REGIONAL CONSTRUCTION STANDARDS

SIXTH EDITION

Publication Update 6.1

(Full Committee Approved Proposed Revision 6.1 –
Ductile Iron Pipe Protections - Section 200
As Publication Update 6.1)

March 27, 2018

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7. ASTM A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

8. AWWA C105 –Polyethylene Encasement **and V-Bio Enhanced Polyethylene Encasement** for Ductile-Iron Pipe Systems

9. Coatings shall be provided on the exterior of all pipe, joints and fittings as required by AWWA/ANSI C110/A21.10, C111/A21.11, C115/A21.15, C116/A21.16, C151/A21.51, or C153/A21.53 as applicable. All pipes, joints, and fittings shall be examined after laying to determine if the coating was damaged during installation. Any damaged areas shall be coated with **an Owner-approved coating in accordance with the manufacturer's recommendations** ~~a minimum of 2 mils of an approved bituminous coating.~~**. If required in the Contract Documents, the exterior of the pipe shall be coated with a layer of arc-sprayed zinc in accordance with ISO 8179. The mass of zinc applied shall be 200 g/m^2 of pipe surface area. A finishing layer topcoat shall be applied to the zinc. The mean dry film thickness of the finishing layer shall not be less than 3 mils with a local minimum not less than 2 mils. The zinc coating system shall conform to ISO 8179-1 "Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer (Second Edition 2004-06-01)**

10. Pipe diameters 12-inches and smaller shall be gaged and delivered round and true throughout its entire length. Pipe diameters over 12-inches shall have one piece of gaged pipe delivered for each fitting and at connections to existing pipelines. Gaged pieces shall be marked on the pipe with markings indicated in the shop drawings.

11. Corrosion Resistant Linings

~~a. All ductile iron pipe and fittings shall be seal coated in accordance with ANSI/AWWA C104/A21.4.~~

a. Ductile iron pipe and fittings shall be lined with ceramic epoxy coating **as specified below. Acceptable products shall be Protecto 401, Permox CTF, or approved equal.**

(i) **The corrosion resistant linings shall be a ceramic-filled amine-cured novalac epoxy lining containing at least 20% by volume of ceramic quartz pigment.**

(ii) The lining shall be shop applied to bare metal in strict accordance with the manufacturer's recommendations to cover the inner surface of the pipe and fittings. The lining shall be a nominal thickness of 40 mils and a minimum thickness of 35 mils.

(iii) **Due to the tolerances involved, the gasket groove and spigot end, up to 6 inches back from the end of the spigot end, must be coated with 6 mils nominal, 10 mils maximum dry film thickness of the lining manufacturer's un-reduced Joint Compound. The Joint Compound shall be applied by brush and care shall be taken to ensure the coating is smooth and without excess buildup in the gasket seat/groove and on the spigot end. Coating of the gasket**

seat/groove and spigot ends shall be done after the application of the lining of the pipe barrel.

(iv) ~~The gasket area and spigot end up to 6 inches back from the end of the spigot on the outside of the pipe shall be coated with 6 mils nominal, and 10 mils maximum.~~**The following tests must be run on coupons from factory lined ductile iron:**

a) ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5 mm undercutting and/or disbondment after 30 days.

b) Immersion testing rated using ASTM D-714-87

i. 20% Sulfuric acid—No effect after two years.
ii. 140° F 25% Sodium Hydroxide—No effect after two years.
iii. 160° F Distilled Water—No effect after two years.

c) ASTM D-4060 Abrasion Resistance shall not exceed a weight loss of more than 0.30 grams (CS17 Wheel, 1000-gram load, 1000 cycles).

d) ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.

(v) Surface Preparation:

All pipe and fittings shall be delivered to the application facility without cement or asphalt lining or any other lining on the interior surface. Because total removal of old linings is generally not possible nor cost effective, the intent of this specification is that the entire interior of the DIP and fittings shall be as cast without any lining material prior to application of the specified lining.

(vi) Applicator Requirements

a) **The application shall be performed by an applicator and/or certified firm approved by the coating manufacturer, in accordance with the manufacturer's instructions and under controlled conditions at the applicator's shop or pipe manufacturer's plant. The lining shall be applied by a certified applicator and/or firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.**

b) All applicators must be independently inspected at least two times per year to insure compliance with the requirements of this specification. This inspection must be coordinated and reviewed by the manufacturer of the lining material and any deviation from the application

and/or quality requirements shall be corrected by the applicator. All inspections shall be in writing and a permanent record maintained.

(vii) Lining

a) Upon completion of the blast cleaning operation, the lining material should be applied to the interior of the pipe within 12 hours in order to avoid any possible post blast surface contamination. Any area found to have rust bloom prior to application must be reblasted.

b) Where field touch up is required to seal cut ends and repair damaged areas, Joint Compound shall be applied by brush to ensure complete coverage in accordance with the manufacturer's recommendations. Joint Compound may be used over lined pipe and fittings, or on bare substrate. Care must be taken that the joint compound is applied smooth, without excessive buildup in the gasket seat or on the spigot ends and allowed to cure for 24 hours in accordance with the manufacturer's recommendations. At least 1-inch of overlap shall be applied to the area being repaired. ~~Protecto 401~~**The ceramic-filled amine-cured novalac epoxy lining** shall not be applied over ~~Protecto 401~~ Joint Compound. Joint Compound shall not be applied over wet or frozen surfaces.

(viii) Factory Inspection and Certification

a) The lining in each joint of pipe and fittings shall be tested for pin holes and pass a non-destructive 2,500-volt pin hole/holiday test. The pin hole/holiday detection testing shall be conducted over 100% of all lined surfaces for the ductile iron pipe and fittings. All holidays shall be repaired in accordance with the manufacturer's instructions and tested again to ensure a pinhole free lining. Short lengths of pipe required to accommodate the pipeline geometry shall be furnished factory-lined.

b) Dry film thickness determination for the interior lining of all pipe and fittings shall be checked for thickness using a properly calibrated magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.

c) The pipe or fitting manufacturer must supply a written certificate attesting to the fact that the applicator met the requirements of this specification, that the material used was as specified, and that the material was applied as required by the specification.

~~The lining in each joint of pipe and fitting shall pass a 2,500 volt pin hole/holiday test. The pin hole/holiday detection testing shall be conducted over 100% of all lined surfaces for the ductile iron pipe and fittings. All holidays shall be repaired in accordance with the manufacturer's instructions and tested again to ensure a pinhole free lining. Short lengths of pipe required to accommodate the pipeline geometry shall be furnished factory lined. All outlets shall be tapped by the pipe manufacturer at the factory prior to applying the pipe lining.~~

12. Each length of ductile iron pipe shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any leak or rupture of the pipe wall.

13. For ductile iron pipe diameters 16-inches and greater:

    a. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the Owner at the Owner's expense.

    b. A manufacturer's representative shall be made available when requested by the Owner during the manufacturing furnishing, transporting, and unloading of the pipe and during installation and testing to assist in confirming that the pipe is properly fabricated, transported, unloaded, stored in the field, joined and tested.

    c. The manufacturer's representative shall be made available a minimum of 2 working days (time on site) during the project when requested by the Owner, including the first 2 Days of pipeline installation.

    d. The cost for the services of the manufacturer's representative, including expenses, shall be considered incidental to the project and will not be paid separately.

B. Polyvinyl Chloride (PVC) Pipe

1. PVC pipe shall be furnished in 20-foot laying lengths, with push-on joints. Pipe shall be restrained joint where shown in the Contract Documents.

2. PVC pipe, 4 to 12-inches in diameter, shall conform to the requirements of AWWA C900 - Class 150 (DR-18), unless otherwise indicated in the Contract Documents. PVC pipe greater than 12-inches in diameter shall be AWWA C-905 - Class 235 (DR 18) or Class 165 (DR 25), as specified in the Contract Documents.

    a. The pipe, shall be made from virgin polyvinyl chloride resin or clean rework materials generated from the manufacturer's own pipe production that equals or exceeds cell class 12454-B as defined by ASTM D 1784, and shall bear the seal of approval by the NSF. The pipe shall be unplasticized polyvinyl chloride plastic pressure pipe with integral wall bell and spigot joints.

    b. Joints shall be push-on type with a flexible factory assembled elastomeric ring in the integral bell-end. O-ring gaskets shall conform to ASTM F 477.

2. Brass Pipe shall be red brass pipe meeting the requirements of ASTM B 43. Pipe sizes, wall thickness and dimensions shall meet the requirements of ASTM B 251 Table I for regular pipe. Brass pipe fittings shall be screwed end malleable iron pattern meeting the requirements of ANSI B16.15. They shall be finished rough, unless otherwise specified. Unions shall be of all brass or bronze with ground joints and shall be left semi-finished. Fittings shall be rated for steam working pressures up to 125 psi. Joints shall be screwed type with threads clean cut, tapered and smooth, meeting the requirements of ANSI B2.1.

3. Service Saddle - Shall be designed and sized for the force main on which the saddle is to be installed. The service saddle shall also meet the following requirements:

   a. Stainless steel saddle bodies shall be 18-8, Type 304, stainless steel with all welds fully passivated to restore stainless steel characteristics.

   b. Ductile iron saddle bodies shall conform to ASTM A-536 and have a fusion applied epoxy coating 12-mils dry thickness (D.T.). Straps shall be stainless steel, 18-8, Type 304 fully passivated for corrosion resistance.

   c. Threads shall be AWWA C-800 CC/Taper.

   d. The saddle band shall be a minimum of 2-inches in width.

   e. The saddle shall be provided with a Buna-N rubber gasket meeting ASTM D2000 to seal the saddle and the main pipe.

   f. The nuts, washers, bands, and bolts shall be 18-8 stainless steel.

   g. Acceptable manufacturers are The Ford Meter Box Co., Inc., Model FS202/FS303/FRS202, JCM Model 406, Romac Industries Inc., Style 202N, Cascade Products Style CNS2, or approved equal.

G. Joint Restraint Devices

1. Joint restraints shall be provided where indicated in the Contract Documents.

2. The restrained joint system shall have a pressure rating equal to or greater than that of the pipe on which it is used. Restrained joint devices shall be installed in strict accordance with the manufacturer's recommendations.

3. Ductile Iron Pipe

   a. Push-on Joints

      For push–on joint type pipe, the restrained joint system shall be a manufacturer's standard restrained joint system, ~~SnapLock (U.S.Pipe)~~ **Lok Ring (American Pipe)**, **HP Lok (U.S. Pipe),** TR Flex (U.S. Pipe), FlexRing (American Pipe), or approved equal.

   b. Mechanical Joints

2. DI pipe shall conform to the requirements of ANSI/AWWA C151/A21.51.

3. DI pipe shall be Class 52 for all pipe diameters; or, Class 350 minimum pressure classification for diameters 24-inch and smaller and 250 psi for diameters larger than 24-inches; or, the thickness classification indicated in the Contract Documents. The manufacturer's mark, country where cast, year the pipe was produced, and the letters "DI" or "Ductile Iron" shall be cast or stamped on the pipe.

4. Joints and gaskets shall conform to ANSI/AWWA C111/A21.11 or ANSI/AWWA C115/A21.15 as applicable. The minimum acceptable pressure rating for all joints is 250 psi. All flanges and glands for pipes shall be made of ductile iron.

5. Fittings shall be manufactured in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, as applicable, and shall be ductile iron. Compact fittings are required, and shall have a minimum acceptable pressure rating of 350 psi for 24-inch and smaller piping and 250 psi for larger than 24-inch piping. Fittings shall have the same pressure rating, as a minimum, of the connecting pipe.

6. Coatings shall be provided on the exterior of all pipe, joints and fittings as required by ANSI/AWWA C110/A21.10, C111/A21.11, C115/A21.15, C151/A21.51, C116/A21.16, or C153/A21.53 as applicable. All pipes, joints, and fittings shall be examined after laying to determine if the coating was damaged during installation. Any damaged areas shall be coated **with an Owner-approved coating in accordance with the manufacturer's recommendations** ~~with a minimum of 2 mil of an approved bituminous coating.~~**. If required in the Contract Documents, the exterior of the pipe shall be coated with a layer of arc-sprayed zinc in accordance with ISO 8179. The mass of zinc applied shall be 200 g/m^2 of pipe surface area. A finishing layer topcoat shall be applied to the zinc. The mean dry film thickness of the finishing layer shall not be less than 3 mils with a local minimum not less than 2 mils. The zinc coating system shall conform to ISO 8179-1 "Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer (Second Edition 2004-06-01)**

7. All ductile iron pipe and fittings shall be double thickness cement lined **for diameters up to 30-inch, with single thickness for diameters above 30-inches,** and seal coated in accordance with ANSI/AWWA C104/A21.4.

8. Pipe diameters 12-inch and smaller shall be gaged and delivered round and true throughout its entire length. Pipe over 12-inches in diameter shall have one piece of gaged pipe delivered for each fitting. Gaged pieces shall be marked as such on the pipe and shall be accompanied by the manufacturer's certification. Manufacturer's certification of inspection and testing shall accompany each delivery.

9. ASTM A242 – Standard Specification for High-Strength Low-Alloy Structural Steel

10. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

11. ASTM A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

12. AWWA C105 – Polyethylene Encasement **and V-Bio Enhanced Polyethylene Encasement** for Ductile-Iron Pipe Systems.

13. For pipe diameters 16-inches and greater:

    a. Each length of ductile iron pipe shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any leak or rupture of the pipe wall.

    b. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the Owner at the Owner's expense.

    c. A manufacturer's representative shall be made available to the Owner during the manufacturing furnishing, transporting, and unloading of the pipe during installation and testing of the pipe to assist in insuring that the pipe is properly fabricated, transported, unloaded, stored in the field, joined and tested. Manufacturer's responsibilities relate only to the proper care and treatment of the pipe during these procedures and not the techniques or procedures used during installation and testing.

    d. The manufacturer’s representative shall be made available a minimum of 2 working days (time on site) during the project when requested by the Owner, including the first 2 Days of pipeline installation.

    e. The cost for the services of the manufacturer’s representative, including expenses, shall be considered incidental to the project and will not be paid separately.

B. Polyvinyl Chloride (PVC) Pipe

1. PVC pipe shall be furnished in 20-foot laying lengths, with push-on joints. Restrained joints shall be provided where shown in the Contract Documents.

2. PVC pipe, 4- to 12-inches in diameter, shall conform to the requirements of AWWA C900 - Class 150 (DR-18), unless otherwise indicated in the Contract Documents. PVC pipe greater than 12-inches in diameter shall be AWWA C-905 - Class 235 (DR 18) or Class 165 (DR 25), as specified in the Contract Documents.

3. The pipe, shall be made from virgin polyvinyl chloride resin or clean rework materials generated from the manufacturer’s own pipe production that equals or exceeds cell class 12454-B as defined by ASTM D 1784, and shall bear the seal of approval by the NSF. The pipe shall be unplasticized polyvinyl chloride plastic pressure pipe with integral wall bell and spigot joints.

4. Joints shall be push-on type with a flexible factory assembled elastomeric ring in the integral bell-end. Joint material including gaskets and lubricants shall conform to AWWA C900.

5. Fittings shall be manufactured in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, and shall be ductile iron. The minimum acceptable

Meter settings shall include meter setter, meter box, water meter, and all appurtenances necessary for providing customer water service at the location designated in the Contract Documents. See the Special Provisions for additional information.

K. Joint Restraint Devices

1. Joint restraints shall be provided where indicated in the Contract Documents.

2. Ductile Iron Pipe

The restrained joint system shall have a pressure rating equal to or greater than that of the pipe on which it is used. Restrained joint devices shall be installed in strict accordance with the manufacturer's recommendations.

a. Push-On Joints

For push–on joint type pipe, the restrained joint system shall be a manufacturer's standard restrained joint system, ~~SnapLock (U.S.Pipe),~~ TR Flex (U.S. Pipe), **Lok-Ring (American Pipe), HP Lok (U.S. Pipe),** FlexRing (American Pipe), Series 3000 Stargrip wedge action restraint (Star Pipe Products), or approved equal.

b. Mechanical Joints

For mechanical joint type pipe, the restrained joint system shall be a manufacturer's standard restrained joint system, Series 1100 Megalug ductile iron glands (EBBA iron, Inc.), Series 1400 retainer glands (Ford Meter Box Company, Inc.), Series 3000 Stargrip wedge action restraint (Star Pipe Products), or approved equal.

3. PVC Pipe (4-inch and larger)

The restrained joint system shall have a pressure rating equal to or greater than that of the pipe on which it is used. Restrained joint devices shall be installed in strict accordance with the manufacturer's recommendations.

a. Bell and Spigot PVC Joints

The restraint system for bell and spigot PVC joints shall be Series 1600/2800 ductile iron retainers as manufactured by EBAA Iron, Inc, Series 1390 retainers as manufactured by Ford Meter Box Company, Inc., or approved equal.

b. PVC to Mechanical Joint Fittings

The restraint system for restraining PVC pipe to ductile iron mechanical joint fittings shall be Series 2000 PV ductile iron retainers as manufactured by EBAA Iron, Inc., Series 1500 retainers as manufactured by the Ford Meter Box Company, Inc., Series 4000 Stargrip wedge action restraint (Star Pipe Products),or approved equal.

4. Concrete Reaction Blocking