

2004 EDITION

4"-64"

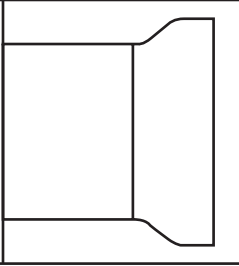
DUCTILE IRON PIPE DESIGN



FOR FIRE PROTECTION, WATER & WASTEWATER

**MORE
THAN
JUST
PIPE.**





DUCTILE IRON PIPE DESIGN

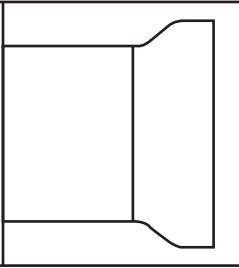


2004 EDITION

P 2

Table of Contents

Ductile Iron Pipe	3
Laying Conditions	5
Design Method and Examples of Selection Method	6
Pressure Class	10
Thickness Class	11
Earth Load Plus Truck Load	12
Internal Pressure	21
Maximum Depth of Cover	22
Products for Water, Waste Water, and Fire Protection	15



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 3

Ductile Iron Pipe

Ductile Iron is a high strength, tough material used in water and wastewater systems in all 50 states of the United States and in many other areas of the world. Continuous testing and field experience have brought the production and use of Ductile Iron pipe to maturity.

Although Ductile Iron is chemically akin to gray iron of low phosphorous content, there are significant differences. Ductile Iron must have a low sulfur content, requiring a desulfurizing treatment when the base metal is melted in a conventional cupola. After this, magnesium is added, which in turn is followed by a post-inoculation treatment with a silicon base alloy. These process steps cause a profound change in the manner that the carbon, as a graphite, is formed during the freezing of the iron. Instead of the interlaced flake form found in gray iron, the graphite develops myriads of isolated spheroids. The matrix becomes relatively continuous, thereby greatly increasing the strength, ductility and impact resistance of the metal.

From the standpoint of mechanical properties, Ductile Iron more nearly resembles steel than gray iron. Ductile Iron has a modulus of elasticity of approximately 24 million psi.

Long-term experience and exhaustive research have clearly established the excellent corrosion resistance of gray cast iron, and in normal environments, it serves indefinitely without special corrosion protection. The fact is well known that in more than 570 utilities in North America, cast iron pipe has served continuously for over a century. The development and use of Ductile Iron pipe made it possible to evaluate its service characteristics as compared to gray iron pipe and it has been confirmed that its corrosion resistance is equal to or greater than the excellent resistance of gray iron pipe. It has also been learned through both laboratory testing and field experience that Ductile Iron is far less susceptible to structural failure resulting from corrosion attack than is gray iron.

Ductile Iron Pipe Research Association (DIPRA) published a proven environmental evaluation system which allows engineers and utilities to determine areas of required external protection for cast gray iron pipe. Knowledge of the comparative corrosion resistance of Ductile Iron pipe makes it proper to apply the same environmental evaluation procedures to this material.

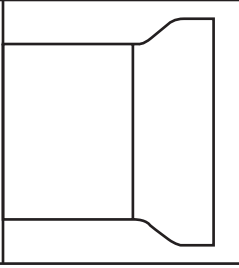
Since years of experience had established that corrosion protection of iron pipe cannot be provided, or even significantly enhanced, by merely increasing pipe wall thickness, DIPRA discovered that loose polyethylene encasement provided excellent protection against soil corrosion as well as stray direct current. This material provides the same complete protection for Ductile Iron as for gray iron pipe. DIPRA has recommended polyethylene encasement for thousands of miles of gray and Ductile Iron pipe in severely corrosive soil areas. Polyethylene encasement has been proven to be an extremely effective and economical corrosion protection system.

ANSI/AWWA Standards

Design methods conform to ANSI/AWWA C150/A21.50.

The mechanical properties of U.S. Ductile Iron pipe conform to ANSI/AWWA C151/A21.51.

NOTE: *If specifiers and users believe that corrosive soils will be encountered where our products are to be installed, please refer to ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile Pipe Systems, for proper external protection procedures.*



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 4

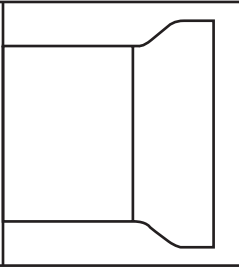
Ductile Iron Pipe (cont.)

In 1971, ANSI Standards Committee A21, under the sponsorship of AWWA, NEWWA, AGA and ASTM (the Committee responsible for the current revision of ANSI/AWWA C150/A21.50) developed ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile Pipe Systems, which provides details on material and installation and incorporates DIPRA's 1968 evaluation procedure as an appendix.

Corrosion resistance data, extensive field service experience and accurate soil evaluation, together with proven corrosion prevention using polyethylene encasement, have demonstrated the correctness of the revision of ANSI/AWWA C150/A21.50. Designers may now approach any known set of field conditions with confidence in the knowledge that properly designed and installed Ductile Iron pipe will not fail because of corrosion.

The 1991 Revisions of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51 include tables with the nominal thickness for each of the standard pressure classes. These standard pressure classes are defined as the rated water working pressure, in psi, of the pipe. The nominal thicknesses shown for these standard pressure classes are adequate for the rated working pressure plus a surge allowance of 100 psi. Other tables in these two standards show the dimensions and weights for special classes of pipe. These "Special Classes" are the thickness classes of the "50" series (i.e. Thickness Class 50, Thickness Class 52, etc.) which have been a part of these standards for a number of years.

U.S. Pipe qualifies for Federal Procurement under Public Law No. 94-580, Section 6002, known as the Resource Recovery Act of 1976, since, due to modern technology, recycled iron and steel scrap is used to a large degree in our Ductile Iron pipe production.



DUCTILE IRON PIPE DESIGN



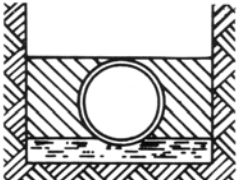
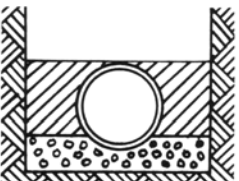
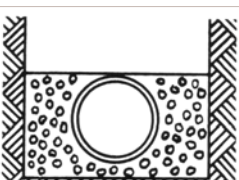


2004 EDITION

P 5

Laying Conditions

Table 1. Design Values for Standard Laying Conditions

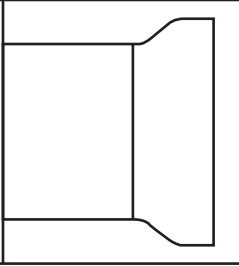
LAYING CONDITIONS	DESCRIPTION	E ¹	BEDDING ANGLE	K _b	K _x
 <p>Type 1*</p>	Flat-bottom trench.† Loose backfill.	150	30°	0.235	0.108
 <p>Type 2</p>	Flat-bottomed trench.† Backfill lightly consolidated to centerline of pipe.	300	45°	0.210	0.105
 <p>Type 3</p>	Pipe bedded in 4" minimum loose soil.†† Backfill lightly consolidated to top of pipe.	400	60°	0.189	0.103
 <p>Type 4</p>	Pipe bedded in sand, gravel or crushed stone to depth of 1/8 pipe diameter, 4" minimum. Backfill compacted to top of pipe. (Approximately 80% Standard Proctor AASHTO T-99.)**	500	90°	0.157	0.096
 <p>Type 5</p>	Pipe bedded to its centerline in compacted granular material, 4" minimum under pipe. Compacted granular or select material†† to top of pipe. (Approximately 90 percent Standard Proctor, AASHTO T-99)**	700	150°	0.128	0.085

*For 14" and larger pipe, consideration should be given to the use of laying conditions other than Type 1.

† "Flat-bottom" is defined as undistributed earth.

†† "Loose soil" or "select material" is defined as native soil excavated from the trench, free of rocks, foreign materials and frozen earth.

** AASHTO T-99, "Standard Method of Test for the Moisture-Density Relations of Soils Using a 5.5 lb. (2.5 kg.) Rammer and a 12 in. (305 mm) Drop." Available from the American Association of State Highway and Transportation Officials, 444 N. Capital St. N.W., Washington, D.C. 20001



Design Method & Examples of Selection Method

The thickness of Ductile Iron pipe is determined by considering trench load and internal pressure separately.

Calculations are made for the thicknesses required to resist the bending stress and the deflection caused by trench load. The larger of the two is selected as the thickness required to resist trench load. Calculations are then made for the thickness required to resist the hoop stress of internal pressure.

The larger of these is selected as the net design thickness. To this net thickness is added a service allowance to obtain the minimum manufacturing thickness, and a casting tolerance to obtain the total calculated thickness.

The standard thickness and the pressure class for specifying and ordering are selected from a table of standard pressure classes. (Table 2, page 10.)

The reverse procedure is used to determine the rated working pressure and maximum depth of cover for pipe of a given class.

Trench Load, P_v . Trench load is expressed as vertical pressure in pounds per square inch and is equal to the sum of earth load P_e and truck load P_t .

Earth Load, P_e . Earth load is computed as the weight of the unit prism of soil with a height equal to the distance from the top of the pipe to the ground surface. The unit weight of backfill soil is taken to be 120 lb/cu ft.

Truck Load, P_t . The truck loads are those specified in ANSI/AWWA C150/A21.50 and are for a single AASHTO H-20 truck on unpaved road or flexible pavement, 16,000-lb. wheel load, and 1.5 impact factor.

Design for Trench Load

The design bending stress f is 48,000 psi, which provides at least a 1.5 safety factor based on minimum ring yield strength and a 2.0 safety factor based on ultimate strength. The design deflection ΔX is 3 percent of the outside diameter of the pipe, which is well below the deflection that might damage cement linings. For a flexible lining, ΔX is limited to 5% of the outside diameter of the pipe. Design values of the trench parameters E^1 , K_b , and K_x are given in Table 1.

Design for Internal Pressure.

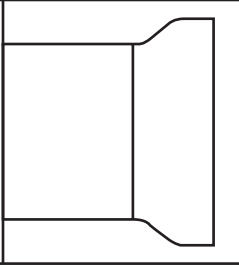
The thickness required to resist the internal working pressure is calculated using the Barlow formula.

$$t = \frac{P_i D}{2S}$$

Where t is the net thickness in inches P_i is the design internal pressure, which is equal to the safety factor of 2.0 times the sum of working pressure (P_w) in pounds per square inch, plus 100 psi surge allowance (P_s). That is $P_i = 2.0 (P_w + P_s)$.

If anticipated surge pressures are greater than 100 psi, then the maximum anticipated pressure must be used. D is the outside diameter of the pipe in inches, and S is the minimum yield strength in tension (42,000 psi).

NOTE: The tables in this brochure are taken from ANSI/AWWA C150/A21.50 and are the standard values of earth load, truck load and surge pressures contained therein. For a more detailed description of the equations, etc. refer to ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 7

Design Examples To Help in Using the Tables in This Brochure

The following are examples of the use of the tables in this brochure. For a more detailed, mathematical design description, please refer to ANSI/AWWA C150/A21.50.

Example No. 1

Select the thickness for 24" Ductile Iron pipe laid on a flat bottom trench with backfill lightly consolidated and laying condition Type 2 under 10 feet of cover for a working pressure of 300 psi.

Step 1. Design for Trench Load

Turn to Table 4 and find the section on 24" pipe. Under the column labeled Depth of Cover enter the table at 10 ft. of cover and find the total calculated thickness under laying condition Type 2. The total calculated thickness for Type 2 laying condition, 24" pipe and 10 ft. of cover is 0.36", use Class 250.

Step 2. Design for Internal Pressure

Turn to Table 2 and enter the table at 24" pipe and find the total calculated thickness under the column marked Class 300. The nominal thickness required is 0.40".

Step 3. Selection of Total Calculated Thickness

Select the larger thickness from Steps 1 and 2.

Step 1 = .36", Use Class 250

Step 2 = .40", Use Class 300

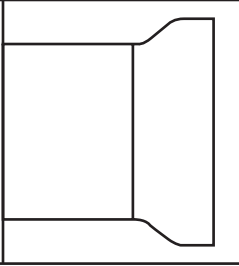
Since the answer derived in Step 2 is greater, the correct pressure class to use is 300, which has .40" metal thickness.

NOTE: A shortcut procedure using the tables in this brochure for Example No. 1 is as follows:

Step 1: For trench loading requirements: Go to the 24" size information in Table 4, page 12. Follow down the second column, Depth of Cover, to 10 feet. For that depth of cover read across horizontally for the pressure class required for the various trench types. In this case, a Type 2 trench requires a pressure class 250 and Type 3 through Type 5 trenches require a pressure class 200. Thus, pressure class 200 is adequate if a Type 3, 4 or 5 trench is used.

Step 2: For internal pressure requirements: Simply use the pressure class, recognizing that the thickness for a pressure class includes a 100 psi surge allowance. Adjustments can be made where the design surge pressure differs from the 100 psi surge allowance. For Example No. 1, the internal pressure requirement necessitates use of a minimum pressure class 300.

Step 3: Selection of pressure class: The trench conditions call for a minimum pressure class 200, whereas internal pressure requires a minimum pressure class 300. Thus, internal pressure controls and pressure class 300 must be used.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 8

Design Examples To Help in Using the Tables in This Brochure (cont.)

Example No. 2

Select the thickness for a 16" Ductile Iron pipe buried under 27' of cover in a Type 4 trench, with 75 psi internal working pressure.

Step 1. Design for Trench Load

Turn to Table 4 and find the section on 16" pipe. Notice that there is no 27' depth of cover listed, therefore, it is necessary to interpolate between 24' and 28' to determine the thickness required.

DEPTH OF COVER Feet	TYPE 4 TOTAL CALCULATED THICKNESS Inches
24	0.30
28	0.34

Interpolating:

$$27 - 24 = 3$$

$$28 - 24 = 4$$

$$.34 - .30 = .04$$

$$(3/4) \times .04 = .03$$

$$.03 + .30 = .33 \text{ Total Calculated Thickness}$$

See Table 2, use Class 350.

Step 2. Design for Internal Pressure

Turn to Table 2

Step 3. Selection of Total Calculated Thickness

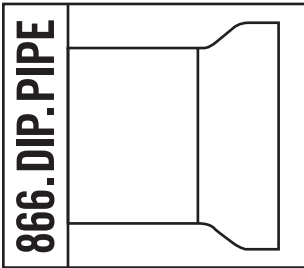
Select the larger thickness from Step 1 and Step 2

Step 1 = .33", Class 350

Step 2 = .30", Class 250

The larger thickness calculated in Step 1 would require Pressure Class 350 pipe be used.

NOTE: For 16" pipe, the lowest nominal thickness available is 0.30" or Class 250.



Design Examples To Help in Using the Tables in This Brochure (cont.)

Example No. 3

A 48" Ductile Iron cement lined gravity sewer is to be installed under 14' of cover beneath the pavement of city streets. Select the proper thickness class and laying conditions.

Step 1. Design for Trench Load

Table 4 gives thickness for 48" pipe using laying conditions Type 2 through Type 5.

For 14' of cover, the following calculated thicknesses and pressure classes are found:

Type 2 = .67", Class 350

Type 3 = .60", Class 300

Type 4 = .49", Class 200

Type 5 = .33", Class 150

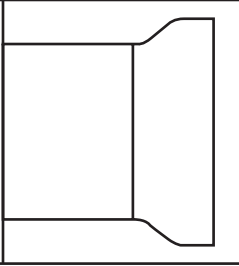
Since this pipe is to be installed beneath city streets a good deal of compaction is required to prevent settlement under the pavement. Also considerable savings in cost of piping can be obtained by choosing a compacted granular bedding. As can be seen above, laying conditions Type 5 offers the most economical pipe. Referring to Table 1, on page 5, laying condition Type 5 is "Pipe bedded in compacted granular material to the centerline of the pipe. Compacted granular or select material to the top of the pipe (approximately 90% Standard Proctor density, AASHTO T-99.)"

Step 2. Internal Pressure Design

Since this is a gravity sewer, internal pressure is assumed to be zero (0) psi. Therefore Pressure Class 150 is adequate.

Step 3. Selection of Total Calculated Thickness

The pressure class selected is dependent on the type of trench used. This example illustrates the designer's choice of pressure classes based on a) the compaction required to support overlying construction and b) piping versus trench costs.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 10

Pressure Class

Table 2. Nominal Thickness for Standard Pressure Classes of Ductile-Iron Pipe

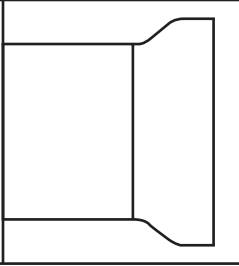
SIZE Inches	OUTSIDE DIAMETER Inches	PRESSURE CLASS*					CASTING TOLERANCES Inches
		NOMINAL THICKNESS Inches					
		150	200	250	300	350	
3	3.96	—	—	—	—	0.25**	0.05
4	4.80	—	—	—	—	0.25**	0.05
6	6.90	—	—	—	—	0.25**	0.05
8	9.05	—	—	—	—	0.25**	0.05
10	11.10	—	—	—	—	0.26	0.06
12	13.20	—	—	—	—	0.28	0.06
14	15.30	—	—	0.28	0.30	0.31	0.07
16	17.40	—	—	0.30	0.32	0.34	0.07
18	19.50	—	—	0.31	0.34	0.36	0.07
20	21.60	—	—	0.33	0.36	0.38	0.07
24	25.80	—	0.33	0.37	0.40	0.43	0.07
30	32.00	0.34	0.38	0.42	0.45	0.49	0.07
36	38.30	0.38	0.42	0.47	0.51	0.56	0.07
42	44.50	0.41	0.47	0.52	0.57	0.63	0.07
48	50.80	0.46	0.52	0.58	0.64	0.70	0.08
54	57.56	0.51	0.58	0.65	0.72	0.79	0.09
60	61.61	0.54	0.61	0.68	0.76	0.83	0.09
64	65.67	0.56	0.64	0.72	0.80	0.87	0.09

NOTE: Per ANSI/AWWA C150/A21.50 the thicknesses above include the 0.08" service allowance and the casting tolerance listed below by size ranges.

Dimensions and weights of Special Classes (Thickness Classes) are found on page 11.

* Pressure classes are defined as the rated water pressure of the pipe in psi. The thicknesses shown are adequate for the rated water working pressure plus a surge allowance of 100 psi. Calculations are based on a minimum yield strength of 42,000 and a 2.0 safety factor times the sum of the working pressure and 100 psi surge allowance.

** Calculated thickness for these sizes and pressure ratings are less than those shown above. Presently these are the lowest nominal thicknesses available in these sizes.



DUCTILE IRON PIPE DESIGN



2004 EDITION

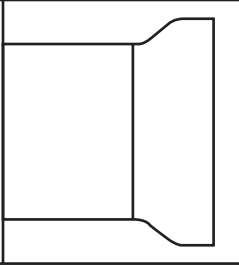
P 11

Thickness Class

Table 3. Special Thickness Classes of Ductile Iron Pipe.

SIZE Inches	OUTSIDE DIAMETER Inches	THICKNESS CLASS Inches						
		50	51	52	53	54	55	56
4	4.80	—	0.26	0.29	0.32	0.35	0.38	0.41
6	6.90	0.25	0.28	0.31	0.34	0.37	0.40	0.43
8	9.05	0.27	0.30	0.33	0.36	0.39	0.42	0.45
10	11.10	0.29	0.32	0.35	0.38	0.41	0.44	0.47
12	13.20	0.31	0.34	0.37	0.40	0.43	0.46	0.49
14	15.30	0.33	0.36	0.39	0.42	0.45	0.48	0.51
16	17.40	0.34	0.37	0.40	0.43	0.46	0.49	0.52
18	19.50	0.35	0.38	0.41	0.44	0.47	0.50	0.53
20	21.60	0.36	0.39	0.42	0.45	0.48	0.51	0.54
24	25.80	0.38	0.41	0.44	0.47	0.50	0.53	0.56
30	32.00	0.39	0.43	0.47	0.51	0.55	0.59	0.63
36	38.30	0.43	0.48	0.53	0.58	0.63	0.68	0.73
42	44.50	0.47	0.53	0.59	0.65	0.71	0.77	0.83
48	50.80	0.51	0.58	0.65	0.72	0.79	0.86	0.93
54	57.56	0.57	0.65	0.73	0.81	0.89	0.97	1.05

NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 12

Earth Load Plus Truck Load

Table 4. Thickness for Earth Load Plus Truck Load

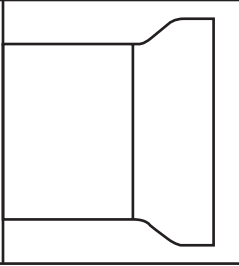
SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
4	2.5	0.19	350	0.18	350	0.17	350	0.16	350	0.15	350
4	3	0.19	350	0.18	350	0.17	350	0.16	350	0.15	350
4	4	0.18	350	0.17	350	0.16	350	0.15	350	0.15	350
4	5	0.18	350	0.17	350	0.16	350	0.15	350	0.15	350
4	6	0.18	350	0.17	350	0.16	350	0.15	350	0.15	350
4	7	0.18	350	0.17	350	0.16	350	0.15	350	0.15	350
4	8	0.18	350	0.17	350	0.16	350	0.15	350	0.15	350
4	9	0.18	350	0.17	350	0.16	350	0.15	350	0.15	350
4	10	0.18	350	0.17	350	0.16	350	0.16	350	0.15	350
4	12	0.19	350	0.18	350	0.17	350	0.16	350	0.15	350
4	14	0.19	350	0.18	350	0.17	350	0.16	350	0.15	350
4	16	0.20	350	0.19	350	0.18	350	0.16	350	0.15	350
4	20	0.21	350	0.20	350	0.19	350	0.17	350	0.15	350
4	24	0.21	350	0.21	350	0.20	350	0.18	350	0.16	350
4	28	0.22	350	0.21	350	0.20	350	0.19	350	0.16	350
4	32	0.23	350	0.22	350	0.21	350	0.19	350	0.16	350
6	2.5	0.22	350	0.20	350	0.19	350	0.17	350	0.16	350
6	3	0.21	350	0.19	350	0.18	350	0.17	350	0.15	350
6	4	0.20	350	0.18	350	0.17	350	0.16	350	0.15	350
6	5	0.19	350	0.18	350	0.17	350	0.16	350	0.15	350
6	6	0.19	350	0.18	350	0.17	350	0.16	350	0.15	350
6	7	0.20	350	0.18	350	0.17	350	0.16	350	0.15	350
6	8	0.20	350	0.18	350	0.17	350	0.16	350	0.15	350
6	9	0.20	350	0.19	350	0.18	350	0.16	350	0.15	350
6	10	0.21	350	0.19	350	0.18	350	0.16	350	0.15	350
6	12	0.21	350	0.20	350	0.18	350	0.17	350	0.16	350
6	14	0.22	350	0.20	350	0.19	350	0.17	350	0.16	350
6	16	0.23	350	0.21	350	0.20	350	0.17	350	0.16	350
6	20	0.24	350	0.22	350	0.21	350	0.18	350	0.16	350
6	24	0.25	350	0.24	350	0.22	350	0.19	350	0.17	350
6	28	—	—	0.25	350	0.23	350	0.21	350	0.17	350
6	32	—	—	—	—	0.24	350	0.22	350	0.17	350

NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 13

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

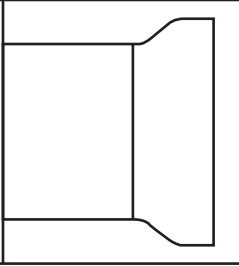
SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
8	2.5	0.24	350	0.22	350	0.21	350	0.18	350	0.16	350
8	3	0.23	350	0.21	350	0.19	350	0.17	350	0.16	350
8	4	0.22	350	0.20	350	0.18	350	0.17	350	0.16	350
8	5	0.21	350	0.19	350	0.18	350	0.17	350	0.16	350
8	6	0.21	350	0.19	350	0.18	350	0.17	350	0.16	350
8	7	0.21	350	0.20	350	0.18	350	0.17	350	0.16	350
8	8	0.22	350	0.20	350	0.19	350	0.17	350	0.16	350
8	9	0.22	350	0.20	350	0.19	350	0.17	350	0.16	350
8	10	0.23	350	0.21	350	0.19	350	0.17	350	0.16	350
8	12	0.24	350	0.22	350	0.20	350	0.18	350	0.16	350
8	14	0.25	350	0.23	350	0.21	350	0.18	350	0.16	350
8	16	0.25	350	0.24	350	0.22	350	0.19	350	0.17	350
8	20	—	—	0.25	350	0.23	350	0.20	350	0.17	350
8	24	—	—	—	—	0.25	350	0.21	350	0.17	350
8	28	—	—	—	—	—	—	0.23	350	0.18	350
8	32	—	—	—	—	—	—	0.25	350	0.19	350
10	2.5	—	—	0.25	350	0.23	350	0.20	350	0.18	350
10	3	0.26	350	0.24	350	0.22	350	0.19	350	0.18	350
10	4	0.25	350	0.22	350	0.21	350	0.19	350	0.17	350
10	5	0.24	350	0.22	350	0.20	350	0.18	350	0.17	350
10	6	0.24	350	0.22	350	0.20	350	0.18	350	0.17	350
10	7	0.24	350	0.22	350	0.20	350	0.19	350	0.17	350
10	8	0.25	350	0.22	350	0.21	350	0.19	350	0.17	350
10	9	0.25	350	0.23	350	0.21	350	0.19	350	0.17	350
10	10	0.26	350	0.23	350	0.21	350	0.19	350	0.17	350
10	12	—	—	0.24	350	0.22	350	0.20	350	0.18	350
10	14	—	—	0.26	350	0.23	350	0.20	350	0.18	350
10	16	—	—	—	—	0.24	350	0.21	350	0.18	350
10	20	—	—	—	—	—	—	0.22	350	0.19	350
10	24	—	—	—	—	—	—	0.24	350	0.19	350
10	28	—	—	—	—	—	—	0.26	350	0.20	350
10	32	—	—	—	—	—	—	—	—	0.21	350

NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 14

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
12	2.5	—	—	0.27	350	0.25	350	0.21	350	0.19	350
12	3	0.28	350	0.25	350	0.23	350	0.20	350	0.18	350
12	4	0.26	350	0.24	350	0.22	350	0.19	350	0.18	350
12	5	0.26	350	0.23	350	0.21	350	0.19	350	0.18	350
12	6	0.26	350	0.23	350	0.21	350	0.19	350	0.18	350
12	7	0.26	350	0.23	350	0.21	350	0.19	350	0.18	350
12	8	0.27	350	0.24	350	0.22	350	0.20	350	0.18	350
12	9	0.27	350	0.24	350	0.22	350	0.20	350	0.18	350
12	10	0.28	350	0.25	350	0.23	350	0.20	350	0.18	350
12	12	—	—	0.26	350	0.24	350	0.21	350	0.18	350
12	14	—	—	0.28	350	0.25	350	0.21	350	0.19	350
12	16	—	—	—	—	0.26	350	0.22	350	0.19	350
12	20	—	—	—	—	—	—	0.24	350	0.20	350
12	24	—	—	—	—	—	—	0.26	350	0.20	350
12	28	—	—	—	—	—	—	0.28	350	0.21	350
12	32	—	—	—	—	—	—	—	—	0.23	350
14	2.5	‡	‡	0.29	300	0.26	250	0.23	250	0.20	250
14	3			0.28	250	0.25	250	0.22	250	0.20	250
14	4			0.26	250	0.24	250	0.21	250	0.19	250
14	5			0.25	250	0.23	250	0.21	250	0.19	250
14	6			0.25	250	0.23	250	0.21	250	0.19	250
14	7			0.26	250	0.24	250	0.21	250	0.19	250
14	8			0.26	250	0.24	250	0.21	250	0.19	250
14	9			0.27	250	0.24	250	0.22	250	0.19	250
14	10			0.28	250	0.25	250	0.22	250	0.20	250
14	12			0.29	300	0.26	250	0.23	250	0.20	250
14	14			0.31	350	0.28	250	0.23	250	0.20	250
14	16			—	—	0.29	300	0.24	250	0.21	250
14	20			—	—	—	—	0.26	250	0.21	250
14	24			—	—	—	—	0.29	300	0.22	250
14	28			—	—	—	—	—	—	0.25	250
14	32			—	—	—	—	—	—	0.27	250

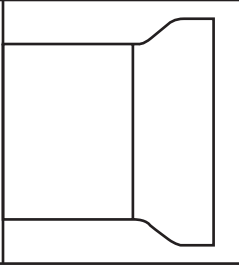
NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 15

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
16	2.5	‡	‡	0.31	300	0.27	250	0.23	250	0.21	250
16	3			0.29	250	0.26	250	0.23	250	0.20	250
16	4			0.27	250	0.25	250	0.22	250	0.20	250
16	5			0.27	250	0.24	250	0.22	250	0.20	250
16	6			0.27	250	0.24	250	0.22	250	0.20	250
16	7			0.27	250	0.25	250	0.22	250	0.20	250
16	8			0.28	250	0.25	250	0.22	250	0.20	250
16	9			0.28	250	0.26	250	0.22	250	0.20	250
16	10			0.29	250	0.26	250	0.23	250	0.20	250
16	12			0.31	300	0.28	250	0.24	250	0.21	250
16	14			0.33	350	0.29	250	0.24	250	0.21	250
16	16			—	—	0.31	300	0.25	250	0.21	250
16	20			—	—	0.34	350	0.28	250	0.22	250
16	24			—	—	—	—	0.30	250	0.24	250
16	28			—	—	—	—	0.34	350	0.27	250
16	32			—	—	—	—	—	—	0.29	250
18	2.5	‡	‡	0.32	300	0.28	250	0.24	250	0.21	250
18	3			0.30	250	0.27	250	0.23	250	0.21	250
18	4			0.28	250	0.26	250	0.23	250	0.20	250
18	5			0.28	250	0.25	250	0.22	250	0.20	250
18	6			0.28	250	0.25	250	0.22	250	0.20	250
18	7			0.28	250	0.26	250	0.23	250	0.20	250
18	8			0.29	250	0.26	250	0.23	250	0.20	250
18	9			0.30	250	0.27	250	0.23	250	0.21	250
18	10			0.31	250	0.28	250	0.24	250	0.21	250
18	12			0.33	300	0.29	250	0.24	250	0.21	250
18	14			0.35	350	0.31	250	0.25	250	0.22	250
18	16			—	—	0.33	300	0.26	250	0.22	250
18	20			—	—	—	—	0.29	250	0.23	250
18	24			—	—	—	—	0.32	300	0.26	250
18	28			—	—	—	—	0.36	350	0.29	250
18	32			—	—	—	—	—	—	0.32	300

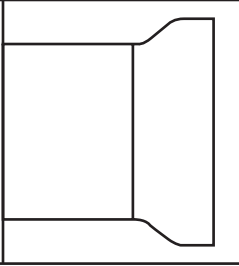
NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 16

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
20	2.5	‡	‡	0.33	250	0.29	250	0.25	250	0.21	250
20	3			0.31	250	0.28	250	0.24	250	0.21	250
20	4			0.30	250	0.27	250	0.23	250	0.21	250
20	5			0.29	250	0.26	250	0.23	250	0.20	250
20	6			0.29	250	0.26	250	0.23	250	0.20	250
20	7			0.30	250	0.27	250	0.23	250	0.21	250
20	8			0.30	250	0.27	250	0.24	250	0.21	250
20	9			0.31	250	0.28	250	0.24	250	0.21	250
20	10			0.32	250	0.29	250	0.24	250	0.21	250
20	12			0.35	300	0.31	250	0.25	250	0.22	250
20	14			0.37	350	0.33	250	0.26	250	0.22	250
20	16			—	—	0.35	300	0.28	250	0.23	250
20	20			—	—	—	—	0.32	250	0.24	250
20	24			—	—	—	—	0.35	300	0.28	250
20	28			—	—	—	—	0.38	350	0.32	250
20	32			—	—	—	—	—	—	0.35	300
24	2.5	‡	‡	0.36	250	0.32	200	0.26	200	0.22	200
24	3			0.33	200	0.30	200	0.25	200	0.22	200
24	4			0.32	200	0.29	200	0.25	200	0.21	200
24	5			0.31	200	0.28	200	0.24	200	0.21	200
24	6			0.31	200	0.28	200	0.24	200	0.21	200
24	7			0.32	200	0.29	200	0.25	200	0.22	200
24	8			0.33	200	0.30	200	0.25	200	0.22	200
24	9			0.35	250	0.30	200	0.26	200	0.22	200
24	10			0.36	250	0.31	200	0.26	200	0.22	200
24	12			0.39	300	0.33	200	0.27	200	0.23	200
24	14			0.41	350	0.36	250	0.29	200	0.24	200
24	16			—	—	0.38	300	0.31	200	0.24	200
24	20			—	—	—	—	0.36	250	0.26	200
24	24			—	—	—	—	0.40	300	0.32	200
24	28			—	—	—	—	0.43	350	0.37	250
24	32			—	—	—	—	—	—	0.40	300

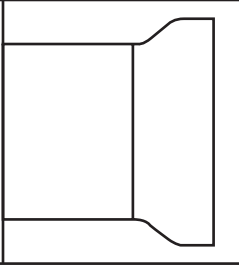
NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 17

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
30	2.5	‡	‡	0.40	250	0.34	150	0.29	150	0.24	150
30	3			0.37	200	0.33	150	0.28	150	0.23	150
30	4			0.36	200	0.32	150	0.27	150	0.23	150
30	5			0.35	200	0.31	150	0.26	150	0.23	150
30	6			0.35	200	0.31	150	0.27	150	0.23	150
30	7			0.36	200	0.32	150	0.27	150	0.23	150
30	8			0.37	200	0.33	150	0.27	150	0.23	150
30	9			0.39	250	0.34	150	0.28	150	0.24	150
30	10			0.41	250	0.35	200	0.29	150	0.24	150
30	12			0.44	300	0.38	200	0.30	150	0.25	150
30	14			0.48	350	0.41	250	0.33	150	0.26	150
30	16			—	—	0.44	300	0.37	200	0.26	150
30	20			—	—	—	—	0.43	300	0.29	150
30	24			—	—	—	—	0.48	350	0.38	200
30	28			—	—	—	—	—	—	0.44	300
30	32			—	—	—	—	—	—	0.48	350
36	2.5	‡	‡	0.43	250	0.37	150	0.31	150	0.25	150
36	3			0.41	200	0.36	150	0.30	150	0.25	150
36	4			0.39	200	0.34	150	0.29	150	0.24	150
36	5			0.39	200	0.34	150	0.29	150	0.24	150
36	6			0.39	200	0.34	150	0.29	150	0.24	150
36	7			0.40	200	0.35	150	0.29	150	0.24	150
36	8			0.42	200	0.36	150	0.30	150	0.25	150
36	9			0.44	250	0.38	150	0.31	150	0.25	150
36	10			0.46	250	0.39	200	0.31	150	0.26	150
36	12			0.50	300	0.42	200	0.33	150	0.27	150
36	14			0.54	350	0.46	250	0.38	150	0.28	150
36	16			—	—	0.50	300	0.43	250	0.29	150
36	20			—	—	—	—	0.51	300	0.33	150
36	24			—	—	—	—	0.56	350	0.44	250
36	28			—	—	—	—	—	—	0.51	300
36	32			—	—	—	—	—	—	0.56	350

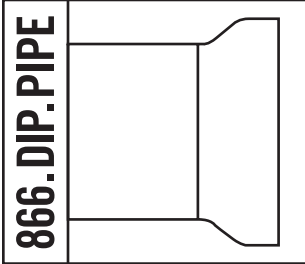
NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN

2004 EDITION P 18

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load (cont.)

SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
42	2.5	‡	‡	0.47	200	0.40	150	0.32	150	0.27	150
42	3			0.44	200	0.38	150	0.31	150	0.26	150
42	4			0.42	200	0.37	150	0.30	150	0.25	150
42	5			0.43	200	0.37	150	0.31	150	0.26	150
42	6			0.43	200	0.37	150	0.31	150	0.26	150
42	7			0.44	200	0.38	150	0.31	150	0.26	150
42	8			0.46	200	0.40	150	0.32	150	0.26	150
42	9			0.48	250	0.41	150	0.33	150	0.27	150
42	10			0.50	250	0.43	200	0.34	150	0.27	150
42	12			0.55	300	0.47	200	0.36	150	0.28	150
42	14			0.60	350	0.52	250	0.43	200	0.30	150
42	16			—	—	0.57	300	0.49	250	0.31	150
42	20			—	—	—	—	0.57	300	0.38	150
42	24			—	—	—	—	—	—	0.50	250
42	28			—	—	—	—	—	—	0.58	350
42	32			—	—	—	—	—	—	0.63	350
48	2.5	‡	‡	0.50	200	0.44	150	0.35	150	0.29	150
48	3			0.48	200	0.42	150	0.34	150	0.28	150
48	4			0.46	150	0.41	150	0.33	150	0.28	150
48	5			0.47	200	0.41	150	0.34	150	0.28	150
48	6			0.48	200	0.41	150	0.34	150	0.28	150
48	7			0.49	200	0.43	150	0.35	150	0.28	150
48	8			0.51	200	0.44	150	0.35	150	0.29	150
48	9			0.54	250	0.46	150	0.37	150	0.29	150
48	10			0.56	250	0.48	200	0.38	150	0.30	150
48	12			0.62	300	0.54	250	0.40	150	0.31	150
48	14			0.67	350	0.60	300	0.49	200	0.33	150
48	16			—	—	0.65	350	0.56	250	0.34	150
48	20			—	—	—	—	0.66	350	0.43	150
48	24			—	—	—	—	—	—	0.57	250
48	28			—	—	—	—	—	—	0.66	350

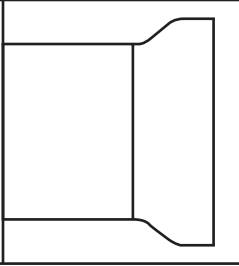
NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 19

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
54	2.5	‡	‡	0.54	200	0.47	150	0.38	150	0.31	150
54	3			0.53	200	0.46	150	0.37	150	0.30	150
54	4			0.51	150	0.44	150	0.36	150	0.30	150
54	5			0.52	200	0.45	150	0.37	150	0.30	150
54	6			0.53	200	0.46	150	0.37	150	0.30	150
54	7			0.54	200	0.47	150	0.38	150	0.31	150
54	8			0.57	200	0.49	150	0.39	150	0.32	150
54	9			0.60	250	0.51	150	0.40	150	0.32	150
54	10			0.63	250	0.53	200	0.41	150	0.33	150
54	12			0.69	300	0.61	250	0.44	150	0.34	150
54	14			0.75	350	0.68	300	0.55	200	0.36	150
54	16			—	—	0.73	350	0.63	250	0.37	150
54	20			—	—	—	—	0.74	350	0.48	150
54	24			—	—	—	—	—	—	0.64	250
54	28			—	—	—	—	—	—	0.74	350
60	2.5	‡	‡	0.56	200	0.48	150	0.39	150	0.32	150
60	3			0.54	150	0.47	150	0.38	150	0.31	150
60	4			0.53	150	0.46	150	0.38	150	0.31	150
60	5			0.54	150	0.47	150	0.38	150	0.31	150
60	6			0.55	200	0.48	150	0.39	150	0.31	150
60	7			0.57	200	0.49	150	0.39	150	0.32	150
60	8			0.59	200	0.51	150	0.40	150	0.33	150
60	9			0.63	250	0.53	150	0.42	150	0.33	150
60	10			0.67	250	0.55	200	0.43	150	0.34	150
60	12			0.74	300	0.65	250	0.46	150	0.35	150
60	14			0.79	350	0.72	300	0.58	200	0.37	150
60	16			—	—	0.78	350	0.67	250	0.38	150
60	20			—	—	—	—	0.79	350	0.51	150
60	24			—	—	—	—	—	—	0.68	250
60	28			—	—	—	—	—	—	0.79	350

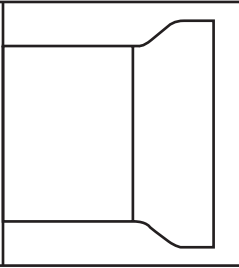
NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 20

Earth Load Plus Truck Load (cont.)

Table 4. Thickness for Earth Load Plus Truck Load

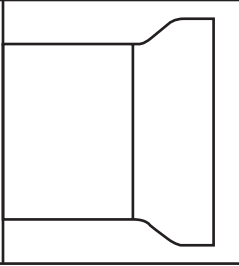
SIZE Inches	DEPTH OF COVER* Feet	LAYING CONDITIONS									
		TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5	
		TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS† Inches	USE PRESSURE CLASS
64	2.5	‡	‡	0.58	200	0.50	150	0.40	150	0.32	150
64	3			0.56	150	0.49	150	0.39	150	0.32	150
64	4			0.55	150	0.48	150	0.39	150	0.32	150
64	5			0.56	150	0.48	150	0.39	150	0.32	150
64	6			0.57	200	0.49	150	0.40	150	0.32	150
64	7			0.59	200	0.51	150	0.41	150	0.33	150
64	8			0.62	200	0.53	150	0.42	150	0.33	150
64	9			0.67	250	0.55	150	0.43	150	0.34	150
64	10			0.70	250	0.58	200	0.45	150	0.35	150
64	12			0.78	300	0.68	250	0.48	150	0.37	150
64	14			0.84	350	0.76	300	0.61	200	0.38	150
64	16			—	—	0.82	350	0.70	250	0.40	150
64	20			—	—	—	—	0.83	350	0.54	150
64	24			—	—	—	—	—	—	0.72	250
64	28			—	—	—	—	—	—	0.83	350

NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048.

*Pipe may be available for depths of cover greater than those shown in the table.

†Total calculated thickness includes service allowance and casting tolerance added to net thickness.

‡For pipe 14" (350 mm) and larger, consideration should be given to laying conditions other than Type 1.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 21

Internal Pressure

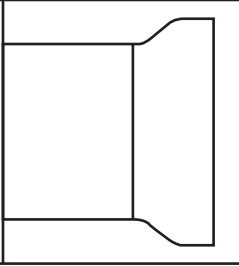
Table 5. Thickness for Internal Pressure

PIPE SIZE Inches	RATED WATER WORKING PRESSURE psi									
	150		200		250		300		350	
	TOTAL CALCULATED THICKNESS* Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS Inches	USE PRESSURE CLASS	TOTAL CALCULATED THICKNESS Inches	USE PRESSURE CLASS
4	0.16	350	0.16	350	0.17	350	0.18	350	0.18	350
6	0.17	350	0.18	350	0.19	350	0.20	350	0.20	350
8	0.18	350	0.19	350	0.21	350	0.22	350	0.23	350
10	0.21	350	0.22	350	0.23	350	0.25	350	0.26	350
12	0.22	350	0.23	350	0.25	350	0.27	350	0.28	350
14	0.24	250	0.26	250	0.28	250	0.30	300	0.31	350
16	0.25	250	0.27	250	0.30	250	0.32	300	0.34	350
18	0.27	250	0.29	250	0.31	250	0.34	300	0.36	350
20	0.28	250	0.03	250	0.33	250	0.36	300	0.38	350
24	0.30	200	0.33	200	0.37	250	0.40	300	0.43	350
30	0.34	150	0.38	200	0.42	250	0.45	300	0.49	350
36	0.38	150	0.42	200	0.47	250	0.51	300	0.56	350
42	0.41	150	0.47	200	0.52	250	0.57	300	0.63	350
48	0.46	150	0.52	200	0.58	250	0.64	300	0.70	350
54	0.51	150	0.58	200	0.65	250	0.72	300	0.79	350
60	0.54	150	0.61	200	0.68	250	0.76	300	0.83	350
64	0.56	150	0.64	200	0.72	250	0.80	300	0.87	350

NOTE: To convert inches (in.) to millimeters (mm), multiply by 25.4; to convert pounds per square inch (psi) to kilopascals (kPa), multiply by 6.895.

The thicknesses shown are adequate for the rated working pressure plus a surge allowance of 100 psi (689 kPa). Calculations are based on a minimum yield strength in tension of 42,000 psi (290 MPa) and a 2.0 safety factor times the sum of working pressure and 100 psi (689 kPa) surge allowance.

*Total calculated thickness includes service allowance and casting tolerance added to net thickness.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 22

Maximum Depth of Cover

Table 6. Rated Working Pressure and Maximum Depth of Cover

SIZE Inches	PRESSURE CLASS* psi	NOMINAL THICKNESS Inches	LAYING CONDITION				
			MAXIMUM DEPTH OF COVER† Feet				
			TYPE 1 Trench	TYPE 2 Trench	TYPE 3 Trench	TYPE 4 Trench	TYPE 5 Trench
4	350	0.25	53	61	69	85	100†
6	350	0.25	26	31	37	47	65
8	350	0.25	16	20	25	34	50
10	350	0.26	11§	15	19	28	45
12	350	0.28	10§	15	19	28	44
14	250	0.28	**	11§	15	23	36
14	300	0.30	**	13	17	26	42
14	350	0.31	**	14	19	27	44
16	250	0.30	**	11§	15	24	34
16	300	0.32	**	13	17	26	39
16	350	0.34	**	15	20	28	44
18	250	0.31	**	10§	14	22	31
18	300	0.34	**	13	17	26	36
18	350	0.36	**	15	19	28	41
20	250	0.33	**	10	14	22	30
20	300	0.36	**	13	17	26	35
20	350	0.38	**	15	19	28	38
24	200	0.33	**	8§	12	17	25
24	250	0.37	**	11	15	20	29
24	300	0.40	**	13	17	24	32
24	350	0.43	**	15	19	28	37
30	150	0.34	**	—	9	14	22
30	200	0.38	**	8§	12	16	24
30	250	0.42	**	11	15	19	27
30	300	0.45	**	12	16	21	29
30	350	0.49	**	15	19	25	33
36	150	0.38	**	—	9	14	21
36	200	0.42	**	8§	12	15	23
36	250	0.47	**	10	14	18	25
36	300	0.51	**	12	16	20	28
36	350	0.56	**	15	19	24	32

NOTE: To convert inches (in.) into millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048; and to convert pounds per square inch (psi) into kilopascals (kPa), multiply by 6.895.

Calculations are based on a 2.0 safety factor times the sum of working pressure and 100 psi (689 kPa) surge allowance. Ductile Iron pipe for working pressures higher than 350 psi (2413 kPa) is available.

*Ductile Iron pipe is adequate for the rated working pressure indicated for each nominal size plus a surge allowance of 100 psi (689 kPa).

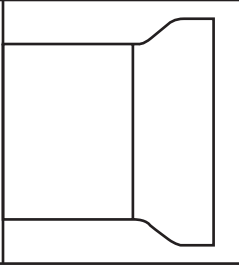
†An allowance for a single H-20 truck with 1.5 impact factor is included for all depths of cover.

‡Calculated maximum depth of cover exceeds 100 ft. (30.5 m).

§Minimum allowable depth of cover is 3 ft. (0.9 m).

**For pipe 14" (350 mm) and larger, consideration should be given to the use of laying conditions other than Type 1.

Table continued on next page.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 23

Maximum Depth of Cover (cont.)

Table 6. Rated Working Pressure and Maximum Depth of Cover

SIZE Inches	PRESSURE CLASS* psi	NOMINAL THICKNESS Inches	LAYING CONDITION				
			MAXIMUM DEPTH OF COVER† Feet				
			TYPE 1 Trench	TYPE 2 Trench	TYPE 3 Trench	TYPE 4 Trench	TYPE 5 Trench
42	150	0.41	**	—	9	13	20
42	200	0.47	**	8	12	15	22
42	250	0.52	**	10	14	17	25
42	300	0.57	**	12	16	20	27
42	350	0.63	**	15	19	23	32
48	150	0.46	**	—	9	13	20
48	200	0.52	**	8	11	15	22
48	250	0.58	**	10	13	17	24
48	300	0.64	**	12	15	19	27
48	350	0.70	**	15	18	22	30
54	150	0.51	**	—	9	13	20
54	200	0.58	**	8	11	14	22
54	250	0.65	**	10	13	16	24
54	300	0.72	**	13	15	19	27
54	350	0.79	**	15	18	22	30
60	150	0.54	**	5‡	9	13	20
60	200	0.61	**	8	11	14	22
60	250	0.68	**	10	13	16	24
60	300	0.76	**	13	15	19	26
60	350	0.83	**	15	18	22	30
64	150	0.56	**	5‡	9	13	20
64	200	0.64	**	8	11	14	21
64	250	0.72	**	10	13	16	24
64	300	0.80	**	12	15	19	26
64	350	0.87	**	15	17	21	29

NOTE: To convert inches (in.) into millimeters (mm), multiply by 25.4; to convert feet (ft.) to meters (m), multiply by 0.3048; and to convert pounds per square inch (psi) into kilopascals (kPa), multiply by 6.895.

Calculations are based on a 2.0 safety factor times the sum of working pressure and 100 psi (689 kPa) surge allowance. Ductile Iron pipe for working pressures higher than 350 psi (2413 kPa) is available.

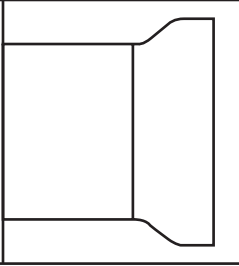
*Ductile Iron pipe is adequate for the rated working pressure indicated for each nominal size plus a surge allowance of 100 psi (689 kPa).

†An allowance for a single H-20 truck with 1.5 impact factor is included for all depths of cover.

‡Calculated maximum depth of cover exceeds 100 ft. (30.5 m).

§Minimum allowable depth of cover is 3 ft. (0.9 m).

**For pipe 14" (350 mm) and larger, consideration should be given to the use of laying conditions other than Type 1.



DUCTILE IRON PIPE DESIGN



2004 EDITION

P 24

Products for Water, Wastewater and Fire Protection

Ductile Iron Pipe	SIZE RANGE
TYTON JOINT® Pipe	4"-64" Ductile Iron
Mechanical Joint Pipe	4"-12" Ductile Iron
TR FLEX® Pipe	4"-64" Ductile Iron
Flanged Pipe	3"-64" Ductile Iron
USIFLEX® Boltless Flexible Joint Pipe -- for Subaqueous Installations	4"-48" Ductile Iron
Restrained Joints	
TR FLEX® Pipe	4"-64" Ductile Iron
FIELD LOK 350® Gaskets	4"-24"
FIELD LOK® Gasket	30", 36"
TR FLEX GRIPPER® Rings	4"-36" Ductile Iron
TR TELE FLEX® Assemblies	4"-24" Ductile Iron
FIELD-FLANGE 350® Fittings	4"-24" Ductile Iron
Ductile Iron Fittings	
TYTON® Fittings	14"-64" Ductile Iron
TRIM TYTON® Fittings	4"-12" Ductile Iron
TR FLEX® Fittings and TR FLEX® Telescoping Sleeves	4"-64" Ductile Iron
Mechanical Joint Fittings	3"-48" Ductile Iron
TRIM TYTE® MJ Fittings	3"-48" Ductile Iron
Flanged Fittings	3"-64" Ductile Iron
XTRA FLEX® Couplings	4"-24" Ductile Iron
M-Series Hydrants	
AWWA Dry Barrel hydrants - METROPOLITAN®/M-94 METROFLOW®/M-03	4-1/2" or 5-1/4" Valve Opening
Valves	
AWWA Resilient Seated Gate Valves - METROSEAL® R/S Gate Valves	3"-36"
Double Disc Gate Valves	16"-60", AWWA C500
Miscellaneous Products	
PROTECTO 401™ Lined Ductile Iron Pipe for Domestic Sewage and Industrial Wastes	4"-64" Ductile Iron
FLANGE-TYTE® Gaskets	4"-64"
Polymeric Coatings and Linings	For all pipe sizes
Saddle Outlets	Various Ductile Iron
Welded Outlets	Various Ductile Iron
Polyethylene Encasement	4"-64"
Tapping Sleeves and Valves	All sizes
Tapping Machines	3"-16"



*All U.S. Pipe brochures and/or products are
subject to change without further notice.*

P.O. BOX 10406
BIRMINGHAM, AL 35202
866.DIP.PIPE (866.347.7473)
FAX: 205.254.7165
EMAIL: INFO@USPIPE.COM
WWW.USPIPE.COM

**MORE
THAN
JUST
PIPE.**

