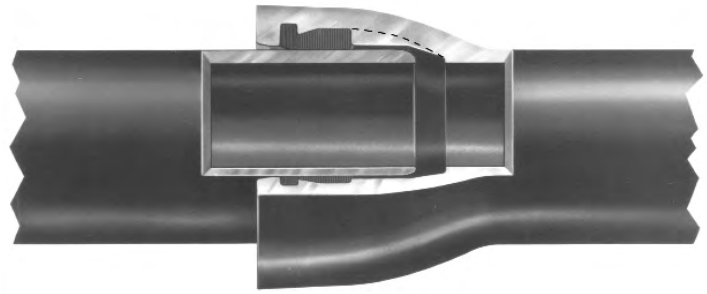
SECTION 2

AMERICAN Pipe Joints

AMERICAN Fastite® Joint Pipe

For Water, Sewage or Other Liquids



AMERICAN Fastite Joint Pipe in sizes 4"-64" for water, sewage or other liquids has the proven long-life and high-strength qualities inherent in pipe produced centrifugally in accordance with AWWA C151. In addition, this significant AMERICAN development, a dependable, single gasket, push-on type joint meeting the requirements of AWWA C111, affords the customer lower joint cost and time-saving advantages in installation. It provides exceptional strength and flexibility and has been widely accepted by engineers, contractors and utility officials since the 1950s. For added flexibility during construction, and for possible elimination of bends, a liberal 5° allowable deflection is standard in all sizes through 30", offering 21" offset in a 20' length of pipe. Liberal deflection can also be provided in larger diameter pipe with standard and Special Fastite Deflection Bells.

The patented AMERICAN Fastite Joint embodies many advanced design features and is rated for a water working pressure of 350 psi. For specific conditions, ductile iron piping with this joint has been approved for much higher pressure conditions. The socket, which is scientifically designed with two gasket recesses and a dividing buttress, is manufactured to close tolerances so that the gasket is self-centered, securely confined, and firmly compressed for a permanent, tight, trouble-free joint. The Fastite joint seal, bubble-tight under vacuum and external pressure, becomes even tighter with the application of internal pressure due to a specially designed wedging surface in the socket.

Fastite Joint Assembly

The bell opening is slightly tapered to provide easy entry of the pipe end; the flared socket design permits liberal joint deflection. The plain end of the pipe is tapered or rounded to facilitate entry into the bell and self-centering in the gasket. On pipe cut in the field, the plain end can be easily beveled and smoothed by the use of a portable grinding wheel or other suitable apparatus. Methods of cutting ductile iron pipe are described in Section 3.

A stripe is painted on the plain end of AMERICAN Fastite Joint Pipe to provide a visual means of checking the joint alignment and to assure proper insertion. See page 2-10 for detailed assembly instructions.

Fastite Gasket

The Fastite Joint sealing component—a molded synthetic rubber ring gasket of two hardnesses, shaped to fit the configuration of the gasket socket—is manufactured per all requirements of ANSI/AWWA C111/A21.11 and under AMERICAN's own rigid specifications, assuring closely controlled dimensional and hardness properties. The smaller end of the gasket is of harder rubber, approximately 85 durometer hardness, which provides a strong shoulder for self-centering on the gasket buttress, a permanent seal against cold flow, and protection from deterioration. The larger end of the gasket is of softer rubber, approximately 65 durometer hardness, providing ease of assembly and positive sealing. The design assures effective sealing at low or high pressures and in straight or deflected joint alignment. It also eliminates any concerns of infiltration or root intrusion, and assures positive sealing against negative pressure, thus preventing gasket "pullout" should a vacuum be created in the line.

A taper on the inside of the gasket allows the entering pipe to locate and center on the hard section and reduces friction loads during

subsequent assembly. The snug fit and the hard section of the gasket, in conjunction with the design of the buttress, act to restrain the gasket against dislodgment during assembly. Additional internal pressure results in increased tightness of the seal when pipe is either in straight alignment or deflected.

Gaskets made of SBR (Styrene Butadiene Rubber) are standard. For information on gaskets made of special types of rubber, for applications involving air or liquid temperatures in excess of 150°F, or for chemical, hydrocarbon or other special service applications, and for installations in contaminated soils where permeation through gaskets might be a concern, consult AMERICAN for recommendations. See Table 2-1.

Fastite Lubricant

AMERICAN Fastite Joint Lubricant is a non-toxic water soluble material imparting neither taste nor odor to the conveyed water and is ANSI/NSF 61 approved. The lubricant is suitable for use in hot or cold weather and will adhere to wet or dry pipe. AMERICAN Fastite Joint Pipe can be assembled when submerged, though for such installation, special AMERICAN underwater joint lubricant is recommended. See Table No. 2-5 for appropriate lubricant quantities.

Fastite Joint Materials

Standard joint materials include Fastite plain rubber gaskets and a sufficient supply of Fastite joint lubricant. Fastite pipes are most often readily joined with available excavating equipment; however, assembly tools can be supplied by AMERICAN on a loan basis with a nominal deposit which is refundable upon return of tools in good condition.

Fittings

AMERICAN Fastite or Flex-Ring fittings and AMERICAN Mechanical Joint Fittings are used with Fastite Joint pipe. See Sections 4 and 5.

Coating and Lining

AMERICAN Fastite Joint Pipe can be furnished asphaltic coated, cement lined, or with special coating or lining where required. See Section 11.

Fastite Gaskets

Table No. 2-1

Common Name or Trade Name*	Chemical Name	Maximum Service Temperature**		Common Uses
		Water & Sewer	Air	
Plain Rubber	Styrene Butadiene Copolymer(SBR)	150°F	150°F	Fresh Water, Salt Water, Sanitary Sewage
Plain Rubber (conductive)	Styrene Butadiene Copolymer(SBR)	150°F	150°F	Electrical continuity for thawing of Service Water and Sewage
EPDM	Ethylene Propylene Diene Monomer	212°F	200°F	Water, Sewage, Ketones, Dilute Acids and Alkalies, Vegetable Oil, Alcohols, Air
Neoprene	Polychloroprene(CR)	200°F	180°F	Fresh Water, Sewage
Nitrile Buna-N	Acrylonitrile Butadiene(NBR)	150°F	150°F	Non-Aromatic Hydrocarbons, Petroleum Oil, Hydraulic Fluids, Fuel Oil, Fats, Oil, Grease†
Fluoroelastomer Fluorel Viton®***	FKM	212°F	300°F	Aromatic Hydrocarbons, Gasoline, Refined Petroleum Products, most Chemicals and Solvents, High Temp., Air (Least permeable of all available Fastite gasket rubbers)

*AMERICAN reserves the right to furnish any Trade or Brand rubber for the chemical formulation specified.
Temperature is in reference to conveyed fluid. **Lubricating oil in air can adversely affect SBR and EPDM performance. SBR, Nitrile and Neoprene are not recommended for hot air exposure in wastewater treatment systems.
***Viton® is a registered trademark of DuPont Dow Elastomers.
Refer to Section 11 for temperature and service capabilities of pipe linings.
Refer higher temperatures or other special requirements to AMERICAN for recommendations regarding suitable gasket material.
†This gasket rubber is chemically resistant in the non-potable water uses shown but is not as resistant to permeation in potable water applications as FKM.
All Fastite gaskets made from the materials in the above table are suitable for use with water containing normal concentrations of chloramine. Where increased resistance to chloramine is desired, neoprene or fluoroelastomer materials should be considered.

AMERICAN Fastite® Joint for Ductile Iron Pipe

ANSI/AWWA C111/A21.11 Standard Dimensions

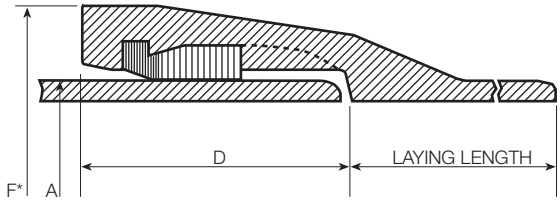


Table No. 2-2

Size in.	Nominal Laying Length ft.	Dimensions in Inches		
		A Outside Diameter	D Depth of Socket	F* Bell O.D.
4	18	4.80	3.31	6.40
6	20	6.90	3.38	8.60
8	20	9.05	3.75	11.16
10	20	11.10	3.75	13.25
12	20	13.20	3.75	15.22
14	20	15.30	5.23	17.73
16	20	17.40	5.23	19.86
18	20	19.50	5.50	22.16
20	20	21.60	5.50	24.28
24	20	25.80	5.50	28.50
30	20	32.00	6.50	34.95
36	20	38.30	6.50	41.37
42	20	44.50	7.50	48.27
48	20	50.80	8.00	54.71
54	20	57.56	8.50	61.65
60	20	61.61	8.75	65.80
64	20	65.67	9.00	70.04

*Dimensions subject to change at our option. Check AMERICAN if exact dimensions required.
See Section 3 for additional information on ductile iron pipe.
See Sections 4 and 7 for information on Fastite fittings.

AMERICAN Fastite® Joint Pipe
Allowable Joint Deflection

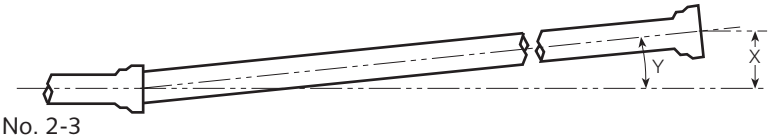


Table No. 2-3

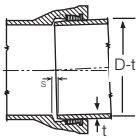
Size in.	Nominal Laying Length ft.	Maximum Recommended Deflection†					
		Standard Bell			Special Deflection Bell		
		X Offset per Nominal Length in.	Y Deflection Angle	Radius of Curve* ft.	X Offset per Nominal Length in.	Y Deflection Angle	Radius of Curve* ft.
4	18	19	5°	206	-	-	-
6	20	21	5°	230	-	-	-
8	20	21	5°	230	-	-	-
10	20	21	5°	230	-	-	-
12	20	21	5°	230	-	-	-
14	20	21	5°	230	-	-	-
16	20	21	5°	230	-	-	-
18	20	21	5°	230	-	-	-
20	20	21	5°	230	-	-	-
24	20	21	5°	230	-	-	-
30	20	21	5°	230	-	-	-
36	20	17	4°	285	21	5°	230
42	20	12	3°	380	21	5°	230
48	20	12	3°	380	17	4°	285
54	20	12	3°	380	17	4°	285
60	20	12	3°	380	17	4°	285
64	20	12	3°	380	17	4°	285

*Approximate radius of curve produced by a succession of nominal lengths of pipe fully deflected.
†Special Deflection Bells must be specifically ordered and will be marked with white bell face for easy identification.
For easiest assembly, the joints should be assembled with the pipe in reasonably straight alignment. After joint assembly, the pipe may be deflected up to the maximum shown above. Offset distances are based on 20' lengths.

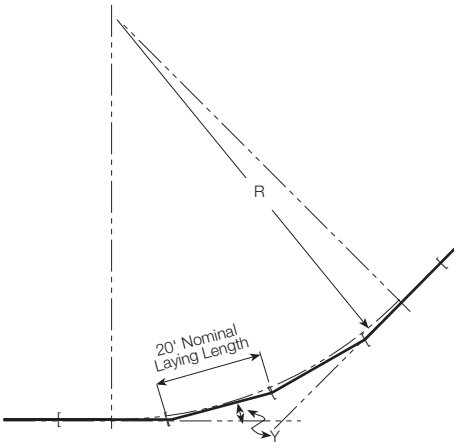
Maximum Allowable Separation

Table No. 2-4

Size in.	S Separation in.
4	3/8
6	9/16
8	3/4
10	15/16
12	1 1/8
14	1 5/16
16	1 1/2
18	1 5/8
20	1 7/8
24	2 1/4
30	2 3/4
36	2 5/8
42	2 1/4
48	2 1/2
54	2 7/8
60	3 1/8
64	3 3/8



Maximum Allowable Separation, "S", in Standard Bell pipe is approximately equal to the median pipe diameter in inches times the sine of the deflection angle. This is provided for information only and should not be used to determine precise joint deflection.



R = Radius of Curve (ft.)

Y = Deflection Angle (degrees)

$$\text{Radius of Curve} = \frac{\text{Nominal Laying Length}}{2 \times \text{Tangent } (Y \div 2)}$$

Section 11

AMERICAN Linings and Coatings

AMERICAN Linings for Pipe and Fittings

The principal standard covering cement lining is ANSI/AWWA C104/A21.4. This and other standards are referenced throughout this Section either by the full ANSI/AWWA designation or by only the AWWA numbering, such as AWWA C104.

Along with technical and metallurgical advancement in piping materials, research on lining requirements for pipe and fittings has resulted in the development of linings to meet many different service requirements. AMERICAN offers several types of linings, the most common being cement lining. Pipe and fittings furnished by AMERICAN are offered unlined or with linings as follows:

1. Cement Lined per AWWA C104.
2. Asphaltic Lined per AWWA C110, C115 or C151.
3. Fusion-Bonded Epoxy (for 4″-16″ Fastite fittinigs) per AWWAA C116.
4. PROTECTO 401 Lined - Ceramic Epoxy Lined.
5. Special Lining - for unusual service conditions

Cement Lining

Cement-mortar lining for ductile iron pipe and ductile and gray iron fittings for water service is in accordance with ANSI/AWWA C104/A21.4.

Cement-lined pipe is also furnished for some sewage service and a number of other applications. In fact, most pipe furnished is cement lined, providing improved flow characteristics and the required protection against internal corrosion. The cement lining is satisfactory for temperatures up to 212°F. If asphaltic seal coat is furnished, the lining is only adequate for temperatures up to 150°F. For other services contact **AMERICAN** regarding temperature limitations of cement lining.

The first recorded installation of cement-lined gray iron pipe was in 1922 at Charleston, S.C. This lining was developed by the Charleston Commission of Public Works in cooperation with American Cast Iron Pipe Company. Since this beginning, AMERICAN has furnished most of its pipe with cement lining. The lining is applied centrifugally with the speed of rotation designed to produce a smooth waterway surface, minimal voids, yet retaining enough moisture for proper curing. **AMERICAN** cement-lined pipe and fittings are listed by ANSI/NSF Standard 61 for potable water contact.

Flow tests on cement-lined pipe under varying service conditions have established that the Hazen-Williams flow coefficient remains as expected at about 140, and flow tests on cement-lined, large-diameter **AMERICAN** Ductile Iron pipe have confirmed flow coefficients much higher than 140.

Handling Cement-Lined Pipe and Fittings

Pipe and fittings with cement lining should be handled with rubber-covered hooks or other type equipment to prevent damage to the cement lining. Bare fork lift arms or bare hooks should not be inserted into open ends.

Characteristics of Cement Lining

AWWA C104 allows for surface crazing and cracks of a specified nature and magnitude. Occasionally cracks and looseness in linings may occur prior to installation, particularly where pipe is stored for a considerable time. Many years' experience with cementlined pipe and fittings has verified that this condition is not detrimental to the perfor-

mance and effectiveness of the lining. When a cement-lined pipe is placed in service and filled with water, two reactions begin immediately. The first is a gradual elimination of the temperature differential between pipe and lining, thus eliminating any stresses in the lining due to this condition.

Secondly, the lining begins to absorb water. Water is absorbed into the pores of the cement and into the capillary channels of the calcium silicate gel. The water absorption causes the lining to swell, restoring it to intimate contact with the pipe wall and virtually closing any cracks present in the lining. This swelling process is relatively slow, taking up to several weeks for the lining to be restored to its maximum volume. This process has been demonstrated on a number of occasions to the satisfaction of customers, contractors and engineers by immersing a pipe or fitting in water for one or two weeks.

After a period of exposure to water, not only does the lining tighten against the pipe wall and the cracks close, but finally the surfaces of the cracks actually re-bond. This occurs by a process called autogenous healing.

This phenomenon, long recognized by the cement industry, has been documented by laboratory tests to occur in cement-lined ductile pipe. In one test, a 48" ductile iron pipe with severely cracked cement lining was held half full of water for several months. At the end of that period, the lining both above and below the water surface was found to be tight, with all cracks either healed completely or sealed by the formation of calcium carbonate.

Field inspections of lines that have been in service for many years have verified the laboratory results; cement linings do tighten and heal in service and provide the corrosion protection to the pipe and the high flow coefficients for which they were designed.

Field Repair of Damaged Cement Linings

Cement lining will withstand normal handling; nevertheless, pipe or fittings may be found at times to have damaged linings which need to be repaired before placing in service.

AWWA C104 provides that damaged lining may be repaired, and the following repair procedure is recommended:

1. Cut out the damaged lining to the metal. Square the edges.
2. Thoroughly wet the cut-out area and adjoining lining.
3. With the damaged area cleaned and the adjoining lining wet, spread the mortar (see recommended mix below) evenly over the area to be patched. (See Table No. 11-1, next page, for lining thicknesses.) After the lining has become firm and adheres well to the surface, finish it with a wet 3" or 4" paint brush or similar soft bristle brush.
4. The repaired lining should be kept moist by tying canvas, wet burlap, or other wrap over the ends of the pipe or fitting for at least 24 hours. As an alternative the repaired lining may be seal coated with a cut back type of asphaltic seal coating. This must be sprayed or brushed on within five to 30 minutes after lining. To maintain NSF certification, patch must be made using a NSF certified cement for 4" pipe and larger, or the patch must be topcoated with NSF certified asphalt paint.

Recommended Cement Mix

Cement mix by volume: 3 Parts Portland Cement; 2 Parts Clean Sand; necessary water for slump of 5" to 8". The sand should be free of clay and screened through a No. 20 Screen.

Precautions

1. Mortar for lining should not be used after it has been mixed for more than one hour.
2. Too rapid a loss of moisture from fresh linings due to hot weather or high wind will prevent proper cure, resulting in the lining being soft and powdery. To prevent this loss of moisture, (a) do not line hot castings and (b) close the ends of the castings with wet burlap.
3. Fresh linings that become frozen will not be serviceable. Avoid lining in freezing weather

Cement Lining
ANSI/AWWA C104/A21.4
Thicknesses and Weights

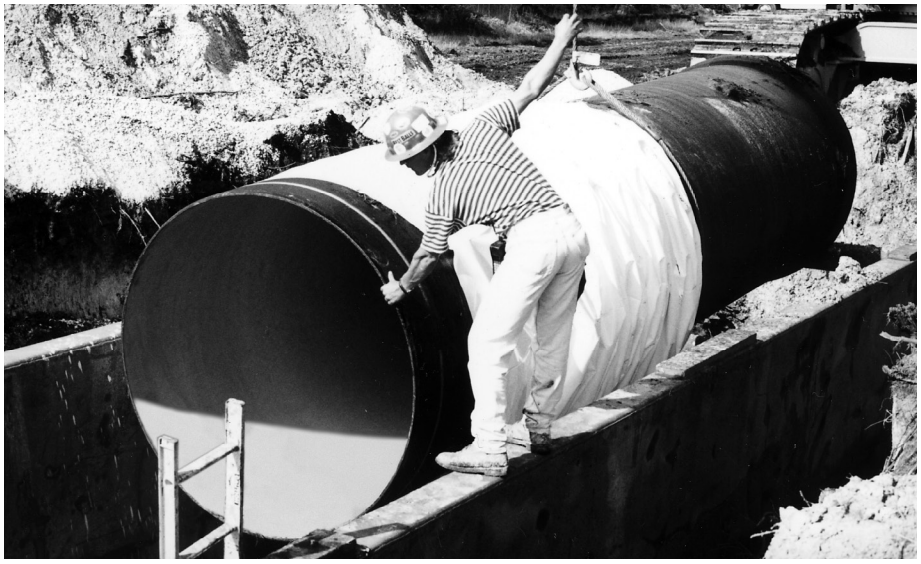
Table No. 11-1

Size in.	Nominal Pipe Length ft.	Standard Thickness			Double Thickness		
		Minimum Thickness in.	Weight Per Foot lb	Weight Per Length lb	Minimum Thickness in.	Weight Per Foot lb	Weight Per Nominal Length lb
4	18	1/16	.87	17	1/8	1.71	31
6	20	1/16	1.30	26	1/8	2.57	51
8	20	1/16	1.74	35	1/8	3.45	69
10	20	1/16	2.15	43	1/8	4.28	86
12	20	1/16	2.57	51	1/8	5.12	102
14	20	3/32	4.49	90	3/16	8.93	179
16	20	3/32	5.13	103	3/16	10.19	204
18	20	3/32	5.76	115	3/16	11.47	229
20	20	3/32	6.40	128	3/16	12.73	255
24	20	3/32	7.68	154	3/16	15.31	306
30	20	1/8	12.76	255	1/4	25.42	508
36	20	1/8	15.31	306	1/4	30.51	610
42	20	1/8	17.82	356	1/4	35.53	711
48	20	1/8	20.35	407	1/4	40.60	812
54	20	1/8	22.89	458	1/4	45.68	914
60	20	1/8	24.71	494	1/4	49.32	986
64	20	1/8	26.35	527	1/4	52.61	1052

Weights are based on the minimum lining thicknesses for minimum pressure classes of Fastite ductile iron pipe. Actual lengths and weights may differ from above.

Linings may taper at the ends.

AMERICAN recommends the use of standard thickness cement lining per AWWA C104 for all normal installations.



This 64" Ductile Iron Fastite Joint water transmission main was furnished with standard cement lining for continuing high flow performance.

Other Linings Available From AMERICAN

Pipe and fittings lined with the following types of coatings are available from AMERICAN on a special order basis. For more detailed information regarding lining selection, application parameters and typical field topcoats, please contact AMERICAN.

ASPHALTIC LINING

AMERICAN furnishes some pipe and fittings lined with an asphaltic material in accordance with AWWA C110, C115, C153 and C151. After thoroughly drying, the lining has no deleterious effect upon the quality, color, taste or odor of potable water. Asphaltic lining is not normally used in water service; the majority of ductile water lines are cement lined. Asphaltic lining or seal-coat, if furnished, on cement lining is adequate for temperatures up to 150°F.

Protecto 401 LINING

AMERICAN can furnish 4"-64" Protecto 401 Ceramic Epoxy-lined ductile iron pipe and fittings. This third-party-designed and -applied lining is amine-cured with novalac and ceramic quartz pigment for an approximately 40-milthick, high-build lining.

Protecto 401 Ceramic Epoxy™ Standard for Lining Ductile Iron Pipe and Fittings for Sewer Service

Protecto 401-lined ductile iron pipe and fittings provide the maximum protection and the strength necessary to do the job in tough sewer pipe applications. Protecto 401 has been successfully used in hundreds of sanitary sewer applications and has been proven with both laboratory testing and years of actual sewer service on all sizes of ductile iron pipe and fittings.

The development of Protecto 401 was begun in 1979. The first Protecto 401-lined ductile iron sewer pipe was lined and placed in service in 1981. Since then hundreds of miles of ductile iron sewer pipe have been lined with Protecto 401 with no lining failure.

Because Protecto 401 Ceramic Epoxy Lining was designed and is used as protection for ductile iron sanitary sewer pipe, it provides the reliability of cement mortar lining with the excellent corrosion protection of novalac epoxy. This concentration of effort has resulted in performance unparalleled by other linings.

Protecto 401 has been tested extensively. Because the specifications for application and testing of Protecto 401 Ceramic Epoxy have been developed for ductile iron pipe using test data and performance history, no deviations from the specification shall be permitted without prior written approval of the lining manufacturer. If required, third-party inspection of Protecto 401 Ceramic Epoxy-lined ductile iron pipe shall be done only after written notice to the applicator of Protecto 401 Ceramic Epoxy. Any third-party inspection shall be accomplished using standard Protecto 401 Ceramic Epoxy Quality Control Procedures.

Protecto 401 is applied to the interior of ductile pipe and fittings utilizing specialized application equipment and a stringent specification. The lining is designed to be applied at a nominal 40 mils thickness. A nondestructive pinhole detection test and a thickness test is performed to insure a sound, chemically resistant protective lining for ductile iron pipe and fittings.

Protecto 401 is intended for use in domestic sanitary sewage lines. Chemical injection for odor control may damage pipe, gaskets and/or protective linings and should be undertaken with extreme caution. Requests for industrial sewer applications of Protecto 401-lined ductile pipe and fittings should be made to a pipe marketing representative for individual recommendations.

Ductile iron pipe lined with Protecto 401 Ceramic Epoxy™ can only be pushed when using a restrained joint system that does not allow the spigot to contact the bell shoulder. The pipe may be pulled using restrained joint pipe or restraining gaskets as restraints. Restraining gaskets must never be pushed; nor should the pipe be homed all the way to the bell shoulder with or without restraining gaskets. Pushing or pulling ductile iron pipe lined with Protecto 401 Ceramic Epoxy™using any other technique may damage the lining. Consult Induron's

brochure for product application concerning pushing or pulling operations.

The practice of pulling a metal mandrel through Protecto 401 Ceramic Epoxy™ lined ductile iron pipe is not recommended and should be considered carefully. Most mandrels have legs with sharp edges produced by wear. Mandrels are usually the size of the interior diameter of PVC pipe, and because ductile iron pipes are larger, these mandrels tend to ride on the edge of the center legs that may result in damage to the lining.

For additional information, contact Induron at 1-888-SPEC401. Reprinted with permission of Induron Protective Coatings.

Protecto 401 Ceramic Epoxy™ Standard Specification for Lining Ductile Iron Pipe for Sewer Service

I. Condition of Ductile Iron Prior to Surface Preparation

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material, and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

II. Lining Material

The Standard of Quality is Protecto 401 Ceramic Epoxy. The material shall be an amine-cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of thetest results.

A. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

B. The following test must be run on coupons from factory-lined ductile iron pipe:

1.ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.
2.ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5mm undercutting after 30 days.
3.Immersion Testing rated using ASTM D-714-87.
   a. 20% Sulfuric Acid - No effect after two years.
   b. 140°F 25% Sodium Hydroxide- No effect after two years.
   c. 160°F Distilled Water- No effect after two years.
   d. 120°F Tap Water (scribed panel) - 0.0 undercutting after two years with no effect.

C. An abrasion resistance of no more than 3 mils (.075mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

III. Application

A. Applicator

The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

B. Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease or any substance which can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compound sshall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.

C. Lining

After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

D. Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area 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 using Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

E. Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.**

F. Touch-Up & Repair

Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

IV. Inspection and Certification

A. Inspection

1. All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.
2. The interior lining of all pipe barrels and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired prior to shipment.
3. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

B. Certification

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

V. Handling

Protecto 401-lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc., shall be placed inside the pipe and fittings for lifting, positioning or laying. The pipe shall not be dropped or unloaded by rolling. Care should be taken not to let the pipe strike sharp objects while swinging or being off-loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

Polybond™ and PolybondPlus™ are no longer available.

FUSION-BONDED EPOXY

All 4"-16" Fastite fittings are fusion-bonded-epoxy lined and coated. Fusion-bonded epoxy is furnished in accordance with AWWA C116.

OTHER SPECIAL LININGS

Customers can request pipe and fittings with special linings other than those listed above (e.g., glass lining, etc.). Because of the variables and complexities involved in the selection of a proper lining for a given service, AMERICAN invites inquiries for technical assistance, availability and cost.

UNLINED

Because some service applications may require unlined pipe & fittings, AMERICAN furnishes any of its products without lining when so specified at time of purchase.

AMERICAN Coatings and Primers for Pipe and Fittings

Several different generic types of exterior primers for pipe and fittings are available upon request. Because of variables and complexities involved in the selection and application of a proper coating for a given service, AMERICAN invites inquiries for technical assistance.

AMERICAN furnishes most pipe and fittings coated outside with an asphaltic coating approximately one mil thick per AWWA C151 for ductile iron pipe, AWWA C115 for flanged pipe and AWWA C110 and C153 for fittings.

All across the United States ductile iron and gray iron pipe and fittings with this standard coating have provided trouble-free service for decades. Unless otherwise specified, an asphaltic coating is applied to the outside of all pipe and fittings manufactured by AMERICAN.

The asphaltic coating works in conjuction with manufacturing annealing scale to provide a barrier to corrosion. If soils are deemed to be corrosive to ductile iron pipe when evaluated in accordance with the Design Decision Model™ (DDM™*) or Appendix A of AWWA C105, polyethylene wrap or other appropriate methods should be used.

Asphaltic coating is not compatible with most top coats. See the following alternative primer recommendations.

MCU UNIVERSAL PRIMER (Moisture-Cured Urethane)

This is a quality, fast-curing, surface tolerant, immersion-grade, moisture-cured urethane (MCU) specially developed and tested for iron substrates. This coating is essentially a universal primer compatible with all major generic topcoats, including acrylics, epoxies, polyurethanes and moisture-cured urethane topcoats. It can also be topcoated with solvent or water-based asphaltic coatings. For the above reasons, it is well suited for most applications, including where the generic topcoats or end uses may not be known.

*DDM™ (Design Decision Model™) developed jointly by Corrpro Companies, Inc., and the Ductile Iron Pipe Research Association.
See american–usa.com, dipra.org or corrpro.com for details.

Other advantages include a very tough, damage-resistant film resulting in less handling and shipping damage and less touch-up and repair in the field than traditional epoxy primers used in the past. This primer does not have a maximum recoat window and does not require field blast cleaning, as long as the surface is clean and free of dust. This primer is considered a high-performance, chemical resistant coating suitable for immersion and non-immersion services. Refer to **AMERICAN** Recommended and Preferred Primer System - Universal Primer (Moisture-cured urethane) for more information and advantages.

PHENOLIC ALKYD PRIMER

This is a fast-drying, lead- and chromate-free, corrosion-resistant primer formulated to accept a wide variety of topcoats. It is well suited for applications where the generic topcoats are unknown but its service is limited to atmospheric exposure. Refer to **AMERICAN** Alkyd-Phenolic Primer. **NOTE: NOT RECOMMENDED FOR IMMERSION. MUST ALLOW UP TO 30 DAYS OF CURING BEFORE TOPCOATING WITH CERTAIN COATINGS.**

EPOXY PRIMER

This is a high-solids, chemical- and corrosion-resistant coating for protection against abrasion, moisture, corrosive fumes, chemical attack and immersion.

This 30" AMERICAN Ductile Iron Fastite joint treated-water transmission main was furnished and installed—as is most ductile iron pipe—with standard asphaltic coating approximately one mil thick on the outside.

High-build properties provide outstanding corrosion protection with fewer coats, particularly on edges. Such highsolids, high film-build epoxies are compatible with most catalyzed finish coats.

Typical (field) finish coatings include: epoxies (amine, polyamide, polyamidoamine, water-borne, coal-tar) and polyurethane. Refer to **AMERICAN** Polyamidoamine Epoxy Primer. **NOTE: AFTER 60 DAYS OF CURING, THIS PRIMER SHOULD BE UNIFORMLY SCARIFIED BY BRUSH-BLASTING WITH FINE ABRASIVE BEFORE TOPCOATING.**

FUSION-BONDED EPOXY

All 4"-16" Fastite fittings are fusion-bonded epoxy (FBE) lined and coated. The FBE coating/lining meets the applicable requirements of AWWA C116, and both FBE and cement linings are ANSI/NSF Standard 61 certified for contact with potable water.

OTHER SPECIAL COATINGS

AMERICAN can also furnish other special exterior coating systems. Contact **AMERICAN** for technical assistance in the selection of special exterior coating systems, lead times and costs.

UNCOATED PIPE

Because some customer applications may require piping or fittings that have no coating applied to the exterior, AMERICAN furnishes, when specified at time of purchase, any of its products without exterior coatings.

NOTE: AMERICAN also has the ability to furnish other primers, but this may affect price and availability.

AMERICAN Cast Iron Pipe Company
Standard O.D. Shop Primer Systems

RECOMMENDED AND PREFERRED PRIMER

MCU Universal Primer
Interior/Exterior/Immersion (Above and Below Grade)
- Single-coat thickness: 3.0-5.0 mils DFT (76-127 microns).
- Typical Topcoats: alkyds, aluminums, epoxies, bituminous, polyurethanes and moisture-cured urethane topcoats.
- Specially developed and tested for iron substrates.
- Single component.
- Low-temperature, fast-curing capability.
- Can be applied over damp, but not wet surfaces.
- Infinite recoat window, as long as surface is clean and free of dust before topcoating.
- This primer is compliant with ANSI/NSF Standard 61 **as a primer and spigot surface coating for pipe, fittings, and valves** when combined with approved topcoats.

OTHER PRIMERS

Alkyd-Phenolic Primer
Interior/Exterior/Non-Immersion (Above Grade Only)
- Single-coat thickness: 2.0-4.0 mils DFT (50-101 microns).
- Typical Topcoats: alkyds, aluminums, epoxies, and urethanes.
- Coating must be cured for 30 days before being overcoated with certain topcoats.
- This primer is **not** recommended for immersion service.
- This primer is compliant with NSF Standard 61 **as an exterior surface coating only.**

Polyamidoamine Epoxy Primer
Interior/Exterior/Immersion (Above and Below Grade)
- Single-coat thickness: 3.0-8.0 mils DFT (76-203 microns).
- Typical Topcoats: epoxies and urethanes.
- This coating must be lightly blast cleaned before topcoating if it has not been exterior exposed for 60 days or longer.
- This primer is compliant with ANSI/NSF Standard 61 for potable water contact for pipe, fittings, and valves when combined with approved topcoats.

V-Bio Enhanced Polyethylene Encasement

Product Description

V-Bio, the latest advancement in corrosion control for ductile iron pipe, is an enhanced polyethylene encasement that targets anaerobic bacteria on the surface of the pipe and inhibits the formation of corrosion cells under the wrap.

Already known for its corrosion control properties, polyethylene encasement has been used to successfully protect cast and ductile iron pipe in aggressive environments since its first use in a water system in 1958. And now, with V-Bio, this wrap offers even greater protection of the industry's most dependable, economic and long lasting pipe material.

Key facts about the V-Bio enhanced polyethylene encasement:

• Builds on a proven method of corrosion control — polyethylene encasement – that has been protecting iron pipe from aggressive soils since it was first installed in 1958.

• Represents a significant evolutionary advancement in corrosion protection for ductile iron pipe.

• Consists of three layers of co-extruded linear low-density polyethylene (LLDPE) film fused into one.

• Features an inside surface that is infused with a proprietary blend of an anti-microbial biocide to mitigate microbiologically influenced corrosion ("MIC") and a volatile corrosion inhibitor ("VCI") to control galvanic corrosion.

• Protects against corrosion without consuming or degrading the biocide or the corrosion inhibitor. The film's enhanced properties will last over time.

• Meets all requirements of the American National Standards Institute and the American Water Works Association (ANSI/AWWA C105/A21.5) standard for polyethylene encasement.

• The most advanced method of corrosion control.

For details about V-Bio enhanced polyethylene encasement, ductile iron pipe or the Ductile Iron Pipe Research Association visit: www.dipra.org/v-bio/

Standard Dimensions and Weights

Table No. 11-2

Pipe Size (in.)	Lay Flat size	Length Per Roll	Tape Required[2] per Joint (ft.)	Weight Per Roll[1]
4	20	500	5	72
6	20	500	6	72
8	20	500	8	72
10	27	380	9	73.9
12	27	380	10	73.9
14	34	300	11	73.44
16	34	300	12	73.44
18	41	260	13	73.8
20	41	260	15	73.8
24	54	210	17	81.6
30	67	150	21	72.4
48	95	120	32	82
54	108	110	35	83.64
60	108	110	36	83.64
64	121	88	39	74.96

[1] Weights and lengths subject to change.

[2] Based on one turn at each end, six 4" long strips to secure loose wrap plus approximately 5% extra.

A Specification for V-Bio Enhanced Polyethylene Encasement for Ductile Iron Pipe

Polyethylene encasement for use with ductile iron pipe shall meet all the requirements for ANSI/AWWA C105/A21.5, *Polyethylene Encasement for Ductile Iron Pipe Systems*.

In addition, polyethylene encasement for use with ductile iron pipe systems shall consist of three layers of co-extruded linear low density polyethylene (LLDPE), fused into a single thickness of not less than eight mils.

The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

Ductile iron pipe and the polyethylene encasement used to protect it shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, *Manual of Water Supply Practices – Ductile Iron Pipe and Fittings*. Specifically, the wrap shall be overlapped one foot in each direction at joints and secured in place around the pipe, and any wrap at tap locations shall be taped tightly prior to tapping and inspected for any needed repairs following the tap.

All installations shall be carried out by personnel trained and equipped to meet these various requirements.

The installing contractor shall submit an affidavit stating compliance with the requirements and practices of ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, ANSI/AWWA C105/A21.5, AWWA C600 and M41.

Traditional Polyethylene Encasement

In areas where severely aggressive soils are encountered, the use of a polyethylene tube or sheet encasement has been proven to provide highly effective, economical protection. The protection against corrosion provided by loose polyethylene is different in several ways and should not be confused with coatings applied directly to the barrel of the pipe. The most significant difference is its ability to protect without creation of concentration cells at holidays. Also, since the encasement is applied when the pipe is actually put in the ground, coating damage due to shipping, handling, etc., is minimized.

As water may be present in the soil around the pipe, water may also be present between the pipe and wrap. Water inside the polyethylene tubing initially bears some characteristics of the soil environment, and corrosion may start. But within a short period of time initial oxidation depletes the oxygen supply in the water, and other electrochemical corrosion reactions also progress to completion. At this point a state of chemical equilibrium is reached.

Since the first field installation of polyethylene wrap on gray iron pipe in 1958, installations have been made in severely corrosive soils throughout the United States. The success of the polyethylene encasement procedure developed in the United States has been adopted by several other countries, and an International Standard for Polyethylene Sleeving (ISO- 8180) has been developed.

Research by the Ductile Iron Pipe Research Association at several severely corrosive test sites has verified that polyethylene encasement provides a high degree of protection and results in minimal and generally insignificant exterior surface corrosion of either ductile or gray iron pipe thus protected. These findings have been confirmed by the results of numerous investigations of field installations.

Field tests have also indicated that the dielectric capability of polyethylene provides shielding for ductile and gray iron pipe against stray current at most levels encountered in the field.

Because polyethylene encasement is a passive method of protecting ductile iron pipe in aggressive soils, it can effect greater reliability and savings than cathodic protection systems which require continual monitoring, maintenance and other operating expenses, and trained personnel. Cathodic protection systems can also cause collateral harm in some cases to nearby unprotected ferrous structures.

For protection in areas of severely aggressive soils, AWWA C105 covers materials and installation procedures for polyethylene encasement of underground installations of ductile iron piping for water and other liquids.

Polyethylene wrap in tube or sheet form for piping encasement is manufactured of virgin polyethylene material conforming to the requirements of ANSI/ASTM Standard Specification D1248. The specified minimum thickness for linear low-density polyethylene film is 0.008 in. (8 mils). The specified minimum thickness for high-density, cross-laminated polyethylene film is 0.004 in. (4 mils).

Material, required markings, and installation methods are all in accordance with the requirements of AWWA C105. This standard and more detailed publications by DIPRA regarding loose polyethylene encasement are available from AMERICAN.

Traditional Polyethylene Tubing and Tape
ANSI/AWWA C105/A21.5

Tubing in Roll

Table No. 11-3

Pipe Size in.	Flat Tube† Min. Width in.	Approximate Weight in Pounds 8 mil low-density P.E.		Approx. weight (lb.) per 500' roll 4 mil high-density cross-laminated P.E.	Tape Required* Per Joint ft.
		Per 1000' of Tube	Per 22' Long Individual Tube		
4	14	89	2	21	5
6	16	102	3	24	6
8	20	128	3	30	8
0	24	154	4	36	9
12	27	173	4	40	10
14	30	192	5	45	11
16	34	218	5	51	12
18	37	237	6	55	13
20	41	262	6	61	15
24	54	346	8	80	17
30	67	429	10	100	21
36	81	518	12	120	25
42	81	518	12	120	28
48	95	608	14	141	32
54	108	689	16	161	35
60	108	689	16	161	36
64	121	772	18	180	39

*Based on one turn at each end, six 4"–long strips to secure loose wrap plus approximately 5% extra.
†Flat tube widths are shown for Fastite, Flex–Ring, Lok–Ring, and MJ Joints. Check AMERICAN for Flat tube widths required for Flex–Lok Joints.
The standard color for low–density polyethylene is black. It can also be furnished white, green, red, buff, royal blue, and lavender on special order. The standard color for high–density, cross–laminated polyethylene is white. It can also be furnished black on special order.

Installation of Polyethylene Encasement

Installment methods as set forth in ANSI/AWWA C105/A21.5 and DIPRA's "Polyethelyne Encasement" brochure should be followed.