**PRESTRESSED CONCRETE CYLINDER PIPE**

**PART 1 GENERAL**

1.01 SCOPE OF WORK

A. Contractor shall furnish all labor, materials, tools, equipment, and incidentals necessary to install, ready for operation, all prestressed concrete cylinder pipe including fittings, rubber gaskets, mortar for joints of all pipe as shown on the drawings and as specified herein. The work shall include the testing of materials, pipe and pipelines.

 1.02 RELATED WORK

 A. Trenching, Backfilling, and Compaction are included in ODOT C&MS 638.

 1.03 SUBMITTALS

A. Submit shop drawings to the Engineer for review, showing details of reinforcement, concrete, and joint dimensions for all pipe and fittings. Submit a tabulated laying schedule which references stationing and elevations as shown on the drawings as well as all fittings, bevels, restrained joints, and specials, along with the manufacturer’s drawings indicating details of all items. The laying schedule shall show code numbers for all pipe, fittings, and specials. These code numbers shall correspond to markings on the pipe, fitting, or special. The above shall be submitted to the Engineer for review before manufacture and shipment. The locations of all pipes shall conform to the locations indicated on the drawings. Pipe supplied from inventory shall be authorized by the Engineer.

 B. Submit anticipated production and delivery schedule.

 C. Design Data:

1. Design specification data sheets listing all parameters used in the pipe design.

 a. Type of Pipe

 1) Lined Cylinder (L-301)

 2) Embedded Cylinder (E-301)

 b. Cylinder Data

 1) Thickness and Diameter

 c. Prestressing Wire Data

 1) ASTM Designation and Class

 2) Size

 3) Area

 4) Wire spacing

 5) Minimum ultimate strength

 6) Wrapping stress

 d. Concrete/Mortar Data

 1) Concrete proportions

 2) Minimum Compressive Strength at Time of Wrapping

 3) Minimum Compressive Strength at 28 days

 4) Core thickness

 5) Coating thickness

2. Submit design calculations in accordance with AWWA C304. Clearly indicate all calculation constants for this specific project.

 D. Test Reports

 1. Shop test results for steel, cement, and gasket rubber

 2. Field pressure/leakage tests

 E. Certificates

 1. Prior to shipment of pipe, submit a certified affidavit of compliance stating that the pipe for this contract was manufactured, inspected, and tested in accordance with the AWWA standards specified herein.

 1.04 REFERENCE STANDARDS

A. The AWWA Standard for Prestressed Concrete Pressure Pipe, Steel ­Cylinder Type (AWWA C301, latest revision) is made a part of these Specifications. Documents referenced in AWWA C301, Section 2 form a part of this specification to the extent specified herein.

B. Other standards applicable to the work specified herein are, but not limited to, the following:

1. AWWA C301 – Prestressed Concrete Cylinder Pipe, Steel-Cylinder Type

 2. AWWA C304 - Design of Prestressed Concrete Cylinder Pipe

3. AWWA C651 - Disinfecting of Water Mains

4. AWWA Manual M9 - Concrete Pressure Pipe

 C. American Society for Testing and Materials (ASTM)

1. ASTM A648 - Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Pipe

 2. ASTM C33 - Standard Specification for Concrete Aggregates

 3. ASTM C150 - Standard Specification for Portland Cement

 4. ASTM A1011 – Standard Specification for Steel, Sheets and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

 5. ASTM A659 - Standard Specification for Steel, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality

 6. ASTM A1018 – Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability

 D. American Association of State Highway and Transportation Officials (AASHTO)

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

 1.05 QUALITY ASSURANCE

 A. Qualification

1. The materials specified herein are intended to be standard types of prestressed concrete cylinder pipe and fittings for use in transporting water.

2. All prestressed concrete cylinder pipe and fittings shall be furnished by reputable manufacturers with a minimum of ten years of experience in manufacturing prestressed concrete cylinder pipe. The manufacturing plant shall have a current Lloyd’s Register Audit Certification for the manufacture of Prestressed Concrete Cylinder Pipe. Additionally, the pipe manufacturer shall be a member of the American Concrete Pressure Pipe Association. The pipe and fittings shall be manufactured and installed in accordance with industry standards and methods and shall comply in all respects with requirements of these specifications and with the latest edition of all referenced standards and specifications.

B. Inspection of the pipe and fittings will be made by the Engineer upon delivery at the site. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements. Pipe rejected after delivery shall be marked for identification and shall be repaired or removed from the job at once unless otherwise approved by the Engineer.

#  PART 2 PRODUCTS

2.01 MATERIALS

 A. Unless otherwise specified, the design materials and workmanship for pipe shall conform to the requirements of AWWA C301. Core and coating thickness for pipe shall be as specified in AWWA C301.

 B. Design Conditions

1. Pipe shall be designed in accordance with the AWWA C304 Standard, using the following design conditions; these conditions shall also be used in designing fittings that include a Portland cement mortar interior and exterior coating of the steel cylinder:

a. External Loading

 1) The earth load shall be taken as the greater of the following:

a) Depth from existing ground level to top of pipe as shown on plans, or

 b) Five feet minimum in all cases.

2) Earth loads shall be computed using the following parameters:

 a) Unit Soil Weight = 120 pounds per cubic foot

 b) TYPE R3 Bedding

 c) Bedding angle = 60°

 3) Live loads shall be calculated as:

a) Pipe in streets and other paved areas: AASHTO HS-20 for two trucks passing

b) Pipe within railroad right-of-way: AREA Cooper E-80

c) Both HS-20 and E-80 live loads shall be computed in accordance with the *American Concrete Pipe Association* "Concrete Pipe Design Manual" or "Concrete Pipe Handbook".

 b. Internal Pressure

 1) Design working pressure (Pw) shall be 120 psi

 2) Surge Pressure (Pt) shall be \_\_35\_ psi.

 3) Field Test Pressure (Pft) shall be 250 psi.

 C. Fittings

1. Steel thickness of all fittings shall be designed in accordance with Chapter 8 of the AWWA M9 Manual. Fittings shall be designed for the same conditions as the adjacent pipe.

2. Fabrication of the fittings shall be as per AWWA M9 Manual and C301.

3. Interior and exterior concrete/mortar coating shall be as per AWWA C301.

D. The date of manufacture or a serial number traceable to the date of manufacture and the design strength classification shall be clearly marked by stencil with waterproof paint at the end of the pipe barrel. Unsatisfactory or damaged pipe will be permanently rejected, repaired in the field if permitted by the Engineer and the pipe manufacturer, or returned to the pipe plant for repairs. Pits, blisters, rough spots, minor concrete or mortar breakage, and other imperfections may be repaired unless prohibited by the Engineer. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 3,000 psi at the end of 7 days and 4,500 psi at the end of 28 days, when tested in cylinders stored in the standard manner. Major breakage or spalling from interior of pipe may be reason for the rejection of pipe. Pipe may be repaired under unloaded conditions (removal of prestressing wire). Cement mortar used for repair shall have a minimum compressive strength of 3,000 psi at 7 days and 4,500 psi at 28 days when tested as standard cylinders. New prestressing wire may be applied when the compressive strength as determined by cylinder testing equals or exceeds the strength required for prestressing as stated in AWWA C301.

 E. Cement shall be Type II and shall be in accordance with ASTM C150.

F. The pipe core shall be produced by the centrifugal method or the vertical casting method.

G. Wire shall be a minimum of No.6 gauge and shall meet the requirements of ASTM A648, Class III. Wire of a class strength greater than Class III will not be permitted.

 H. Steel cylinders shall be No. 16 gauge minimum thickness and shall be hot rolled.

I. Mortar coating shall consist of one part cement to a maximum of three parts fine aggregate by weight.

J. Bell and spigot joint rings shall be steel, self-centering type, and otherwise specified in AWWA C301. Surfaces of the joint rings that will be exposed after fabrication is complete shall receive a zinc metalized coating of 4 mils thickness (0.004”). In areas of the alignment where the pipe will be subject to unbalanced hydrostatic thrust forces (bends, tees, bulkheads, wyes, and valves), the pipe joints shall be restrained (harnessed) by field welding joints or by mechanically restrained joints.

Lengths of restrained joint pipe shall be determined using the computational method as contained in Chapter 9 of the AWWA M9 Manual for Concrete Pressure Pipe. The steel cylinder thickness in pipe sections between the location of the maximum thrust force and the end of the harnessed section can be prorated on the basis of zero longitudinal thrust at the end of the harnessed section.

Two acceptable types of mechanically harnessed or restrained joints are the harness clamp and Snap Ring® types of flexible restrained joints. The clamp type consists of two semicircular steel clamps which fit over steel lugs that are factory welded or rolled into the steel bell and spigot sections. The semicircular clamps are drawn together by bolts at the springline on both sides of the pipe to form a flexible restrained joint.

The Snap Ring® type of flexible restrained joint consists of a split steel ring which is recessed in the special steel bell section of the pipe until the joint is made. Once the joint is made, the split steel ring is drawn down into position to form a lock between the bell and spigot by tightening a single steel bolt.

Both joint types shall be capable of transmitting the longitudinal thrust forces due to working pressure and test pressure and must be encased in grout after the joint has been completed and before the line is pressurized using special grout bands supplied by the pipe manufacturer.

Field welding of the joints for thrust restraint during initial installation can be done from inside the pipe or outside the pipe as permitted by the pipe manufacturer and applicable safety regulations.

K. The rubber gaskets shall be in accordance with AWWA C301 and shall be designed and manufactured so that the completed joint will withstand an internal water pressure in excess of the highest pressure to which the pipe will be subjected without showing any leakage by the gasket or displacement of it.

L. Bell and spigot wall fittings shall be the manufacturer's standard design. Wall fittings shall be supplied with adequate bracing to keep them round and true during transportation and installation.

M. Alignment for long-radius, curved sections as specified on the drawings may be produced by joint deflections of joints not to exceed that recommended by the manufacturer. Required deflections which are in excess of those recommendations shall be produced by beveling the spigot end of the pipe.

N. Exterior Barrier Coating for Above-Ground Pipe Installations:

1. The mortar coating of pipe and exterior mortar coating of fittings shall be painted with two coats of a white epoxy paint. The epoxy can be applied by brush, roller, or spray system using equipment recommended by the manufacturer of the epoxy. The surfaces to be painted shall be clean and dry. The temperature shall be in accordance with the paint supplier’s recommendations. During application and curing, the temperature will be maintained per the paint supplier’s recommendation. Mortar coating surfaces need not be sandblasted.
2. Steel surfaces to be painted should be sandblasted, solvent cleaned, or wire brushed. Time between coats shall be as recommended by the manufacturer of the epoxy and the total dry film thickness shall be a minimum of 16 mils. Vertical surfaces at the exterior bell and spigot shoulders do not require painting if the exterior joint space will be grouted in the field and the same white epoxy paint applied over the cured grout. When the exterior joint space will not be grouted in the field, the pipe supplier shall paint the vertical concrete or mortar surfaces of the outside of the pipe and those portions of the steel joint rings which are outside the gasket seal. The total dry film thickness of the paint on the sealing surfaces of the steel joint rings should not exceed 8 mils.

#  PART 3 EXECUTION

 3.01 GENERAL

A. Care shall be taken during loading, transporting, and unloading to prevent injury to the pipes, fittings, or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when laid, shall confirm to the lines and grades shown on the drawings.

B. If any damaged pipe is discovered after it has been laid, it shall be repaired in a satisfactory manner if permitted by the pipe manufacturer and the Engineer or it shall be removed and replaced with a sound pipe.

C. Regulate and control equipment and construction operations such that the live loading on the pipe does not exceed the loads for which the pipe is designed and manufactured. Pipe found to have longitudinal cracks from construction equipment or other loading exceeding those allowed by AWWA C304 shall be removed from the line and replaced with sound pipe and closures as required.

D. The method of jointing the pipe shall be in strict accordance with the manufacturer’s instructions. Arrange for the manufacturer’s representative to provide installation training for the Contractor’s crew prior to the start of pipe installation. The manufacturer’s representative shall be on the jobsite and witness installation on the first day.

 E. Pipe Manufacturer’s Field Service Representative:

 1. Pipe manufacturer shall provide a qualified Field Service Representative, who shall be available to be on the project site, with proper notice, from the Contractor’s, Engineer’s, or Owner’s representative.

 2. The Field Service Representative, who shall be an employee of the pipe manufacturer, must have experience as a representative of the pipe manufacturer in the area of providing such services.

 3. It is the intent of the Owner to be assured that the installation of this pipeline is performed in accordance with the specified standards and manufacturer’s recommendations. Good installation procedures will assure integrity of the pipeline with the minimum amount of pipe joints required for completion of the main. Therefore, the Contractor shall include in his Bid as a minimum that the pipe manufacturer’s Field Service Representative will be on-site for the following periods:

 a) Initial construction training and monitoring.

 b) Provide problem-solving assistance during construction.

 3.02 INSTALLING PRESTRESSED CONCRETE CYLINDER PIPE AND FITTINGS

A. Prestressed concrete cylinder pipe and fittings shall be installed in accordance with requirements of AWWA M9, except as otherwise provided herein. A firm, even bearing throughout the length of the pipe shall be provided by tamping select fill in the haunch area and at the side of the pipe to achieve the required bedding support angle. BLOCKING WILL NOT BE PERMITTED.

B. All prestressed concrete cylinder pipe shall have a minimum of three and one-half feet of cover. Pipe shall be laid to the elevations shown on the drawings unless approved otherwise by the Engineer. Small construction equipment (pick-up trucks, track hoes, front-end loaders, small tracked tractors, etc.) shall not be operated over newly-installed pipe until at least three (3) feet of earth cover has been placed over the top of the pipe.

C. The pipe interior shall be maintained dry and broom clean throughout the construction period.

D. Gasket, gasket groove, and bell sealing surfaces shall be cleaned and lubricated with a lubricant furnished by the pipe manufacturer. The lubricant shall be approved for use in potable water and shall be harmless to the rubber gasket. Use only lubricant supplied by the pipe manufacturer. Pipe shall be laid with bell ends looking ahead in the direction of laying. As soon as the spigot ring is centered in the bell of the previously laid pipe, it shall be forced home with approved equipment. After the gasket is compressed, verify the position of the gasket in the spigot ring groove with a feeler gage provided by the pipe manufacturer.

E. The grout diaper for PCCP shall consist of a Typar synthetic fabric layer (gray in color) and a layer of closed cell foam. These layers are sewn together along with a pair of 5/8” wide steel bands at each edge which are used to secure the diaper to the pipe exterior. Use only grout diapers supplied by the pipe manufacturer. A stretching tool is used to tighten the steel bands. Once the bands are pulled tight, a steel clip is crimped around the bands to hold them in position. It is important that the diaper be carefully placed against the exterior surface of the pipe to insure that it is flush with no gaps or gathers. The closed cell foam surface is to be placed against the pipe exterior.

 The wet grout will flow down to the bottom of the diaper and begin to bulge it out. It is often helpful to place some bedding material (or sandbags) directly under the diaper at the bottom to support the weight of the wet grout. Take care to not push excessive amounts of bedding material under the diaper such that the diaper is pushed up into the joint recess impeding the flow of wet grout.

Mix the grout using one part ASTM C150 Type 1 or Type 2 Portland cement to not more than three parts clean sand with sufficient water to achieve a pourable consistency. The grout should look and pour like a thick cream. Carefully pour the mixed grout into the gap at the top of the diaper. As the pouring proceeds, the workers must inspect the diaper around the joint periphery to insure that the grout is flowing all around. Once the diaper is full and wet grout is puddling at the gap at the top, apply a stiffer mix the consistency of wet brick mortar over the joint insuring that all steel components of the joint are covered.

F. All pipe shall be sound and clean before laying. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means to prevent unauthorized entrance of people, animals, dirt, or water into the pipeline already installed. Good alignment shall be preserved in laying. The deflections at joints shall not exceed the amount recommended by the pipe manufacturer.

 3.03 TESTING

A. The completed pipeline (or completed sections of the pipeline) shall be bulkheaded, filled with water, and pressure tested to the stipulated field test pressure. After the line is filled, and prior to pressure testing, it shall be allowed to soak under low pressure to allow the pipe walls to absorb water and for temperature stabilization. While filling the line, the contractor shall be responsible for properly bleeding off trapped air to avoid adversely affecting the leakage test results.

During the hydrostatic test, the contractor shall use a calibrated meter or other device to accurately measure the quantity of water necessary to maintain the test pressure on the gauge. The line will not be accepted until this measured quantity is less than 10 gallons per inch of diameter per mile of pipe per 24 hours. All visible leaks must be repaired regardless of the measured leakage.

 3.04 CLEANING

A. At the conclusion of the work, thoroughly clean all of the new pipelines by flushing with water or other means to remove all dirt, stones or other debris which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

END OF SECTION