will apply to each mix design.

d. Cure optional shipping strength cylinders under the same conditions as the product they represent. Test a minimum of 2 cylinders for shipping strength at the same age. Attain a minimum of 80 percent of the specified 28-day compressive strength for the product on each cylinder before shipping. These products are still subject to the requirements of this section and final approval at the project site. Note in the monthly report which products are shipped after 28 days of age, therefore not requiring shipping strength data.

When shipping strength cylinders are utilized, a minimum of 1 set is to be produced at the same time period and from the same concrete batch as the 28-day compressive strength cylinders. Additional shipping strength cylinders may be produced at other times from different concrete batches and tested if desired. Submit all shipping strength data to KDOT and provide availability to the inspector at the production site.

e. The individuals conducting quality control sampling and testing for all producers are to be certified by ACI, or a KDOT approved equivalent, in the appropriate method(s) of sampling and testing, or the laboratory must be AASHTO accredited. Provide copies of the certifications to the KDOT. Notify the KDOT within 2 months of any changes in certification status or QC testing personnel.

1902.4 PRODUCER PREQUALIFICATION

a. Becoming Prequalified.

(1) Notify KDOT of desire to prequalify. Produce 5 lots of concrete that would be used on KDOT products. Provide 28-day compressive strength test data for all 5 lots. Allow KDOT to sample and test 1 of the 5 lots. This sample will be a split sample, with KDOT and Producer testing essentially the same product. The maximum variation between the average of the Producer's 5 lots and KDOT's test results is 10%.

(2) Demonstrate that all highway and bridge construction industry related products manufactured at each facility are produced under a Quality Control Program. Present a Quality Control Plan to the KDOT, Chief of Materials and Research, for evaluation and disposition. The plan must provide the following information as the minimum requirements:

- Name and location of the producer's facility.
- Name, telephone number, level of authority (organizational chart), and qualifications of the persons and alternates directing quality control at the facility. One of these individuals must be present during production at the facility.
- The name and location of the laboratory, whether internal or external to the facility, conducting the quality control testing for the producer. A listing of any accreditation of the laboratory as well as the frequency of NIST traceable equipment calibrations is required.
- Except as described in **subsection 1902.4a(4)**, a lot is defined as the production from each mix design during the 7 consecutive day period beginning Sunday and ending Saturday of each week. Test 1 lot from each mix design used at the facility during this 7-day period. Lot size is 7 consecutive days regardless of the size or type of product or whether the mix is used only once during that 7-day period or each of the 7 days.
- List the QC tests to be performed, including which tests are used for shipping strength. Define the method for obtaining random samples for each test and the number of samples to be tested per lot.
- The frequency of submitting quality control summary reports. This is not to be less than 1 report per month.

(3) The program will be reviewed, and if found acceptable, the producer's facility will be placed on a list of prequalified precast product sources maintained by the Bureau of Materials and Research.

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(4) Upon approval by the Engineer, Producers that demonstrate a continually low monthly production rate, or do not continually provide products to KDOT may base their lots on a per unit basis, not to exceed 1 month. Producers of manholes, inlets, boxes and other project specific products that choose this option must notify the Bureau of Materials and Research when producing KDOT products. KDOT may also choose to decrease the frequency of verification sampling, testing and production monitoring for any Producer.

b. Maintaining Prequalified Status.

(1) Monitor on a lot by lot basis for each mix design or product the 5 lot moving average of compressive strength, \bar{X}_t ; the $n - 1$ weighted standard deviation of the 5 test values used to determine the moving average, S_t ; the quality index, Q_L ; and the associated percent within limits (PWL) as referenced in the Terminology and Definitions.

Notify KDOT of changes in mix designs, concrete materials sources, mixing equipment, or sources of concrete. Changes that significantly affect the control charts may constitute a new mix design and therefore require a new five lot moving average. Produce 5 successive lots complying with the minimum strength requirements for each new mix design.

Selection of the production lot or test number, t is important since it determines the 5 test moving average. Since t is an integer, it is suggested that for the first lot, set $t = 1$, increment by 1 for each successive lot.

A producer, at their option, may impose a more stringent quality control requirement than the five lot moving average. Inform the KDOT as to the frequency of quality control testing, the PWL, the production quantity represented by the test or tests, other types of control monitoring such as attributes, variables, tracking and traceability methods, etc. The Producer and the KDOT must mutually agree upon this program.

The frequency of sampling and testing may be decreased with the approval of the KDOT if proficiency in maintaining the quality control of the products is demonstrated to the satisfaction of the KDOT.

(2) Clearly mark the lot when any single cylinder test value for that lot has a final strength of less than 85 percent of the specified minimum 28-day compressive strength. Clearly mark this material to prevent it from being included in a KDOT project and store it separately from the approved material.

(3) Comply with a 90 percent within limits (PWL) requirement relative to the minimum specified 28-day compressive strength for the 5 lot moving average. The Lower Spec Limit (LSL) for each product is that product's required 28-day compressive strength. Notify the KDOT immediately whenever the 5 lot moving average falls below 90 PWL, and comply with the following. Produce 5 successive lots complying with the minimum strength requirements as agreed upon by KDOT and the Producer, and provide documentation that corrective action has been taken and that compliance has been reestablished.

(4) Maintain optional control charts of \bar{X}_t , S_t and PWL vs. test number t .

(5) Display plant name, initials, or logo, date manufactured, AASHTO class when applicable, and size on all inventories. Clearly mark all products not intended for KDOT use. Maintain traceability of all products shipped to KDOT projects.

(6) The producer's facility will be randomly visited to inspect the placement of the steel and other necessary requirements for the project.

(7) Provide KDOT with the current week's production schedule at the beginning of each week. Verification samples will be taken at a minimum of once every 5 lots for each product. This may include, but is not restricted to, any combination of cylinders, core samples, and, for pipe, 3-edge bearing tests. The same statistical parameters (\bar{X}_t , S_t and PWL) will be developed from the verification test data of the cylinders. Under normal conditions, no more than 10 pieces of pipe per year will be tested to ultimate strength when the 3-edge bearing test is used for verification testing.

(8) A minimum of 5 of the KDOT's verification test results will be compared with the associated producer's quality control tests through the F and t statistical test to determine if they represent the same population. Continual deviations will be rectified with the Producer.

(9) Any unacceptable practices witnessed by KDOT personnel at the producer's facility may result in loss of Prequalified Status if not corrected or eliminated after notification.

c. Terminology and Definitions. Refer to 5.17.09 in Part V for terminology and definitions concerning QC/QA and Statistical Analysis.

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d. Monthly Report Requirements

- (1) Include the following information in the quality control summary reports.
 - Clear and consistent identification of each mix design and test samples. Use only 1 producer defined lower specification limit for each mix design.
 - The date the sample, product, or cylinders were produced and the dates tested for both shipping strength and 28-day compressive strengths of laboratory cured cylinders. Include documentation when products are not shipped before 28 days, therefore waving the shipping strength requirements.
 - The load at failure, compressive strength, applicable correction factor, and corrected strength, for each individual sample tested as per **subsection 1902.3c**.
 - The statistical analysis of this data as described in **subsection 1902.4b(1)** and the optional control charts.
- (2) Do not send QC Reports for products that are not normally used in the highway and bridge construction industry.
- (3) Reports that are more than 2 months late will cause a loss of Prequalified Status for a 6-month period. Further delinquent reports may cause permanent loss of Prequalified Status.
- (4) Make available the actual test data and reports, including shipping strength data, to the inspector at the production site. Test reports are to bear the names and signatures of the certified technicians or representative of the laboratory conducting the sampling and testing. For precast facilities that are performing their own QC testing, actual data records are to be initialed by the certified technicians conducting the testing. Make available for inspection the shipping records for KDOT projects.

1902.5 BASIS OF ACCEPTANCE

Delete the basis of acceptance in AASHTO M 170, AASHTO M 206 and AASHTO M 207, and replace with the following:

- a. Prequalification as required by **subsection 1902.4**.
- b. Receipt and approval of a Type C certification as specified in **DIVISION 2600**.
- c. All products governed by this special provision are subject to final visual inspection for shipping damage, fit and other visual defects, and disposition when delivered to the project site.

1903 - CAST IRON AND DUCTILE IRON PIPE

SECTION 1903

CAST IRON AND DUCTILE IRON PIPE

1903.1 DESCRIPTION

This specification governs pipe, fittings, and accessory items produced from malleable, gray, or ductile (nodular) cast iron and intended for various piping system applications, including drainage systems.

1903.2 REQUIREMENTS

a. General. Provide pipe, fittings, and accessory item castings that comply with the design, dimensions, alloy designation and thermal treatment, requirement for supplemental corrosion protection, and specific fabrication requirements as specified in the Contract Documents. Provide compliant components of pipe systems that are open to atmospheric pressure complying with **subsection 1903.2b**. Provide compliant closed systems that can be pressurized with the specification(s) selected from ASTM A 377 that is (are) appropriate for the intended application. The selected specification(s) is (are) denoted in the Contract Documents.

b. Material Specifications. Provide compliant components of open systems complying with ASTM A 48 when produced from gray cast iron or ASTM A 536 when produced from ductile cast iron. Accessory items may also be produced from ferritic malleable cast iron in compliance with ASTM A 47. Provide compliant pipe, fittings, and accessory items for these piping systems with ASTM A 74. The mechanical property requirements of ASTM A 74 determine the class or grade of cast iron required.

1903.3 TEST METHODS

Conduct all tests required by the applicable ASTM or other specification of **subsection 1903.2b** according to the procedures specified in that standard.

1903.4 PREQUALIFICATION

Not applicable.

1903.5 BASIS OF ACCEPTANCE

Receipt and approval of a Type D certification as specified **DIVISION 2600**.

Inspection by field personnel of all products and components for compliance with dimensional and supplemental corrosion protection coating requirements when corrosion protection is specified, quality of workmanship, delivery condition, approval of the required associated documentation, and any other requirements as may be specified in the Contract Documents.

1904 - CORRUGATED METAL PIPE AND END SECTIONS

SECTION 1904

CORRUGATED METAL PIPE AND END SECTIONS

1904.1 DESCRIPTION

This specification governs corrugated steel pipe, arches, corrugated aluminum alloy pipe, arches, and the associated end sections and accessory items for use in drainage systems and other applications.

1904.2 REQUIREMENTS

a. General. Provide pipe, arches, end sections, and accessory items that comply with the design, dimensions, alloy designation and thermal treatment, requirement for supplemental corrosion protection, and specific fabrication requirements as specified or in the Contract Documents. The components of pipe systems are to comply with **subsection 1904.2b**. The selected specification(s) is (are) denoted in the Contract Documents.

b. Material Specifications.

(1) Comply all corrugated steel pipe, arches, and accessory items with AASHTO M 36. Comply all steel sheet utilized to fabricate the pipe and arches with AASHTO M 218 when zinc coated, or AASHTO M 274 when aluminum alloy coated. The type of pipe, type and class of coating, and seam type will be specified in the Contract Documents. Do not interconnect components with differing coating types within a piping system.

(2) Comply all corrugated aluminum alloy pipe, arches, and accessory items with AASHTO M 196. The type of pipe and seam type will be specified in the Contract Documents. Do not interconnect metal aluminum alloy pipe with metal steel pipe or accessory items except as permitted through M 196.

(3) Repairs to the high frequency resistance welded (HFRW) seam in steel continuous welded helical corrugated metal pipe (CMP) are to be adherent to the following guidelines:

(a) For pipes with a nominal diameter of 24 inches or greater, the maximum allowable total length of manual weld repair for the helical weld seam in a section of steel CMP is ½-inch of weld per 1-inch of nominal pipe diameter per 20 feet (or fraction thereof) of pipe section length.

(b) For pipes with a nominal diameter of less than 24 inches, the maximum allowable total length of the manual weld repair referenced in (a) is 12 inches.

(c) For pipes with a nominal diameter of 24 inches or greater, the maximum allowable length of a single weld repair for the helical weld seam in a section of steel CMP is 1/4 -inch of weld per 1-inch of nominal pipe diameter, not to exceed 18 inches.

(d) For pipes with a nominal diameter of less than 24 inches, the maximum allowable length of the single weld repair referenced in (c) is 6 inches.

(e) Do not space repair welds closer than 1 helix length of welded seam. One helix length is the distance traversed by a point on the weld seam during 1 revolution of the pipe.

(f) Repair welds are not permitted within the re-roll areas at the ends of a steel CMP section.

(g) No visible discontinuities, e.g., hot or cold cracks, porosity, entrapped slag, voids, etc., are permitted within the total weld length, repair and coil splice welds included, of the finished section of steel CMP.

(h) The preferred weld repair method is, but not restricted to, gas metal arc welding (GMAW). Any method that utilizes a ferrous based filler metal compatible with the parent coil steel and provides an acceptable repair weld is adequate. Weld repair without the use of filler metal, such as by Gas Tungsten Arc Welding (GTAW), is also acceptable when practical.

(i) Minimize the number of plant coil splices within a section of steel CMP. This is subject to the judgment of the KDOT inspector and based on the steel CMP section size. In no instance is the number of coil splices to exceed 3 per steel CMP section.

(4) Produce end sections from the same metal and provide with the same coating as the pipe to which they are to be attached. Comply with the design and dimension requirements as stated in **subsection 1904.2a**. However, the thermal treatment, denoted by the temper designation for aluminum alloys, must not reduce the ductility of the metal to the degree that forming tears or cracks occur during production of the end section. A section of CMP that is an integral component of the end section is subject to **subsection 1904.2b**.

1904 - CORRUGATED METAL PIPE AND END SECTIONS

1904.3 TEST METHODS

Conduct all tests required by the applicable AASHTO, ASTM or other specification of **subsection 1904.2b** according to the procedures specified in that standard.

1904.4 PREQUALIFICATION

Not applicable.

1904.5 BASIS OF ACCEPTANCE

a. Receipt and approval of a Type A certification as specified in **DIVISION 2600** for all corrugated metal pipe (CMP) and the associated end sections and accessory items provided through this specification.

b. Inspection, and testing when applicable, by field personnel of CMP and end sections and accessory items for compliance with corrosion protection coating thickness requirements when applicable, mechanical or welded seam quality, and dimensional requirements.

c. The final disposition of CMP and end sections and accessory items will be completed at the final destination as the result of inspection for the quality of workmanship, the delivery condition, and receipt and approval of the associated required documentation. Corrugated metal pipe and end sections and accessory items may also require inspection during the production process at the fabrication facility.

1905 - STRUCTURAL PLATE FOR PIPE, PIPE ARCHES, AND ARCHES

SECTION 1905

STRUCTURAL PLATE FOR PIPE, PIPE ARCHES, AND ARCHES

1905.1 DESCRIPTION

This specification governs the steel and aluminum alloy structural plate and accessory items utilized in the construction of pipe, pipe arches, and arches.

1905.2 REQUIREMENTS

a. General. Provide pipe, pipe arches, arches, and accessory items that comply with the design, dimensions, alloy designation and thermal treatment, requirement for supplemental corrosion protection, and specific fabrication requirements as specified in the Contract Documents. Comply with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

Properly form the components required to construct these units to facilitate and expedite their assembly. When the end of an assembly is required by the Contract Documents to comply with the finished fill slope angle; precut the end components so the end of the assembled unit complies with this indicated angle.

b. Material Specifications.

(1) Provide compliant components and accessory items produced from steel metal for pipe, pipe arches, and arches with AASHTO M 167.

(2) Provide compliant components and accessory items produced from aluminum alloy metal for pipe, pipe arches, and arches with AASHTO M 219.

(3) Do not interconnect steel metal components and accessory items with aluminum alloy metal components and accessory items except as permitted through the specifications previously referenced.

1905.3 TEST METHODS

Conduct all tests required by the applicable AASHTO, ASTM or other specification of **subsection 1905.2b** according to the procedures specified in that standard.

1905.4 PREQUALIFICATION

Not applicable.

1905.5 BASIS OF ACCEPTANCE

a. Receipt and approval of a Type A certification as specified in **DIVISION 2600** for all steel and aluminum alloy components and accessory items utilized in the construction of pipe, pipe arches, and arches.

b. Inspection, and testing when applicable, by field personnel of the components and accessory items for compliance with corrosion protection coating thickness requirements when applicable, placement of fastener holes, uniformity of corrugations, dimensional requirements, and any other specification requirements considered pertinent to the construction of the final product.

c. The final disposition of all steel and aluminum alloy components and accessory items utilized in the construction of pipe, pipe arches, and arches will be completed at the final destination as the result of inspection for the quality of workmanship, the delivery condition, and receipt and approval of the associated required documentation. Inspection during the production process of components and accessory items at the manufacturing or fabrication facility may also be required.

**1906 - ASPHALT COATED CORRUGATED METAL PIPE,
PIPE ARCHES, COUPLING BANDS AND STRUCTURAL PLATE**

SECTION 1906

**ASPHALT COATED CORRUGATED METAL PIPE,
PIPE ARCHES, COUPLING BANDS AND STRUCTURAL PLATE**

1906.1 DESCRIPTION

This specification covers asphalt coated corrugated metal pipe, pipe arches, coupling bands and structural plate. The following four types of treatments are included:

- Type A. Fully Asphalt Coated
- Type B. Half Asphalt Coated with Paved Invert
- Type C. Fully Asphalt Coated with Paved Invert
- Type D. Fully Asphalt Coated and 100% Paved or Lined

1906.2 REQUIREMENTS

a. Provide "Type A" coated pipe unless otherwise specified in the Contract Documents.

b. Supply asphalt coated corrugated metal pipe, pipe arches, coupling bands and structural plate complying with AASHTO M 190 with the following revisions or additions:

- (1) Asphalt coat only corrugated metal pipe, pipe arches, coupling bands and structural plate that comply with the applicable **SECTIONS 1904** and **1905**.
- (2) Do not apply the Imperviousness Test in AASHTO M 190.

c. As an alternate, coat corrugated structural plate in accordance with AASHTO M 243.

1906.3 TEST METHODS

Test in accordance with the methods shown in AASHTO M 190 and/or M 243.

1906.4 PREQUALIFICATION

None Required

1906.5 BASIS OF ACCEPTANCE

Asphalt coated corrugated metal pipe, pipe arches, coupling bands and structural plates are accepted based on receipt and approval of a Type D certification as specified in **DIVISION 2600** and visual inspection for conditions and dimensional requirements.

**1907 - PLASTIC PIPE FOR UNDERDRAINS,
EDGE DRAINS, OUTLETS AND DRAIN TILE**

SECTION 1907

**PLASTIC PIPE FOR UNDERDRAINS,
EDGE DRAINS, OUTLETS AND DRAIN TILE**

1907.1 DESCRIPTION

This specification covers polyvinyl chloride (PVC) pipe for use in underdrain, pavement edge drain, and outlet installations. Polyethylene (PE) is also permitted for edge drains.

1907.2 REQUIREMENTS

a. Underdrain Pipe. Provide perforated polyethylene or polyvinyl chloride underdrain pipe and fittings in the diameter shown in the Contract Documents that complies with ASTM F 891 for polyvinyl chloride, except the minimum pipe stiffness required is 100 psi, at 5% deflection, for PVC pipe.

b. Edge Drain Pipe. Provide perforated edge drain pipe and fittings in the diameter shown in the Contract Documents that complies with AASHTO M 252 for polyethylene, except the minimum pipe stiffness required is 46 psi, at 5% deflection, or AASHTO M 278 for PVC pipe.

c. Outlet Pipe. Provide a smooth interior walled pipe in the diameter shown in the Contract Documents that complies with ASTM F 891 for polyvinyl chloride, except the minimum pipe stiffness required is 100 psi, at 5% deflection, for PVC pipe.

d. Drain Tile. Provide perforated polyethylene drain tile and fittings in the diameter shown in the Contract Documents that complies with AASHTO M 252 or M 294 for perforated polyethylene pipe.

1907.3 TEST METHODS

Test pipe supplied for this specification according to the procedures referenced and outlined in AASHTO M 252, AASHTO M 278, AASHTO M 294, and ASTM F 891.

1907.4 PREQUALIFICATION

None Required.

1907.5 BASIS OF ACCEPTANCE

Tubing for underdrains, edge drains, and outlets will be accepted based on receipt and approval of a Type D certification as specified in **DIVISION 2600** and visual inspection for conditions and dimensional requirements.

1908 - POLYETHYLENE (PE) PIPE

SECTION 1908

POLYETHYLENE (PE) PIPE

1908.1 DESCRIPTION

This specification covers polyethylene pipe for storm sewers and culverts.

1908.2 REQUIREMENTS

a. Polyethylene Pipe. Provide polyethylene (PE) pipe for storm sewers and culverts that complies with one of the following:

(1) AASHTO M 294 (Corrugated Pipe) with the following additions or exceptions:

- Type S, Type SP and Type D are acceptable. (Type C and Type CP will not be accepted.)
- Rotational Molded Pipe will not be accepted.

(2) ASTM F 894 (Ribbed, Profile) with the following additions or exceptions:

- AASHTO LRFD Bridge Design Specifications, SECTION 12, 50 year life requirements.
- Minimum Cell Class per ASTM D 3350 of 334433C or 335434C.
- Minimum section properties as noted in SECTION 12.

(3) ASTM F 714 (Smooth Wall) with the following additions or exceptions:

- A DR of 21 or less will be required.
- AASHTO LRFD Bridge Design Specification, SECTION 12, 50 year life requirements.
- Minimum Cell Class per ASTM D 3350 of 335434C.

(4) Soil tight joints are required (AASHTO LRFD Bridge Construction Specifications, SECTION 26).

- Maximum opening is 1 inch.
- For openings over 1/8-inch, exceed the channel length by four times the length of the opening. Channel length is the length of the path that the soil must infiltrate.
- The D_{85} soil size to size of opening ratio must be 0.3 for medium to fine sand and 0.2 for uniform sands. D_{85} is the sieve size that 85% of the backfill material is smaller than.

b. End Sections. Provide culvert end sections that comply with the sizes and dimensions in the Contract Documents. Fabricate end sections from materials that comply with these specifications. Corrugated metal or concrete end sections are also acceptable. Connect dissimilar materials using a soil-tight connection approved by the Engineer.

c. Deflection. Maximum deflection (reduction of the barrel base inside diameter) is 5%. Measurement will be made using a mandrel or other method as approved by the Engineer not less than 30 days following the installation. Deflections in excess of 5% may require the pipe to be removed and reinstalled, or replaced if permanently deformed or damaged in any way.

d. Provide the same product as prequalified under the AASHTO National Transportation Product Evaluation Program (NTPEP).

1908.3 TEST METHODS

Test materials in accordance with the AASHTO and ASTM standards cited in **subsection 1908.2**.

1908.4 PREQUALIFICATION

Supply samples for prequalification to the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test report to the Bureau Chief of Materials and Research for evaluation.

1908 - POLYETHYLENE (PE) PIPE

Manufacturers whose products comply with this specification will be placed on a prequalified list. Only provide products that have been prequalified. Manufacturers will remain on the list as long as the results of verification samples and performance in the field are satisfactory. Any changes in formulation will require re-submittal for prequalification testing.

1908.5 BASIS OF ACCEPTANCE

Prequalification as specified in **subsection 1908.4**.

Receipt and approval of a Type B certification as specified in **DIVISION 2600**.

Visual inspection for condition and dimensional requirements.

Successful testing with a mandrel as outlined in **subsection 1908.2d**.

1909 - POLYVINYL CHLORIDE (PVC) PIPE

SECTION 1909

POLYVINYL CHLORIDE (PVC) PIPE

1909.1 DESCRIPTION

This specification covers polyvinyl chloride pipe (PVC) for storm sewers and culverts.

1909.2 REQUIREMENTS

a. Polyvinyl Chloride Pipe. Provide polyvinyl chloride (PVC) for storm sewers and culverts that comply with one of the following:

(1) AASHTO M 304 (Profile Wall Pipe) with the following additions or exceptions:

- Seamless construction will be required; spiral wound pipe will not be allowed.
- ASTM D 1784, Cell Classifications of 12454B or 12454C are acceptable.
- ASTM D 1784, Cell Classification of 12364C will not be allowed.

(2) AASHTO M 278 (Class PS 46 Pipe), ASTM F 679 (PVC Large Diameter Sewer Pipe) with the following additions or exceptions:

- ASTM D 1784, Cell Classifications of 12454B or 12454C are acceptable.
- ASTM D 1784, Cell Classification of 12364C will not be allowed.
- ASTM F 679 Wall Thickness of T-1.

(3) Soil tight joints are required (AASHTO LRFD Bridge Construction Specifications, SECTION 26).

- Maximum opening is 1 inch.
- For openings over 1/8-inch, exceed the channel length by four times the length of the opening. Channel length is the length of the path that the soil must infiltrate.
- The D_{85} soil size to size of opening ratio must be 0.3 for medium to fine sand and 0.2 for uniform sands. D_{85} is the sieve size that 85% of the backfill material is smaller than.

b. End Sections. Provide culvert end sections that comply with the sizes and dimensions in the Contract Documents. Fabricate end sections from materials that comply with these specifications. Corrugated metal or concrete end sections are also acceptable. Connect dissimilar materials using a soil tight connection approved by the Engineer.

c. Deflections. Maximum deflection (reduction of the barrel base inside diameter) is 5%. Measurement will be made using a mandrel or other method as approved by the Engineer not less than 30 days following the installation. Deflections in excess of 5% may require the pipe to be removed and reinstalled, or replaced if permanently deformed or damaged in any way.

1909.3 TEST METHODS

Test materials in accordance with the AASHTO and ASTM standards cited in **subsection 1909.2**.

1909.4 PREQUALIFICATION

None required.

1909.5 BASIS OF ACCEPTANCE

Receipt and approval of a Type B certification as specified in **DIVISION 2600**.

Visual inspection for condition and dimensional requirements.

Successful testing with a mandrel as outlined in **subsection 1909.2d**.