

**SPECIFICATIONS - DETAILED PROVISIONS**  
**Section 15054 - Reinforced Concrete Pipe with PVC Lining**

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**SECTION 15054**  
**REINFORCED CONCRETE PIPE WITH PVC LINING**

**PART 1 - GENERAL**

These Specifications apply to reinforced concrete pipe intended to be used for the construction of storm drains, sewers, and related structures.

The size, type, and D-load of the concrete pipe to be furnished shall be as shown on the Plans, or as specified under the item of work for the project.

Unless otherwise specified, pipe shall be either cast or spun.

Cast reinforced concrete pipe shall be manufactured by placing the concrete into stationary, vertical, cylindrical metal form.

Spun reinforced concrete pipe shall be manufactured by introducing the concrete into a rotating, horizontal, cylindrical metal form.

The interior surface of the pipe shall be smooth and well-finished. Joints shall be of such type and design and so constructed as to be adequate for the purpose intended so that, when laid, the pipe will form a continuous conduit with a smooth and uniform interior surface.

Sockets and spigots shall be free from any deleterious substance or condition which might prevent a satisfactory mortar bond at the joints.

If the Engineer determines that the forms, end rings or form gaskets used in the manufacture of the pipe are inadequate for the purpose intended, the Contractor shall replace or repair said equipment to the satisfaction of the Engineer.

Pipe stronger than that specified may be furnished at the Contractor's option, and at its expense, provided such pipe conforms in all other respects to the applicable provisions of these Specifications.

The Contractor shall furnish, install and maintain stulls or other devices in the pipe as may be necessary to meet the limitation on cracks as specified herein, throughout pipe handling, transportation, and field installation.

## **PART 2 - PRODUCTS**

### 2.01 MATERIALS

Except when otherwise permitted by the Engineer, no materials shall be used in manufacturing of the pipe other than water, portland cement, mineral aggregates and steel conforming to ASTM C 76.

The aggregates shall be so graded, proportioned, and thoroughly mixed in a batch mixer to produce a homogeneous concrete mixture of such quality that the pipe will conform to the test and design requirements of these Specifications. The proportion of portland cement shall be not less than 560 pounds per cubic yard of concrete.

### 2.02 LENGTH

The nominal length shall be not less than 8 feet except as otherwise specified or required for bends or special joints.

Variations in laying lengths of two opposite sides of pipe shall be not more than 1/8 inch per foot of diameter with a maximum of 5/8 inch in any length of pipe.

### 2.03 REINFORCEMENT

- A. General. The reinforcement shall be a cage fabricated of bars or wire. Transverse reinforcement shall be in the amount and type required to sustain the specified test loads. Longitudinal reinforcement shall be sufficient to make the cage rigid and to support the transverse reinforcement firmly in place in the forms during placing and consolidation of the concrete.

Fastenings (supports), approved by the Engineer, shall be used for holding the cage rigidly in place in the form in its circular shape. In cast pipe these fastenings shall be spaced not closer than 2 feet center-to-center along the length of the longitudinal reinforcement.

All reinforcing steel shall be clean and free from loose rust, scale, paint, grease, form oil, or other foreign matter.

Splices shall be butt-welded, or lap-welded a minimum of 6 diameters. Nonwelded splices shall be lapped a minimum of 20 diameters for deformed bars and 40 diameters for plain bars or cold-drawn wire. Nonwelded lapped splices shall be wired tightly. Welds shall develop not less than 75 percent of the minimum specified ultimate strength of the bars or wires being welded.

The Contractor shall furnish data to the Engineer indicating the lot number, wall thickness, and the size, spacing and positioning of reinforcement for any pipe manufactured.

- B. Location of Reinforcement. Measurements of position, except for concrete cover, shall apply to the center of the bar or wire.

The required minimum cover measured between reinforcement surface and pipe surface, and the permitted cover tolerances for 48" pipe are as follows:

Transverse Reinforcement:	3/4" - 1/4", +3/8"
Longitudinal Reinforcement:	1/2" minimum

For lined pipe, the cover shall be increased as necessary to ensure that the distance from any reinforcement to embedded lugs or locking extensions of the liner is at least 1/4 inch.

- C. Placement of Reinforcement. The transverse reinforcement shall be placed in the body of the pipe in such a manner that the longitudinal reinforcement of the cage will hold the last hoop or coil 1 inch from the end plate or rings. Both ends of the transverse reinforcement shall be finished off with a complete hoop of reinforcement. For cast pipe, the longitudinal reinforcement shall have a minimum cover of 1 inch from the end faces of the pipe.

Transverse reinforcement shall be included in the tongue or groove projection only when the reinforcement has been specifically designed to reinforce the tongue or groove projection.

- D. Joints. Joints shall be designed so as to be self-centering. Unless otherwise specified, joints in concrete pipe shall be of the rubber-gasketed type. Joint details shall be submitted to the Engineer for approval before commencing pipe manufacture.

If required by the Engineer, the pipe shall be "match-marked" to meet specified laying tolerances at the place of manufacture and laying diagrams shall be furnished to the Contractor.

## 2.04 GENERAL MANUFACTURING REQUIREMENTS

- A. Cast Pipe. During the placing of each batch, the concrete shall be vibrated continuously with internal or external mechanical vibrators operating at a minimum rate of 6,500 vibrations per minute.

- B. Spun Pipe. After the concrete materials have been mixed, they shall be promptly placed in the forms and spun on a horizontal axis. If, for any reason, the work of filling the forms is interrupted long enough for the concrete to take its initial set, any partly filled form shall be emptied and the concrete rejected. While the concrete is being placed in the forms, they shall be revolved on a horizontal axis at a speed that will ensure as uniform a distribution of the fine and coarse aggregate as possible. After all the concrete has been placed in the forms, the forms shall be revolved at the proper speed for sufficient length of time to secure as dense a concrete as possible, and the interior surface shall be made smooth. Water and laitance collecting on the surface of the pipe shall be troweled and finished to the form of a true cylinder.

## 2.05 CURING

- A. Steam Curing Facilities. The manufacturer shall provide adequate enclosures, steam plant, piping, and other facilities for curing pipe. The enclosures shall be such that the temperature and humidity can be controlled to keep the pipe surfaces moist at all times and the temperature maintained continuously between 80°F and 170°F. Bulkhead curing is permissible, but will only be given credit for a maximum of 12 hours of the steam cycle.
- B. Curing Procedures
1. General. Cast and spun pipe shall be cured by steam or water, or a combination of both, as described in the following paragraphs:
  2. Steam Curing. Steam may be applied as soon as the pipe is enclosed but not later than 10 hours after completion of concrete placement. The temperature within the enclosure shall not be raised above 100°F by the use of steam for the first hour; thereafter the temperature shall not be increased at a rate greater than 40°F per hour. The temperature shall be maintained continuously between 80°F and 170°F for 28 hours.  
  
Six hours of steam (at least 5 hours at 80°F or higher) is required before forms may be removed. The period necessary to remove the forms may be included in the 28 hours, as long as it does not exceed 4 hours. Any time more than 4 hours shall be added to the total steam cycle. The time lapse during form removal shall not exceed 1 working day.
  3. Combination Curing. At any time after 6 hours of the steam cycle, the steam may be stopped and the cure continued, using water applied in such a manner that the outside surface of the pipe is kept continuously moist. Water may be substituted for steam on a basis of 4 hours of water being equal to 1 hour of steam. The manufacturer shall notify the Engineer prior to using water in lieu of steam.

4. Water Curing. Pipe may be water cured by any method that will keep the outside surface continuously moist for 4 consecutive days. Pipe to be given a total water cure may not be stripped from the forms until 20 hours after concrete placement or until the concrete has reached a compressive strength of 1,500 psi, whichever occurs first.
5. Alternate Curing Based on Compressive Strength. Pipe cured by any of the above methods may have the water or steam stopped when the concrete strength reaches 3,000 psi. The strength shall be determined in accordance with ASTM C 31 and C 39.
6. Alternate Curing Procedures. The manufacturer may request approval of alternate methods of curing that differ from the procedures specified above. The alternative method shall be specified in writing to the Engineer and fully substantiated by test data.

#### 2.06 CAUSES FOR REJECTION

Inspection of pipe by the District will be made at the place of manufacture, and may be rejected for any of the following reasons:

- A. A piece of any size broken out of the pipe.
- B. Defects that indicate imperfect mixing or molding.
- C. Any crack extending entirely through the wall of the pipe and having a longitudinal or transverse length greater than the wall thickness of the pipe.
- D. Any shattering or flaking of concrete at a crack.
- E. A deficiency greater than  $\frac{1}{4}$  inch from the specified wall thickness of pipe 30 inches or smaller in diameter, or a deficiency greater than 6 percent from the specified wall thickness of pipe larger than 30 inches in internal diameter, except that the deficiency may be 8 percent adjacent to the longitudinal form joint, provided that the additional deficiency does not lie closer than 20 percent of the internal diameter to the vertical axis of the pipe and does not extend along the circumference for a distance greater than 20 percent of the internal diameter of the pipe.

The deficiencies in wall thickness permitted herein do not apply to gasket contact surfaces in gasketed joint pipe. Dimensions and tolerances of such contact surfaces shall be submitted for approval.

- F. A variation from a true circle of the specified diameter by more than 1 percent.

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- G. Rock pockets and water pockets in any pipe.
- H. Exposure of any reinforcement arising from misplacement thereof.
- I. Surface defects indicating honeycomb or open-texture.
- J. Separations or "blisters".
- K. For sewer pipe, any crack showing two visible lines or separation for continuous length of 2 feet or more, or an interrupted length of 3 feet or more anywhere in evidence, both inside and outside, except where such cracks occur during the external loading test specified herein.
- L. Any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of depth or position in the wall of the pipe.
- M. The pipe fails the strength test.

The imperfections and variations as causes for rejection in sewer pipe, as specified herein, shall apply to pipe for which design details are indicated on the Plans as well as for pipe which is specified by D-load.

Pipe shall be considered ready for transporting to the project site when it conforms to the specified requirements for curing, testing and inspection.

2.07 BASIS FOR ACCEPTANCE

- A. General. The basis for acceptance shall be by one of the following, as designated in the Specifications:
  - 1. The D-load bearing strength test, compliance with these Specifications, inspection of the pipe manufacture, and inspection of the completed pipe.
  - 2. The structural design details, materials, tests, inspection of the pipe manufacture, and inspection of the completed pipe.
  - 3. Acceptance of certification of compliance with these Specifications.
- B. Acceptance of Stockpiled Pipe. Pipe may be used from stockpiles only when approved in advance by the Engineer, and provided the pipe meets all other requirements for pipe with the exception of inspection of manufacture.

For the purpose of these Specifications, "stockpiled" pipe shall be defined as pipe manufactured in quantity which will meet requirements of this section, but which was

not manufactured for use in specific projects. However, pipe which has been rejected by another agency will not be considered as "stockpiled" pipe, nor will such pipe be accepted.

## 2.08 MARKING

The date of manufacture, size and D-load, lot number, manufacturer's identification mark, and where elliptical reinforcement is used, a 4-inch (100mm) high "T" marking the location of the minor axis of the reinforcement shall be legibly painted or stamped on the inside of each pipe.

Sections of pipe to be inspected shall be so situated at the manufacturer's plant as to provide the Engineer with free accessibility for inspection and marking. In no case shall the pipe be stacked to a height that would require the Engineer to climb or use a ladder to properly inspect the pipe.

At the place of manufacture, the Engineer will indicate acceptance of the pipe for delivery to the Work by marking the pipe with the Agency's stamp. Such acceptance, however, shall be considered a tentative acceptance. Final acceptance will be made only when the project has been completed.

If pipe is rejected subsequent to its manufacture, the mark placed thereon by the Engineer shall be defaced.

## 2.09 LINED REINFORCED CONCRETE PIPE

- A. General. These specifications apply to pipe manufactured with a plastic lining. The plastic lining material shall comply with Section 2.10.

Such pipe shall conform to the applicable provisions governing reinforced concrete pipe set forth in Section 15054 except that the causes for rejection shall be as listed herein, and repair of pipe will be permitted only within the limits set forth under these causes for rejection and by the methods provided in this subsection.

All such pipe shall be manufactured with Type II cement unless another type is specified. All cement shall contain not more than 0.6 percent by weight of alkalis calculated as  $\text{Na}_2\text{O}$  plus  $0.658 \text{ K}_2\text{O}$ .

Chairs or spacers between the reinforcement and forms or base rings shall be stainless steel or a nonferrous material approved by the Engineer, and in no case shall any chair or spacer come in contact with liner plate.

- B. Causes for Rejection. Lined pipe may be rejected for any of the following reasons:

1. Exposure of any wires, positioning spacers or chairs used to hold the reinforcement cage in position, or steel reinforcement in any surface of the pipe, except for holding rods in end projections.

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2. Transverse reinforcing steel found to be in excess of 1/4 inch out of specified position after the pipe is molded.
3. Any shattering or flaking of concrete at a crack.
4. Air bubble voids (bugholes) on the interior and exterior surfaces of the pipe exceeding 1/4 inch in depth unless pointed with mortar or other approved material.
5. Unauthorized application of any wash coat of cement or grout.
6. A deficiency greater than 1/4 inch from the specified wall thickness of pipe 30 inches or smaller in internal diameter, except that the deficiency may be 8 percent adjacent to the longitudinal form joint, provided that the additional deficiency does not lie closer than 20 percent of the internal diameter to the vertical axis of the pipe and does not extend along the circumference for a greater than 20 percent of the internal diameter of the pipe. The deficiencies in wall thickness permitted herein do not apply to gasket contact surfaces in gasketed joint pipe. Dimensions and tolerances of such contact surfaces shall be submitted for approval.
7. A variation from the specified internal diameter in excess of 1 percent, or interior surfaces which have been reworked after placing of the concrete. The variation in internal diameter permitted herein does not apply to gasket contact surface in gasketed joint pipe. Tolerances at such contact surfaces shall be submitted for approval.
8. A water pocket (identified by tapping the internal surface of the pipe) which is greater than 30 inches in length or wider than three times the specified wall thickness.
9. A piece broken from the end projections of the pipe which has circumferential length exceeding 60 degrees of the circle, or extends into the body of the pipe, or extends into the gasket contact surfaces of gasketed joint pipe for a circumferential length in excess of 6 inches (measured at the midpoint of the gasket contact surface on the bell end, and at the inner shoulder of the gasket groove at the spigot end). If two or more pieces are broken from an end projection, the total length of such broken pieces on any end shall not exceed 90 degrees of the circle; and there shall be a distance of at least 9 inches of sound concrete between breaks. The total length of broken pieces that extends into the gasket contact surfaces of gasketed joint pipe shall not exceed a circumferential length of 6 inches.

If less than 9 inches of sound concrete exists between two individual breaks, the two breaks shall be considered as one continuous break.

10. Defects that indicate imperfect molding of concrete; or any surface defect indicating honeycomb or open-texture (rock pockets) greater in size than an area equal to a square with a side dimension of two and one-half times the wall thickness or deeper than two times the maximum graded aggregate size; or a local deficiency of cement resulting in loosely bonded concrete, the area of which exceeds in size the limits of area described in (h) and (i) above when the defective concrete is removed.
11. Any of the following cracks:
  - a) A crack having a width of 0.01 inch or more throughout a continuous length of 1 foot or more.
  - b) Any crack extending through the wall of the pipe and having a length in excess of the wall thickness.
  - c) Any crack showing two visible lines of separation for a continuous length of 2 feet or more, or an interrupted length of 3 feet or more anywhere in evidence, both inside and outside.

When required by the Engineer, any crack which is 0.01 inch wide or wider and is not a cause for rejection, shall be filled with neat cement grout composed of cement mixed with water to a fluid consistency.

#### 2.10 PVC SHEET LINER FOR REINFORCED CONCRETE PIPE

PVC sheet liner shall be Ameron T-lock or approved equal. The manufacturer of the lining shall furnish to the District an affidavit attesting to the successful use of its material as a lining for sewer pipes for a minimum period of 10 years in sewage conditions recognized as corrosive or otherwise detrimental to concrete. All work for and in connection with the installation of the lining in concrete pipe, and the field sealing and welding of joints, shall be done in strict conformity with all applicable specifications, instructions and recommendations of the lining manufacturer. All welding must be done by individuals who have certification by manufacturers of each individual that will be performing the work.

**END OF SECTION 15054**

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