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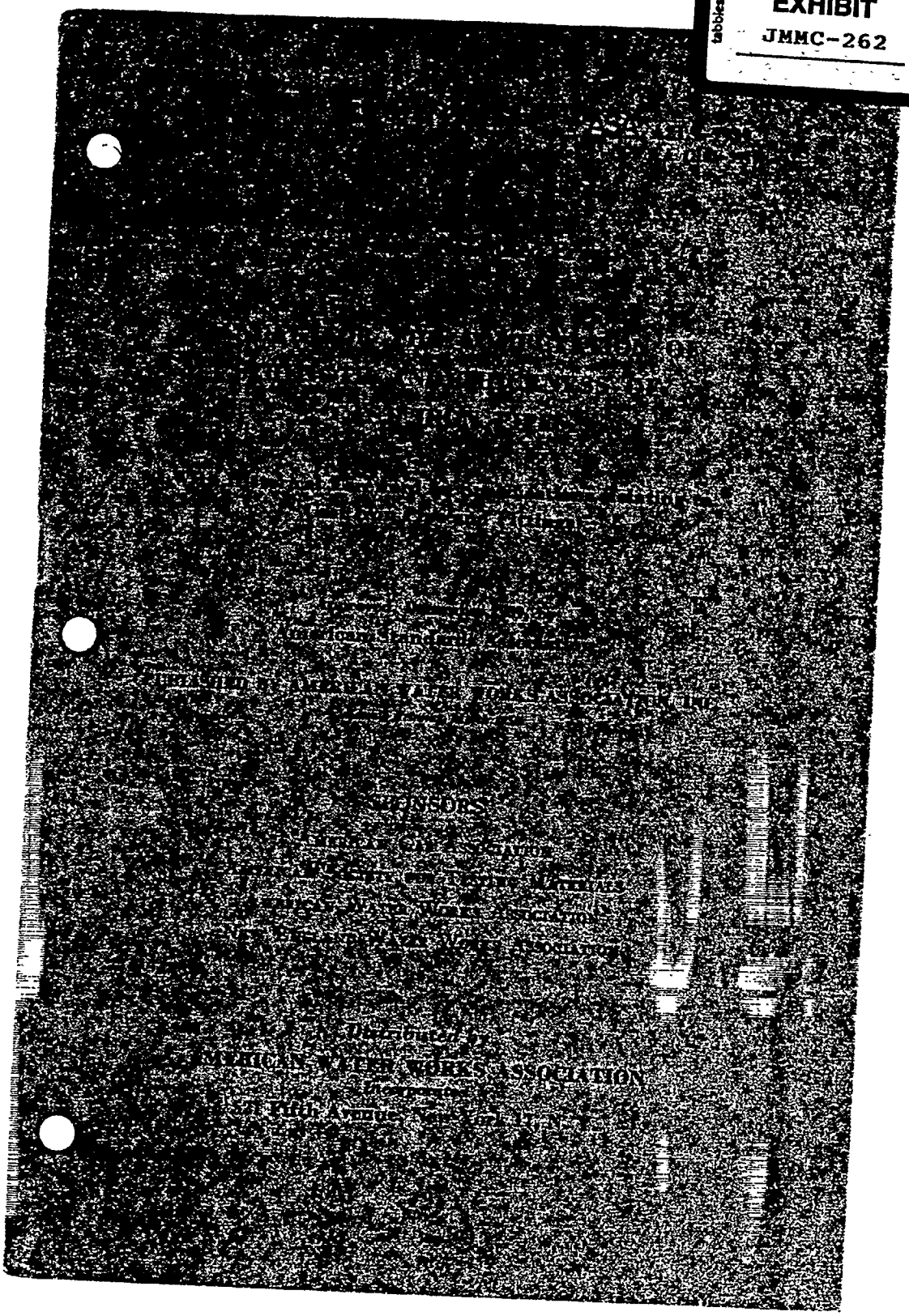

FOREWORD

On September 10, 1902, the New England Water Works Association adopted Standard Specifications for Cast Iron Pipe and Special Castings. These covered bell and spigot pipe and fittings and contained ten classes, A to K. The allowable heads for these classes were not given in the specifications but the thicknesses were based on allowable heads varying by 50 feet; 50-ft. head for Class A, 100-ft. head for Class B, up to 500-ft. head for Class K. Fairly complete dimensions were given, also weights of pipe and fittings.

In 1904 the American Society for Testing Materials adopted Standard Specifications for Cast Iron Pipe and Special Castings. These covered bell and spigot pipe and fittings and contained four classes, A to D, with allowable working heads varying by 100-ft.; 100-ft. head for Class A to 400-ft. head for Class D. Dimensions and weights of pipe were given.

On May 12, 1908, the American Water Works Association adopted Standard Specifications for Cast Iron Pipe and Special Castings. These covered bell and spigot pipe and fittings and contained eight classes, A to H, with allowable working heads varying by 100 feet; 100-ft. head for Class A to 800-ft. head for Class H. Fairly complete dimensions were given, also weights of pipe and fittings. Classes A to D were the same in thickness as in the A.S.T.M. Specifications

The Sectional Committee (A21) on Specifications for Cast Iron Pipe and Special Castings, which developed the specifications contained herein, was organized in 1926 under the rules of the American Engineering Standards Committee, now the American Standards Association. The sponsor societies are the American Gas Association, the American Society for Testing Materials, the American

Water Works Association and the New England Water Works Association. Committee A21 was assigned the following scope:

"Unification of specifications for cast iron pipe, including: materials; dimensions; pressure ratings; methods of manufacture (including such new developments as centrifugal casting), in so far as they may be necessary to secure satisfactory specifications; elimination of unnecessary sizes and varieties; consideration of the possibility of developing a coordinated scheme of metallic pipe and fittings applicable to all common mediums; and methods of making up joints in so far as they are determining as to the dimensional design of cast iron pipe.

The types of cast iron pipe to include: bell and spigot pipe; flanged pipe; flanged and bell mouth fittings and wall castings; pipe elbows, tees, Y's, return bends and other fittings not now included in standard lists; cast iron pipe threaded for flanges or couplings; soil pipe and other light types of cast iron pipe and fittings. The standardization is not to include methods of installing pipe and similar matters, except as to the making up of joints in its relationship to the dimensional standardization of pipe and fittings, as noted above."

At the Committee's request soil pipe was assigned to another committee. Screw fittings have been omitted from the work of the Committee.

Specifications are being issued, simultaneously with this Manual, on Cast Iron Pit Cast Pipe for Water or Other Liquids (A.S.A. A21.2-1939) and on Cement Mortar Lining for Cast Iron Pipe and Fittings (A.S.A. A21.4-1939). Committee A21 has in preparation specifications on Cast Iron Pit Cast Pipe for Gas, on pipes other than pit cast, including pipe cast centrifugally, on Cast Iron Bell and Spigot Fittings, on Cast Iron Flanged Pipe and Fittings, and on Coal-Tar Dip Coating for Cast Iron Pipe and Fittings.

Committee A21 has had the benefit of a fund for tests and research, provided largely by the producers. Records of tests made and conclusions drawn have been or will be published in separate volumes. These tests include tests of corrosion of different kinds of cast iron; tests of pipe under combined earth and internal pressures, upon which designs of barrel of pipe have been based; tests of hydraulic friction losses in fittings; bursting tests of pipe and fittings; tests of holding strength and deflection of bell and spigot joints; tests of lugs and harness for bell and spigot joints; tests of welded clips for use with harness. The publications already issued and those projected are listed.

Publications Developed under the Committee's Direction

Investigation of Bell and Spigot Joints in Cast Iron Pipe. By John C. Prior, January, 1935, being Bulletin No. 87, Engineering Experiment Station, Ohio State University; 57 pages, price 50 cents.
Part 1—Pull Out Strength; Part 2—Bell Strength; Part 3—Harness Strength.
Note: Work participated in by Cast Iron Pipe Research Association, City of Columbus, Ohio, and Committee A21.

Long versus Short Body Fittings for Water Supply.
Part I—Loss of Head Caused by Bends, Tees and Crosses. By Ernest W. Schoder and Arthur N. Vanderlip.
Part II—Economic Comparison. By Allen T. Ricketts and Thos. H. Wiggin.
Cornell University Engineering Experiment Station, Bulletin No. 20, September, 1935. 102 pages; Price $1.25.

Report of Tests to Determine the Shearing Strength of Steel Anchor Clips Bronze Welded to Cast Iron Pipe.
By W. J. Krefeld, Engineer of Tests, Civil Engineering Laboratories, Columbia University in New York City, with Memorandum by Leonard P. Wood of Committee A21. Published in 1936 by Committee A21, 18 pp., 25 cents.

Strength and Elastic Properties of Cast Iron.
By W. J. Schlick and Bernard A. Moore. Bulletin 127, Iowa Engineering Experiment Station, June, 1936; 95 pages.
(Note: Work described was mostly not done for Committee A21 but was related to it, done in same period and shows some correlations with results of work done for Committee A21.)

Publications Projected

Bulletin of University of Illinois, Engineering Experiment Station, describing bursting tests, beam tests and many other miscellaneous tests on cast iron pipe and fittings. By Dean M. L. Enger.

Bulletin of Iowa State College, describing tests of cast iron pipe supported in various ways and with exterior loads only or with various combinations of exterior load and interior pressure applied simultaneously. By W. J. Schlick.

Corrosion Tests of Cast Iron of Various Chemical Compositions.
Work done at Massachusetts Institute of Technology.

From the tests and research a new theory of design was developed in which not only static water pressure and water hammer but also earth pressure and load from trucks are included in computations for thickness; also different methods of laying, i.e., pipe supported on blocks or on trench bottom, with or without tamping of backfill and with various depths of earth cover. The specifications (A21.2 – 1939) give thicknesses for some of these laying conditions. This Manual describes the principles and methods of computing pipe thicknesess, and of estimating trench and truck loads.

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PREFACE

This Manual is intended primarily to explain the new principles and methods which have been used by Sectional Committee A21 in the computation of standard pipe thicknesses which are included with the specifications for pit cast and other types of cast iron pipe. These principles and methods are of general application to cast iron of any strength and Part 1 of the Manual shows how the methods may be used to compute the necessary thickness of a pipe under known conditions of internal pressure, earth cover and method of laying, for any specified strength of iron.

Diagrams of earth load, truck super load, ratio to 3-edge bearing and other data used in computing and fixing thicknesses in the specifications, as well as data which may be used for conditions other than those covered by the specifications, are included in the Manual.

In Part 2 of the Manual the particular application of the methods for computing barrel thickness described in Part 1 is made to Cast Iron Pit Cast Pipe, cast with iron having the strength assumed in the specifications therefor; and Appendix 2A of Part 2 gives extended tables of thickness for Cast Iron Pit Cast Pipe for Water or Other Liquids. These extended tables include a greater range of cover than Tables 1 through 4 of the specifications and also include thicknesses for two additional methods of laying which are little used as yet but are of possible interest to the pipe-user under certain special conditions. Additional parts of the Manual containing data on other types of pipe will be issued when specifications for the other types of pipe are completed.

It is the intention to add to the Manual any data which the Committee shall believe necessary for a proper understanding and use of any of the specifications for straight pipe, for fittings or for coatings which may be produced by the Committee in fulfilment of its assigned scope or for intelligent use of the Manual.

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MANUAL

Part 1

Method of Computing Thickness of Barrel of Cast Iron Pipe

Sect. 1-1. New Factors in Design of Cast Iron Pipe

The method used in computing thickness of pipe in the schedules contained in the specifications of which this Manual is explanatory is based both on tests made for Sectional Committee A21 and on many earlier tests made at the Iowa State College on sewer pipe and culverts. The earlier tests developed the magnitude of the backfill loads transmitted to pipe laid in ditches or under road embankments, and of the load added by vehicles superimposed on the backfill, also the effect of various methods of supporting the pipe and the effect of tamping and not tamping the backfill.

The tests made for Committee A21 carried the Iowa State College investigations a step further by the inclusion of internal pressure applied simultaneously with external earth load to pipe supported in various ways and with backfill tamped and not tamped. An additional method of support, beyond those previously included at Iowa State College was introduced, viz., by blocking which is used by some constructors for water and gas pipe but not used for sewer pipe.

Sect. 1-2. Methods of Laying, or "Field Conditions," Considered

Four common and two uncommon methods of laying cast iron water pipe and gas pipe were selected as covering conditions met with at present or likely ever to be met with in case of pipe laid in trenches having approximately vertical sides. These were named "field conditions" and are as shown on the following page.

FIELD CONDITIONS

Field Condition	Explanation
A	Flat bottom trench, backfilling not tamped.
B	Flat bottom trench, backfilling tamped.
C	Pipe supported on blocks, backfilling not tamped.
D	Pipe supported on blocks, backfilling tamped.
E	Bottom of trench shaped to fit bottom of pipe for about 90° (unevennesses filled in by sand as required), backfilling not tamped.
F	Same as E except that backfilling is tamped

Field conditions E and F are common for sewer pipe but have been rarely used for cast iron water and gas pipe though the superior strength of pipe so laid has caused some increase in the use of this practice for pipe lines.

Another condition, viz. pipe under embankment, will be treated in an appendix (not yet prepared).

Sect. 1-3. Law of Behavior of Pipe under Both External Load and Internal Pressure

The tests made for Committee A21 showed that, when a pipe has both an external load applied in 3-edge bearing (see Sections 1-4 and 1-5) and an internal pressure, the relation between the external load and the internal pressure at the point of breaking can be represented with sufficient accuracy for various combinations of internal pressure and trench load by a parabola drawn as in Fig. 1.

The load-pressure curve (Fig. 1), employed either graphically or algebraically by use of its equation, is the basis of the whole system of barrel thickness computation used by Com. A21. It was initially the work of Prof. W. J. Schlick of Iowa State College, the institution employed by Com. A21 to make its tests on combined earth load and internal pressure.

Sect. 1-4. Equation of Load-Pressure Parabola and Values of Constants in Equation

The equation of the load-pressure parabola may be expressed,

$$w = \frac{W}{\sqrt{P}}\sqrt{P - p}$$

where the letters signify quantities in relation to the parabola as explained in Sect. 1-3 and Fig. 1. A definite equation may be written for any pipe for which P and W are known and these may be computed from the formulae given below using breaking strengths determined by crushing and bursting tests.

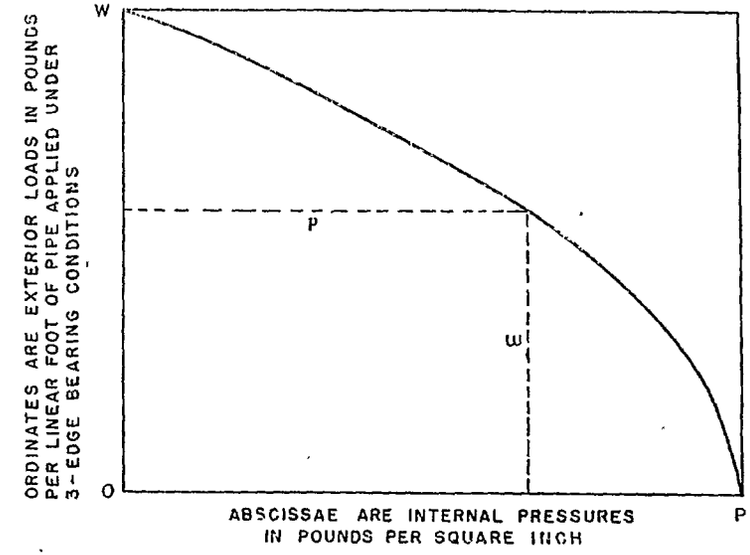


FIG. 1. Load-Pressure Curve.
EXPLANATION: Load-Pressure Curve is a parabola with apex at P. P is the bursting pressure of the pipe when no earth load exists. W is the crushing load per linear foot of pipe in 3-edge bearing when no internal pressure exists. p and w are any combination of internal pressure and external load which will just cause fracture. For equation of parabola and values of P and W see Sect. 1-4.

P, the bursting pressure of the pipe in lb. per sq.in., is found by the usual cylinder formula,

$$P = \frac{2tS}{d}$$

where t is the thickness of the pipe in inches,

S is the bursting strength in lb. per sq.in. of the metal in the pipe, as determined by bursting tests of full lengths of pipe having metal of the same kind.

d is the internal diameter of the pipe in inches.

W, the crushing load in lb. per lin. ft. of pipe supported in 3-edge bearing, is found by the following formula.

$$W = \frac{t^2 R}{.0795\ (d + t)}\ **$$

where t is the thickness of the pipe in inches,
d is the internal diameter of the pipe in inches.

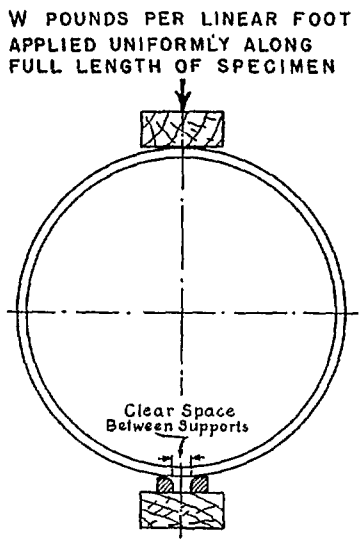


FIG. 2

NOTE—The condition of loading shown in Fig. 2 is usually called, and is called in the specifications and Manual of Committee A21, the "three-edge bearing load" because two supports close together are used to facilitate the laboratory test work by keeping the specimen from rolling on the table of the testing machine.

and R is the modulus of rupture in lb. per sq.in. of the metal in the pipe as determined by crushing tests of specimens of pipe having metal of the same kind, the pipe being loaded as shown in Fig. 2.

** This formula is approximate since the deflection, y, is omitted, but is near enough for designing purposes. The accurate formula is:

$$W = \frac{t^2 R}{.0795\ (d + t + 0.85y)}$$

It is often more convenient to use $(O.D. - t)$ instead of $(d + t)$.

p and w are any combination of internal pressure and external load which will just cause fracture. In the design of pipe thickness, p and w are quantities obtained by multiplying the internal water pressure and the earth load, each as determined by the condition under which the pipe is assumed to be used, by the desired factor of safety.

Sect. 1-5. Ratios to Three-Edge Bearing

As noted in Sections 1–3 and 1–4 the parabola described in those sections is for a pipe to which the exterior load and support are applied as in 3-edge bearing. This does not represent any field condition but is used as a convenient medium of computing for the field conditions, A, B, C, D, E and F, previously described. The factor or "ratio to 3-edge bearing" by which the trench load acting in each of these field conditions A to F must be divided so that the load thus altered will have *the same effect on a pipe subjected to 3-edge bearing as the actual load does on the pipe subjected to the given field condition*, has been determined with sufficient accuracy for design purposes and is shown in Fig. 3. In general terms it will be seen that all field conditions except C (blocks with no tamping) and D (blocks with tamping) are more favorable than 3-edge bearing in that the loads are to be divided by a ratio larger than unity.

Pipes laid on blocks, as in Field Conditions C and D, particularly C in which the fill is untamped, have the most unfavorable ratios. The ratios in these cases are less definite than for Field Conditions A, B, E and F because they are affected greatly by firmness of foundation under the blocks, firmness of tamping, size of blocks and hardness of the wood, and presence or absence of wedges which, when substantial, aid the strength by forming haunch supports. Values of the C ratio shown on Fig. 3 are for a rather severe condition and those for the D ratio an ordinary or average condition. In either case blocks are assumed to be spaced 6 feet apart on the average, i.e. two blocks per 12-foot length and a correspondingly greater number for longer lengths of pipe. *Greater average spacing will give more severe conditions to which the ratios are not applicable.*

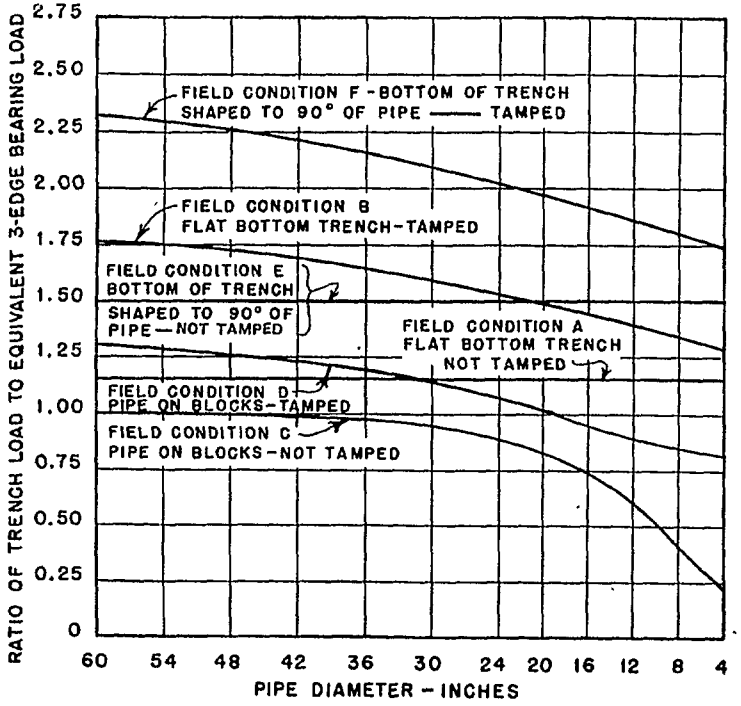
See Section 1–13 for the effect of beam action on thickness of smaller pipes spanning between blocks in Field Condition C.

Sect. 1-6. Forces Acting on Pipe When in Service

Cast iron or other pipe laid in the ground are acted on by one or more of the following forces:

1. Internal static pressure of the liquid or gas which is contained in the pipe.

2. Water hammer (or hammer from other liquid).
3. Load from the backfill.
4. Load and impact from passing trucks or other vehicles.



SIZE	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	48"	54"	60"
A	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
B	1.29	1.32	1.34	1.36	1.38	1.41	1.43	1.45	1.47	1.52	1.58	1.64	1.69	1.72	1.75	1.77
C	.22	.31	.40	.50	.60	.67	.73	.78	.81	.87	.93	.96	.98	.99	.99	1.00
D	.82	.83	.84	.86	.88	.91	.95	.98	1.01	1.07	1.14	1.19	1.23	1.25	1.28	1.31
E	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
F	1.75	1.78	1.80	1.83	1.85	1.88	1.90	1.93	1.95	2.00	2.08	2.14	2.20	2.25	2.29	2.31

Note: C and D ratios are for an average block spacing of 6 feet.

FIG. 3. Ratios to 3-edge Bearing

Loads 2 and 4 are occasional and transitory. In the specifications of Committee A21 they are not assumed as acting simultaneously but both are considered separately as loads added to static pressure and backfill load, and whichever of the two gives the greater computed

thickness of pipe, when taken together with the normal loads 1 and 3, is controlling in the determination of pipe thickness for the case under consideration.

Pipe for gas are free from the hammer caused by liquids and are hence always computed with truck load and its impact added to to the load from backfill.

Definite values of the above loads, obtained as explained in Sections 1-7, 1-8 and 1-9, are used in the parabolic curve, generally graphically, to obtain the computed pipe thicknesses.

Sect. 1-7. Water Pressure and Water Hammer

The static pressure will of course be known or assumed from conditions fixed by the pipe line design. The intensities of water hammer vary greatly according to types of gate valves, check valves and altitude valves; types of pump and power; presence or absence of automatic relief valves with effective quick acting controls; arrange-

TABLE 1

Allowances for Water Hammer

DIAM. OF PIPE, INCHES	WATER HAMMER, LB. PER SQ.IN.	DIAM. OF PIPE, INCHES	WATER HAMMER, LB. PER SQ.IN.
4 to 10	120	24	85
12 to 14	110	30	80
16 to 18	100	36	75
20	90	42 to 60	70

ment of pipe line, i.e., whether single or part of a grillage system; and other factors which it would require too much space to enumerate. Experiments on water hammer under the various usual conditions in which water pipe are used are few and Committee A21 has been unable from its inquiries to suggest improvements over the assumptions of water hammer made by the late Dexter Brackett, which have therefore been used in computing the thickness tables. They are listed in Table 1. *Each designer of a pipe line should consider whether the conditions in his case may need a more liberal water hammer allowance.*

Sect. 1-8. Estimation of Earth Loads

Earth loads are computed by mathematical formulae developed at Iowa State College and based on full scale tests extending over a period of more than 25 years. The growth of this system of earth load estimation is to be found in Bulletins 31, 36, 47, 57, 76, 80, 96,

104, 108, 112 of the Engineering Experiment Station at Iowa State College. Simplified statements may be found in a paper by Wiggin, Enger and Schlick given before the American Water Works Association in April, 1938 (Jour. A. W. W. A., 31: 841 (1939)) and in one by W. D. Moore before the American Water Works Association in June, 1939 (Jour. A. W. W. A., 31: 1655 (1939)).

On account of the mathematical work involved in computing these loads, Committee A21 arranged with Professor Schlick to make or supervise the necessary computations of earth loads under several

TABLE 2

List of Fill-Load Diagrams

FIG. NO.	TRENCH		WEIGHT OF EARTH, LB. PER CU. FT.	FIELD CONDITIONS OF LAYING TO WHICH APPLICABLE
	Width	Slope of Sides		
4	d + 2 ft.	Vertical	120	A, B, C, E and F
5	d + 2 ft.	Vertical	120	D
6	d + 1 ft.	Vertical	120	A, B, C, D, E and F
7	See Diagram	1 on 1	110	A, B, C, D, E and F
8	See Diagram	2 on 1	120	A, B, C, D, E and F

Note 1. d is nominal diameter of pipe expressed in feet.

Note 2. Figures 4, 6, 7 and 8 are applicable to all field conditions, except D, by direct use of the curves. Figure 5 gives earth loads for Field Condition D with d + 2 ft. trench. For the d + 1 ft. trench and the sloping-sided trenches loads for Field Condition D are found by reading from the diagrams and applying the percentages given on the diagrams for condition D.

Note 3. This Manual does not include fill-load diagrams and tables of 3-edge bearing ratios for conditions produced when an embankment is placed over a pipe which is laid wholly or partly projecting from the base on which the embankment is subsequently deposited.

different conditions of trench width, slopes of sides of trench, methods of supporting the pipe and depths of cover. These computations have been used in preparing the diagrams listed in Table 2. Copies of these diagrams follow in this Manual.

The earth loads used in computing the thickness tables in Committee A21 work are shown on diagrams, Figures 4 and 5, listed in Table 2, i.e., for vertical-sided trench 2 feet wider than the nominal diameter of the pipe. Figures 6, 7 and 8 give fill-loads for use in design for three types of trench different from those assumed in computing the pipe thickness tables.

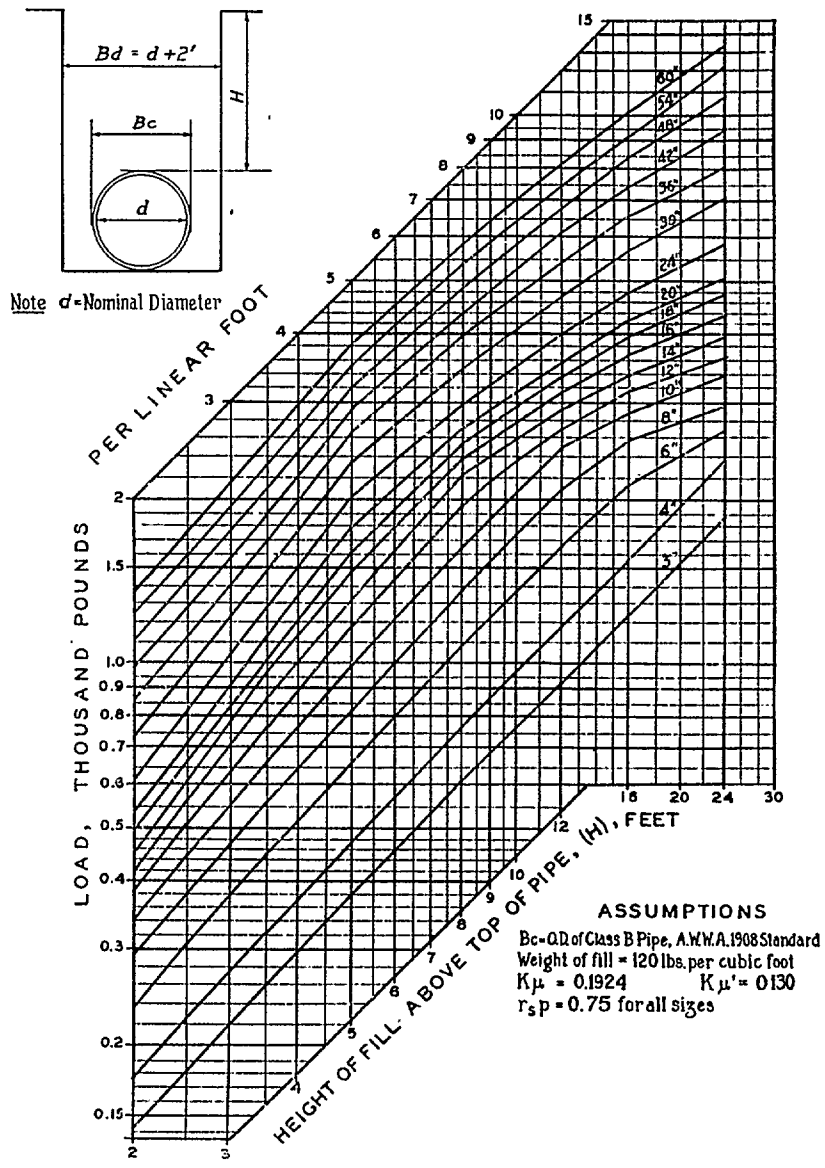


FIG. 4. Fill Loads on Pipe for Width of Ditch d + 2 feet and Field Conditions A, B, C, E, and F

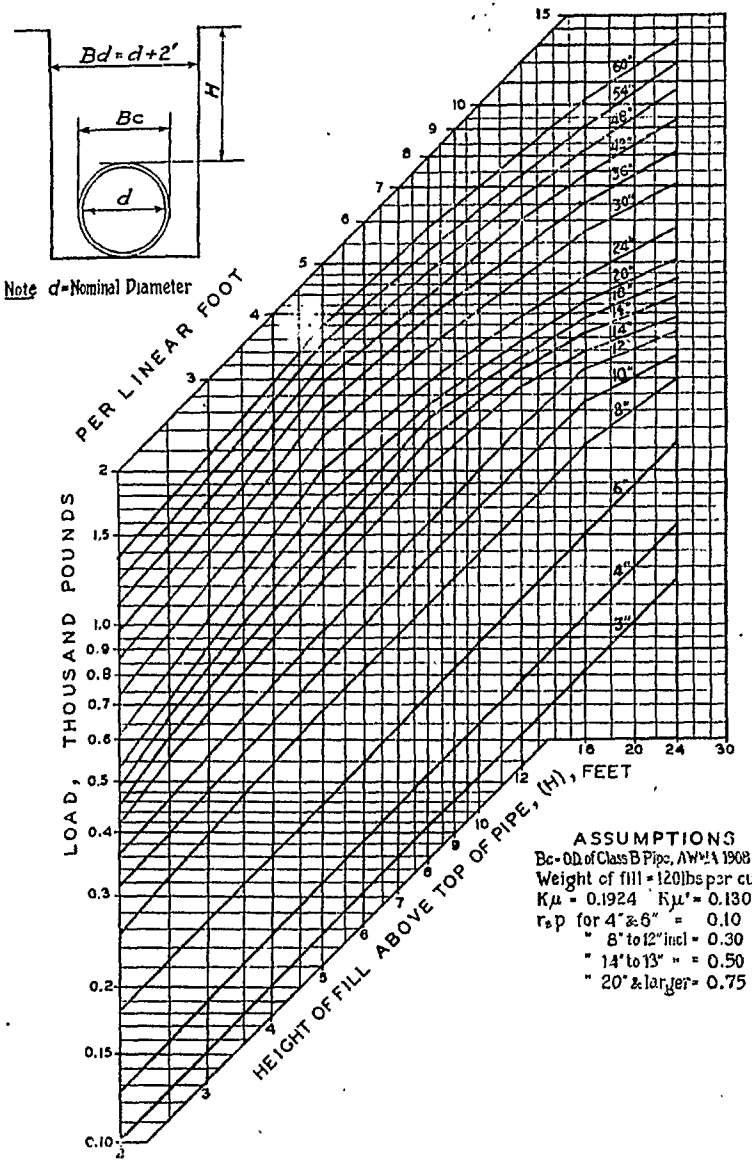
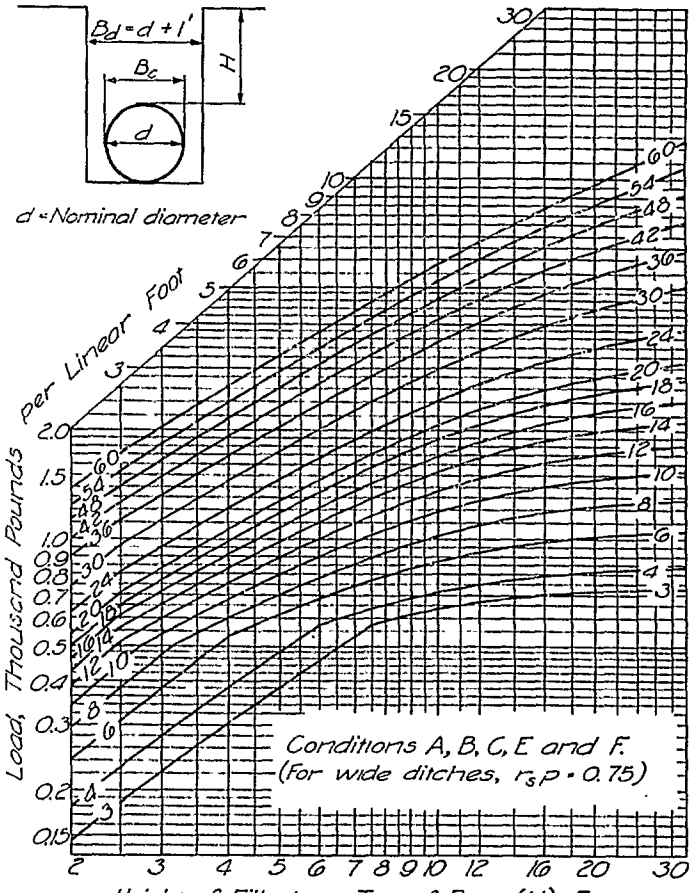


FIG. 5. Fill Loads on Pipe for Width of Ditch d + 2 feet and Field Condition D

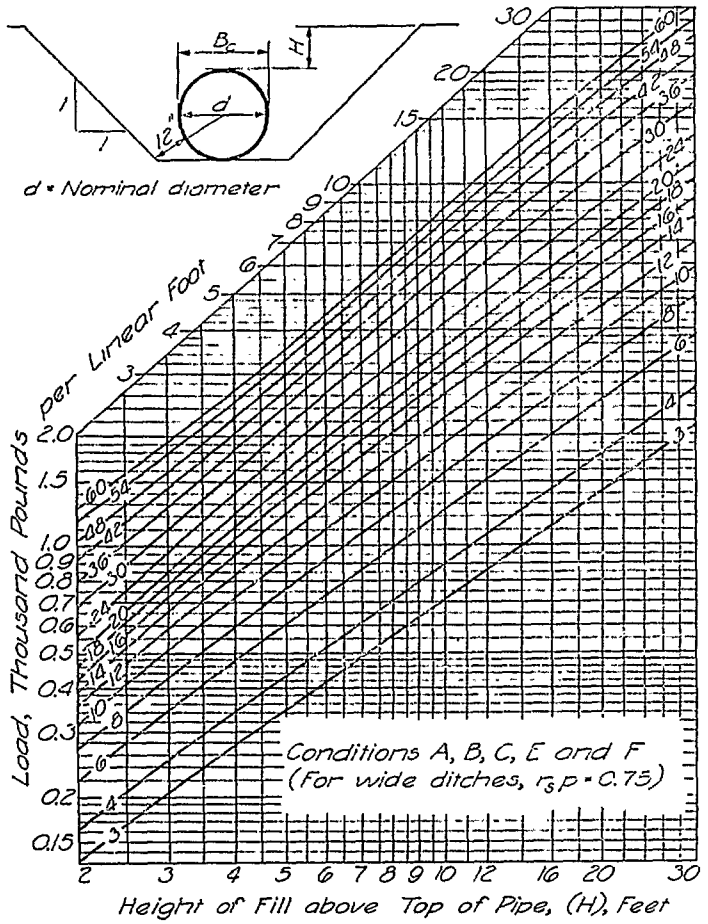


Condition D

Size of pipe, inches	r₃p for wide ditches	Percent of diagram load — Values of H, feet				
		2	5	10	18	30
3 to 6	0.10	70	70	95	100	100
8 to 12	0.30	90	100	100	100	100
14 to 18	0.50	100	100	100	100	100
20 & more	0.75	100	100	100	100	100

Fill Loads - Vertical Sided Ditch of Width d + 1'
For B_c = O.D. of Class B, A.W.W.A. 1908 Standards
W = unit weight of fill = 120 lb. per cu. ft.
Kμ = 0.1924 Kμ' = 0.130

FIG. 6. Fill Loads on Pipe for Width of Ditch d + 1 ft.



Condition D

Size of pipe, inches	$r_s p$ for wide ditches	Percent of diagram load, Values of H, feet				
		2	5	10	18	30
3 to 6	0.10	70	70	70	65	65
8 to 12	0.30	90	85	80	80	80
14 to 18	0.50	100	95	90	90	90
20 & more	0.75	100	100	100	100	100

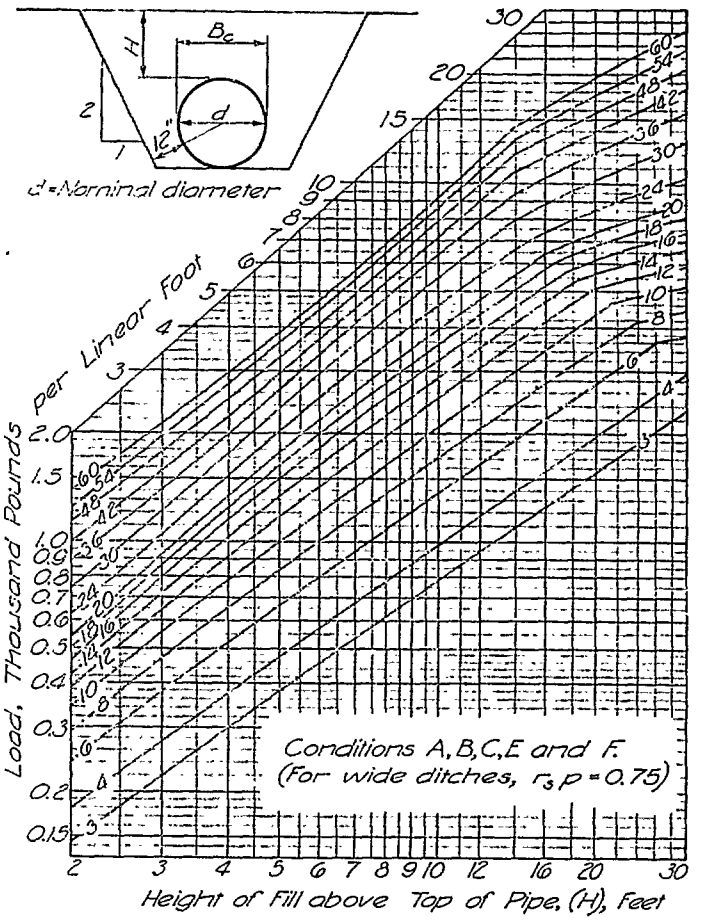
Fill Loads - Ditch with Sides Sloping 1 on 1

For B_c = O.D of Class B, A.W.W.A. 1908 Standards

W = unit weight of fill = 110 lb. per cu. ft.

$K\mu$ = 0.1924 $K\mu'$ = 0.130

Fig. 7. Fill Loads on Pipe for Ditches Having 1 on 1 Side Slopes



Condition D

Size of pipe, inches	$r_s p$ for wide ditches	Percent of diagram load, Values of H, feet				
		2	5	10	18	30
3 to 6	0.10	70	70	70	70	70
8 to 12	0.30	95	85	80	80	100
14 to 18	0.50	100	95	90	95	100
20 & more	0.75	100	100	100	100	100

Fill Loads - Ditch with Sides Sloping 2 on 1

For B_c = O.D. of Class B, A.W.W.A. 1908 Standards

W = unit weight of fill = 120 lb. per cu. ft.

$K\mu$ = 0.1924 $K\mu'$ = 0.130

Fig. 8. Fill Loads on Pipe for Ditches Having 2 on 1 Side Slopes

Sect. 1-9. Truck Superload and Impact

In computing pipe thicknesses, truck loads are added to earth loads in certain cases (see Sections 1-6 and 1-11, Sub-section (f)). Two passing trucks are assumed with rear axles both over the pipe at the same time, adjacent wheels of the two trucks 3 feet apart

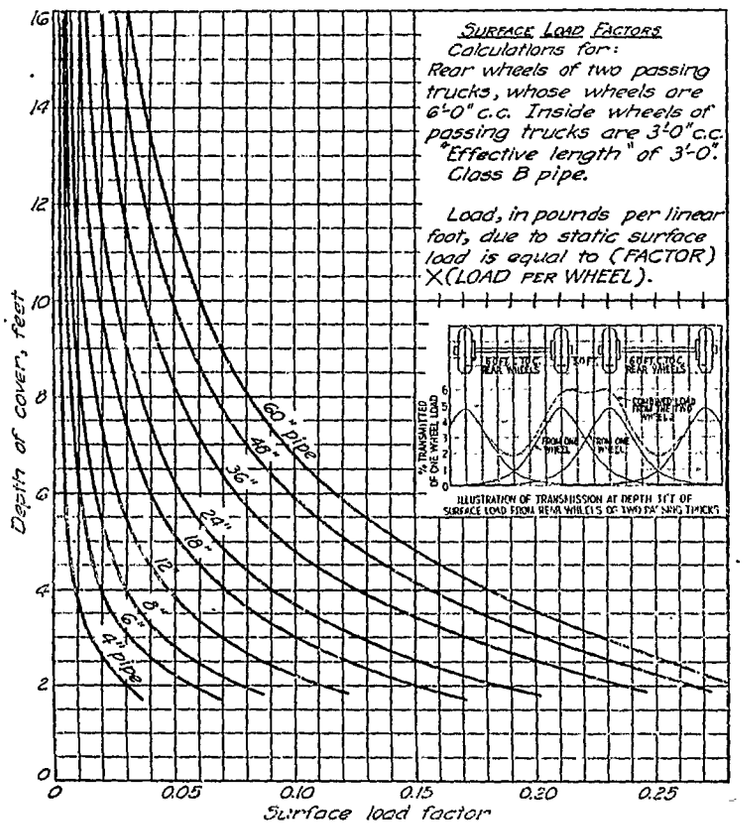


Fig. 9. Surface Load Factors for Two Passing Trucks

center to center, and load on each rear wheel 9,000 lb. To the load thus obtained 50 per cent is added for impact of the moving trucks over a road or trench surface assumed to be rough.

The proportion of a wheel load which is transmitted through the backfill to the pipe itself (the remainder being spread on either side

of the pipe) diminishes as depth of cover increases, and the length of pipe, over which the load which comes on the pipe is spread, increases with increase in depth of cover. These effects have been determined quantitatively by experiment at Iowa State College over a period of years and the results have been plotted by Prof. W. J. Schlick of that college for use of Committee A21. Figure 9 shows Prof. Schlick's diagram from which may be read the factors varying with size of pipe and depth of cover by which to multiply a single truck wheel load in order to give the average load per foot on the pipe from the two adjacent truck wheels placed three feet center to center along the pipe as above described.

On this diagram, Fig. 9, is a small sketch illustrating the distribution of this truck load along the pipe. In designing the pipe there

TABLE 3

DIAMETER OF PIPE, INCHES	PERCENTAGES OF TRUCK LOAD USED							
	2.5'-3.5' Cover Field Cond.		4'-7' Cover Field Cond.		8'-10' Cover Field Cond.		Over 10' Cover Field Cond.	
	A, B, E & F	C & D	A, B, E & F	C & D	A, B, E & F	C & D	A, B, E & F	C & D
4 to 12	100	78	100	84	100	90	100	95
14	92	78	100	84	100	90	100	95
16	88	78	95	84	100	90	100	95
18	85	78	90	84	100	90	100	95
20	83	78	90	84	95	90	100	95
24 to 30	81	78	85	84	95	90	100	95
36 to 60	80	78	85	84	90	90	100	95

are reductions to be made in the truck loads determined as above described. With field conditions C and D, in each of which the pipe is supported on blocks, the truck load, which is of intensity indicated by the diagram only over a few feet of the pipe, gives less load on the blocks than if the truck load were continuous over at least two lengths of the pipe. Similarly with field conditions A, B, E, and F the parts of the pipe which receive the truck load in its full intensity are aided in carrying the load by adjacent parts of the pipe which receive less load or no load from the trucks. These effects have been studied in detail by the Committee and the ameliorating effects estimated as given in Table 3.

The use of Table 3 is illustrated in the examples of actual design of pipe given in Section 1-11, Sub-section (g).

Sect. 1-10. The Factors of Safety

The factors of safety assumed by Committee A21 in computing pipe thicknesses are as follows:

For external loads.....2.5
For internal pressure....2.5

These factors of safety are necessarily chosen arbitrarily. They are considerably lower than the factor of safety which was formerly thought to exist for cast iron pipe but that was when only water pressure and water hammer were considered. The factors of safety were chosen of a magnitude which would result in thicknesses for pipe under ordinary conditions of use, which have been found satisfactory under those conditions, considering both American and foreign experience but giving more weight to American experience. The foreign standards are generally thinner than American standards for the same service.

It will be seen in Sect. 1-12 that the factor of safety is in effect generally made higher for pipe 8 inches and less in diameter for ordinary pressures and depths of cover, because their computed thicknesses are smaller than experience shows to be safe for handling, so that greater thicknesses are used arbitrarily.

Sect. 1-11. Details of Applying Method of Computing Net Barrel Thickness, with Illustrations

(a) *Net Thickness Defined; Additions to Net Thickness for Foundry Tolerance and Corrosion.* Section 1-11 relates especially to computation of *net thickness*. Net thickness is assumed in this Manual to mean the thickness available for resisting the external loads and internal pressures to which the pipe may be subjected. The net thicknesses computed in accordance with the following sub-sections are to be increased by the additions below noted in order to obtain the total or gross thickness.

(1) Foundry tolerance permitted below standard thickness.
(2) Corrosion allowance.

These additions to thickness, being different in total magnitude for pipes manufactured by different methods, are treated in detail in subsequent parts of the Manual which are devoted each to a separate type or group of types of pipe; e.g., see Part 2 for Cast Iron Pit Cast Pipe.

(b) *Equation Used and Data Required.* In computing net barrel thicknesses of cast iron pipe the equation for the load-pressure

parabola explained in Sect. 1-4 is used. This equation in convenient form for use is

$$w = \frac{W}{\sqrt{P}}\sqrt{P - p}, \text{ where}$$

w, W, p & P have the significance explained in Sect. 1-4.

The problem is generally as follows:
Given:

(1) Nominal diameter of pipe, d, inches
(2) Assumed width of trench, feet
(3) Cover, or depth of fill over pipe, feet
(4) Assumed Field Condition, i e. A, B, C, D, E or F.
(5) Maximum static pressure expected to occur in service, lb. per sq.in.
(6) Assumed magnitude of water hammer, lb. per sq.in.
(7) Assumed strength of iron in bursting pipe, S, lb. per sq.in.
(8) Assumed strength of iron in crushing of pipe as a ring, R, lb. per sq.in.
(9) Factor of safety.

Required: to find the necessary thickness of the pipe.

(c) *Graphical Method Described.* The easiest approach to the problem is to assume two or three different net thicknesses, varying by $\frac{1}{10}$ inch, covering the range within which the thickness to be determined is expected to lie. Plot the load-pressure curves for each of these thicknesses on the same diagram, using the same coordinate axes. Then plot a single point on the same diagram with the p and w (see Sect. 1-3, Fig. 1) for the given conditions as coordinates. The thickness is obtained by interpolation. Figures 10, 11, and 12 illustrate three methods of making such diagrams.

(d) *First Graphical Method—Load Pressure Parabolas Plotted to Natural Scale (Fig. 10).* The first method, shown on Fig. 10, is to draw the load-pressure parabolas to natural scale. They can be drawn when the values of P and W for each assumed thickness have been computed in the manner explained in Sect. 1-4, P being the abscissa of the vertex of the parabola and W being the ordinate with abscissa zero. The remainder of each parabola is located by plotting back from a vertical line through the vertex of the parabola three intermediate points with the fractional abscissae $\frac{1}{16}P$, $\frac{1}{16}P$, and $\frac{9}{16}P$, the corresponding ordinates being $\frac{1}{4}W$, $\frac{1}{2}W$, and $\frac{3}{4}W$ respectively. If preferred, the intermediate points may be obtained

from the equation of the parabola, assuming values of p in round numbers and computing the corresponding values of w.

(e) *Second Graphical Method—Load-Pressure Parabolas Plotted as Straight Lines (Fig. 11).* The second method of plotting, shown in Fig. 11, is by use of a special scale of ordinates in which the plotted length of each ordinate is the square of the actual length. This

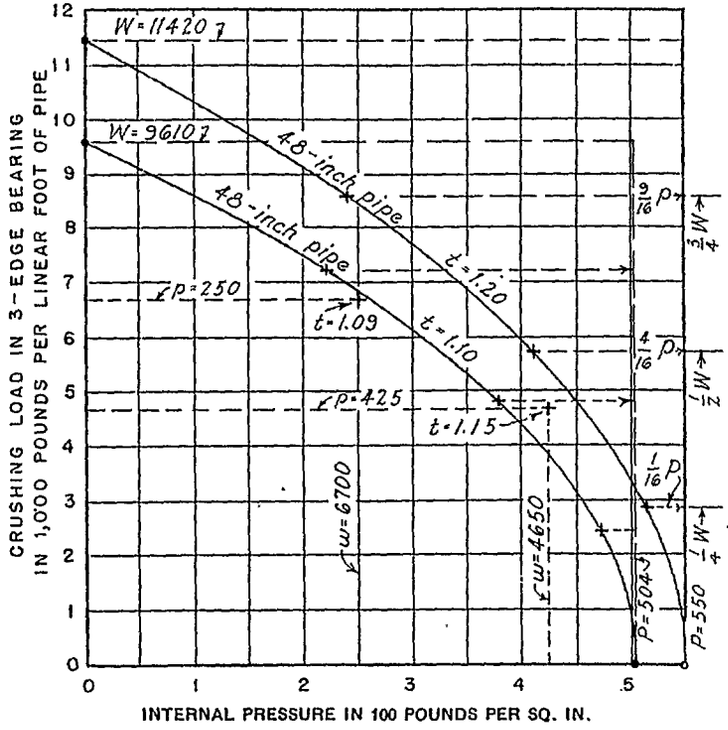


FIG. 10. Determining Thickness of Cast Iron Pipe by Parabolic Load-Pressure Curves Drawn to Natural Scale; 48-inch Pipe Used as Sample

makes the parabolas plot as straight lines which can be drawn at once when the values of P and W are known for each parabola. Standard forms like Fig. 11 were used extensively in thickness computations for Committee A21 and are applicable in the solution of any problem with any assumptions as to unit strengths of iron (S and R) or other conditions. For computation of the many cases required for tables of thickness with constant values of S and R,

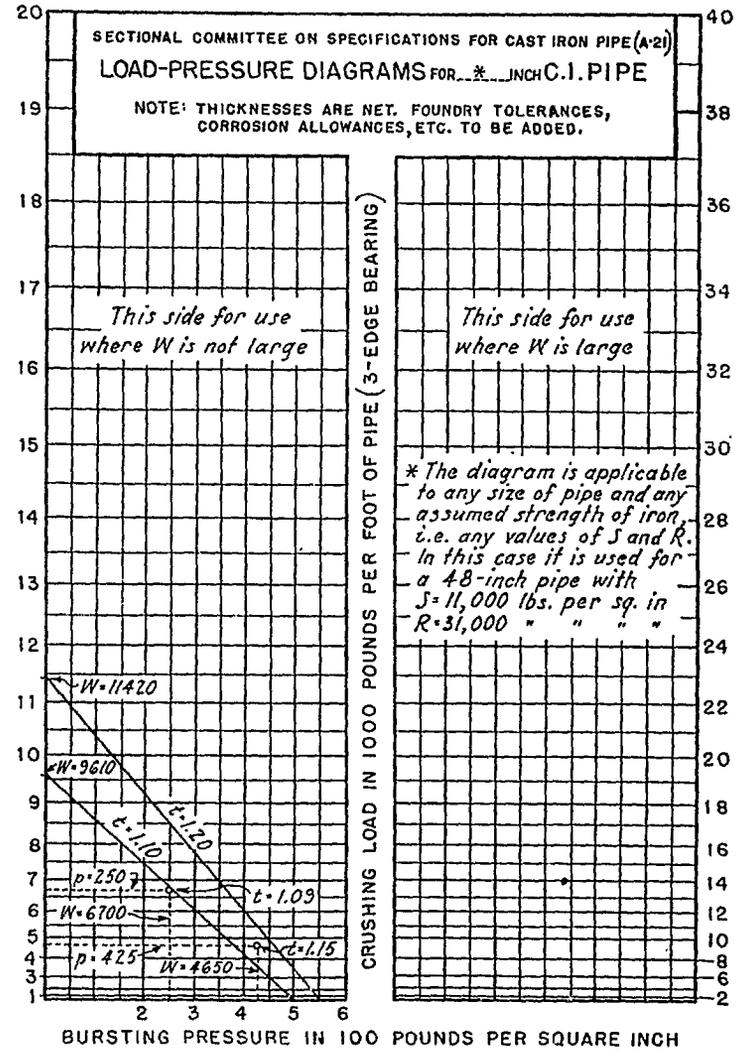


FIG. 11. Determining Thickness of Cast Iron Pipe by Load-Pressure Parabolas Drawn as Straight Lines; 48-inch Pipe Used as Sample

the method shown in Fig. 12, explained below, is much more expeditious and was used in the final tables of thicknesses submitted by Committee A21.

(f) *Third Graphical Method—Nomogram (Fig. 12).* In this third graphical method shown in Fig. 12, definite thickness points are plotted between which the desired thickness may be obtained by interpolation. As in Fig. 11, the external load scale (at left in Fig. 12) is one in which the vertical distance from zero is plotted as a height equal to the *square* of the exterior load which is actually marked on the scale. The internal pressure scale (at the right in Fig. 12) is a natural scale.

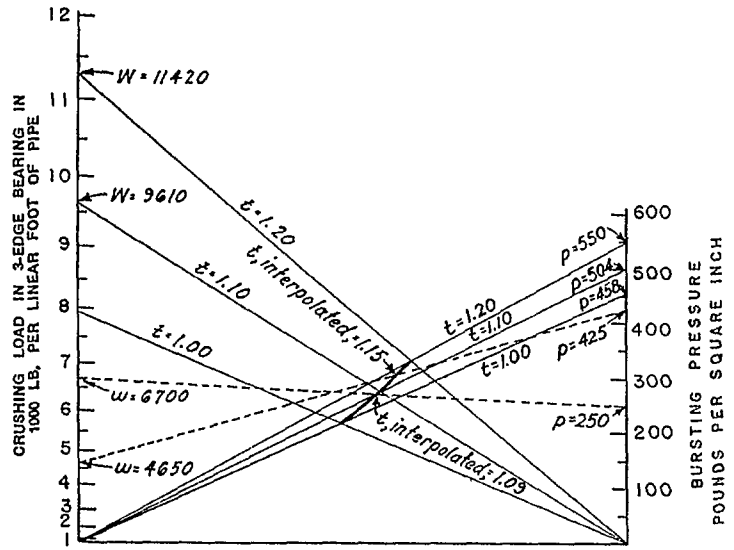


FIG. 12. Determining Thickness of Cast Iron Pipe by Nomogram Method; 48-inch Pipe Used as Sample

Such a diagram, in blank, with the exterior load and the interior pressure scale constructed as above described, may be used, as may Fig. 11, to plot any two or more thicknesses (computed with any specified values of S and R) between which to interpolate for solving any problem in barrel thickness computation by the Committee A21 method. The particular diagram or nomogram shown as Fig. 12 shows merely three definite thickness points between which interpolation for a single problem has been made but Figures 2.1, 2.2 and 2.3 in Part 2 show thickness points covering a wide range of thicknesses for pipes from 3 inches to 60 inches in diameter, for iron having S = 11,000 and R = 31,000 pounds per square inch.

This type of nomogram, devised by C. K. Donoho of the American Cast Iron Pipe Company, is the best method yet known for general use. With a group of such nomograms for each desired pair of corresponding values for S and R any net thickness may be read by a single application of a straight edge between known points p and w which have been determined for the particular problem.

(g) *A concrete example* is worked out below by each of the three methods.

The Example:

Nominal diameter of pipe	48 inches
Trench width	$d + 2' = 6$ ft.
Cover	5 ft.
Method of laying	Field Condition B
Static pressure	100 lb. per sq.in.
Water hammer—as in Sect. 1-7	70 lb. per sq.in.
Strength of iron in bursting pipe	S = 11,000 lb. per sq.in.
Strength of iron in crushing of pipe as a ring	R = 31,000 lb. per sq.in.
Factor of safety	2.5

To find required net barrel thickness.

Solution:

Fill load per lin. ft. of pipe, (Fig. 4)	3,200 lb.
Truck load (Fig. 9), 0.1225 × 9000 = 1100	
Add for impact 50% = 550	
1650	
Percent. of Truck Load used (Table in Sect. 1-9) 85% of 1650 =	1,400
Fill load plus truck load	4,600

Since the load-pressure curve is applicable only when exterior loads are transformed to loads in 3-edge bearing (see 1-5 and Fig. 3) the fill load of 3200 and the fill load plus truck load are to be reduced by dividing by the 3-edge ratio for 48-inch pipe with B condition of loading. This ratio is 1.72 (see Fig. 3).

3-edge bearing load equivalent to fill-load = 3200/1.72.. = 1860

3-edge bearing load equivalent to fill load + truck load = 4600/1.72 = 2680

Case 1. Water Hammer Assumed but No Truck Load.

The pipe is to be designed so that it will just break when subjected simultaneously to:

p = (static pressure plus water hammer) × factor of safety 2.5 and

w = (3-edge bearing load equivalent to fill load) × factor of safety 2.5

In this case: $p = (100 + 70) \times 2.5 = 425$

$w = 1860 \times 2.5 = 4650$

Case 2. Truck Load Assumed but no Water Hammer.

The pipe is to be designed so that it will just break when subjected simultaneously to:

p = static pressure × factor of safety 2.5

w = (3-edge bearing load equivalent to fill load plus truck load) multiplied by factor of safety 2.5

In this case: $p = 100 \times 2.5 = 250$

$w = 2680 \times 2.5 = 6700$

The values of p and w in Cases 1 and 2 are to be plotted on diagrams to be constructed by the three methods described in sub-sections (d), (e), and (f) above. Two arbitrary pipe thicknesses will be assumed in making these diagrams, viz. 1.10 and 1.20.

For $t = 1.10$:

$$P = \frac{2tS}{d} \text{ (Sect. M4)} = \frac{2 \times 1.10 \times 11000}{48} = 504$$

$$W = \frac{t^2R}{.0795\,(d + t)} \text{ (Sect. M4)} = \frac{(1.10)^2 \times 31{,}000}{.0795 \times 49.1} = 9{,}610$$

For $t = 1.20$:

$$P = \frac{2 \times 1.20 \times 11000}{48} = \ldots\ldots\ldots\ldots\ldots\ldots 550$$

$$W = \frac{(1.20)^2 \times 31{,}000}{.0795 \times 49.2} = \ldots\ldots\ldots\ldots\ldots\ldots 11{,}420$$

With the above values of P and W the parabolas for $t = 1.10$ and $t = 1.20$, respectively, are plotted as curves on Fig. 10 and as straight lines on Fig. 11. On Fig. 12 the two definite thickness points, viz. for $t = 1.10$ and $t = 1.20$, are plotted by the intersection

of two lines as shown, and in order to make the shape of the thickness curve for the 48-inch pipe more evident, a third point has been added for $t = 1.00$ with P and W 458 and 7960 respectively, computed in the same manner as shown previously for $t = 1.10$ and $t = 1.20$.

Interpolations are made on each of the three diagrams by using values of p and w for Case 1 and Case 2 computed above on page 22. The same results are seen to be obtained from all three diagrams and are as follows:

For Case 1, assuming water hammer but no truck load, the plotted point falls about half way between the load-pressure lines for $t = 1.10$ and $t = 1.20$, and by this interpolation..... $t = 1.15$

For Case 2, assuming truck load but no water hammer, the plotted point falls just below the load-pressure line for $t = 1.10$, giving..... $t = 1.09$

The nomogram, Fig. 12, gives the same results.

The water hammer assumption is hence controlling and the net design thickness is..... $t = 1.15$

For a gas pipe, where water hammer is absent, Case 2 only would be computed and the net thickness would be..... $t = 1.09$

(h) *Net Thickness Increased by Foundry Tolerance and Corrosion Allowance.* To each of the net thicknesses computed in Sub-section (g) above, are to be added foundry tolerance and corrosion allowance, which, for 48-inch pit cast pipe, have been assumed by Committee A21 as .10 and .08 inch respectively. These additions will make the thicknesses as follows:

For water pipe, $1.15 + .10 + .08 = 1.33$

For gas pipe, $1.09 + .10 + .08 = 1.27$

By reference to the Manual, Part 2, Appendix 2A, table 2A.2, page 17, it will be noted that the calculated thickness of a 48-inch water pipe for 100 lb. pressure and 5 foot cover is 1.33, though, as explained in Part 2, the standard thickness is made 1.37 which is the nearest standard thickness class. The standard thickness class for the above gas pipe is 1.27.

Sect. 1-12. Arbitrary Minimum Thickness, when Greater than Computed Thickness, Used Instead of Computed Thickness

Irrespective of calculated thickness, no standard thickness is made less than a certain minimum thickness for the particular diameter and kind of iron. This minimum thickness is chosen by judgment with due regard to shocks received by the pipe in handling and transporting. This provision controls thicknesses of 3-inch and 4-inch pipe for most pressures and covers, controls thicknesses of 6-inch and 8-inch under most of the ordinary conditions of pressure and cover, and controls thicknesses of 12-inch and 14-inch pipe under a few of the lighter pressures and covers.

As these minimum thicknesses vary for pipe made by different processes, they are treated in detail for each kind of pipe in the appropriate part of the Manual, e.g., Pit Cast Pipe in Part 2.

Sect. 1-13. Beam Conditions Control Thicknesses of Smaller Pipe with Field Condition C unless Blocks are Favorably Spaced

A pipe supported on blocks with untamped backfill acts as a beam spanning between the blocks to a greater or less extent depending on the hardness of the foundation under the blocks, the size and hardness of the blocks themselves, also the stiffness of the pipe as a beam and the degree to which some supporting fill happens to run under the pipe between blocks. The only safe assumption is to assume conditions giving unreduced beam action. For the smaller pipe, 3-inch to 8-inch inclusive, it has been found necessary to investigate the pipe as beams. Wherever the thickness of the pipe computed as a beam, using the net thickness as defined in Sect. 1–11, Sub-sect. (a), is greater than that determined by the methods described in Sect. 1–11 and 1–12, the beam thickness is used.

Spacing of blocks affects greatly the stresses caused by beam action. The most favorable location for two blocks under a 12-foot length of pipe is approximately 30-inches from each end of the pipe. With such a spacing, the 3-inch size is the only one (of those included in the thickness tables) in which the thicknesses are affected by beam conditions and then only with earth covers over about 10-feet. For other spacing of blocks, thicknesses of 4-inch, 6-inch and 8-inch pipe may be affected. Tables 2A.3 and 2B.3 in Appendices 2A and 2B, in Part 2 of the Manual, show these effects in detail for pit cast pipe. Corresponding tables for other types of pipe will show similar data for such types of pipe.

Sect. 1-14. To Compute Factor of Safety of a Given Pipe

The formula for load-pressure relationship can be used to compute factors of safety when thickness of pipe is known. Two examples are given below.

Example 1

For convenience in checking results, the same example, a 48-inch pit cast pipe, that was used in Sect. 1–11 to illustrate methods of computing barrel thickness, will be reversed by using the thickness therein computed (see Sect. 1–11, Sub-sect. (g), and finding its factor of safety. Case 1, assuming water hammer and no truck load, will be used. Field Condition B will be assumed as before.

The necessary thickness to order from the foundry was computed as 1.33. If the particular length were of minimum thickness permitted under the specifications, 1.23, and had further corroded so as to have a loss in strength equal to that which would be produced by making it 0.08 inch thinner, its net thickness would be 1.15.

For a 48-inch pit cast pipe of thickness 1.15, made of iron having $S = 11{,}000$ and $R = 31{,}000$,

$$P = \frac{2tS}{d} = \frac{2 \times 1.15 \times 11{,}000}{48} = 527 \text{ lb. per sq.in.}$$

$$W = \frac{t^2R}{.0795\,(d+t)} = \frac{(1.15)^2 \times 31{,}000}{.0795 \times 49.15} = 10{,}490 \text{ lb.}$$

The formula for the load-pressure curve is:

$$w = \frac{W}{\sqrt{P}}\sqrt{P - p}$$

In this case W and P have the values computed above, and, if we call the unknown factor of safety x, w has the value $1860x$ (see page 21 for the 1860) and p has the value $170x$ (see page 22 for 170).

The factor of safety is found algebraically as shown below. By substituting the above values in the above formula the equation becomes:

$$\begin{aligned}
1860x &= \frac{10490}{\sqrt{527}}\sqrt{527 - 170x} \\
1860x &= 457.5\sqrt{527 - 170x} \\
x &= .246\sqrt{527 - 170x} \\
x^2 &= .0605\,(527 - 170x) \\
x^2 &= 31.9 - 10.3x \\
x &= -5.15 + \sqrt{31.9 + (5.15)^2} \\
x &= -5.15 + \sqrt{58.4} = -5.15 + 7.64 \\
x &= 2.49
\end{aligned}$$

Since the factor of safety used in the original example was 2.5, a good check is afforded by the 2.49 obtained above.

Example 2

This example is to find what factor of safety the same 48-inch pipe with net thickness of 1.15 would have, assuming the same loading and internal pressure, if it were laid on blocks with untamped backfill.

By reference to Fig. 3, the ratio to 3-edge bearing is found to be 0.99. The 3-edge bearing load equivalent to the fill load will be:

$3200/.99 = 3230$, instead of:

$3200/1.72 = 1860$, as in the previous example.

All other values in the formula remain as in Example 1 above and the equation becomes:

$$3230x = \frac{10490}{\sqrt{527}}\sqrt{527 - 170x}$$

$$3230x = 457.5\sqrt{527 - 170x}$$

$$x = .1413\sqrt{527 - 170x}$$

$$x^2 = .0200\,(527 - 170x)$$

$$x^2 = 10.54 - 3.40x$$

$$x = -1.70 + \sqrt{10.54 + (1.7)^2}$$

$$x = -1.70 + \sqrt{13.43} = -1.70 + 3.66$$

$$x = 1.96$$

That is, the factor of safety in this case is reduced from 2.5 to 1.96 by using blocks with untamped backfill instead of flat bottomed trench, with tamped backfill.

MANUAL FOR THE COMPUTATION OF STRENGTH AND THICKNESS OF CAST IRON PIPE

PART 2

with

Comprehensive Tables

Of Calculated and Standard Barrel Thicknesses

For Pit Cast Pipe for Water or Other Liquids

All Computations Based on: S=11,000 lb. per sq.in. and R=31,000 lb. per sq.in.

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MANUAL

Part 2

Cast Iron Pit Cast Pipe

Sect. 2A-1. Introductory Statement; Unit Strength of Iron

Calculated thicknesses given in the comprehensive tables in Appendices 2A and 2B are computed by the method described in the Manual Part 1, using unit strengths of pit cast pipe iron which comply with the specifications for Cast Iron Pit Cast Pipe for Water or Other Liquids and with the specifications for Cast Iron Pit Cast Pipe for Gas. These unit strengths are as follows:

S, Bursting Strength, = 11,000 lb. per sq.in.
R, Crushing Strength, = 31,000 lb. per sq.in.

Figures 2.1, 2.2 and 2.3 are the nomograms by use of which the necessary net thickness may be determined for any pipe from 3-inch to 60-inch inclusive, made of 11000-31000 cast iron, and, within the limits of the diagrams, for any internal pressure and any exterior equivalent 3-edge load. The use of these nomograms is described in the Manual, Part 1, Section 1-11, Sub-sections (f) and (g) and Fig. 12. The three nomograms, Figures 2.1, 2.2 and 2.3, with varying scales, are needed to cover the full range of conditions. One diagram, made to sufficiently large scale to permit reading the smaller loads, would be very large because of the fact that the squares of the loads are plotted.

Sect. 2A-2. Additions to Net Computed Thicknesses to Obtain Calculated Thicknesses

Calculated thicknesses are obtained by adding to net thickness computed by the parabolic formula the following constants:

(a) Maximum foundry tolerances permitted by the specifications;
(b) Corrosion allowance of .08 inch.

Maximum foundry tolerances are as follows:

Diameters Inches	Maximum Foundry Tolerances Inches
3 to 8 inclusive	.07
10 to 24 inclusive	.08
30 to 60 inclusive	.10

Sect. 2A-3. Minimum Thicknesses of Pipe

Irrespective of calculated thicknesses no standard thickness is made less than the minima shown in Table 2.1, chosen by judgment with due regard to shocks received by the pipe in handling and transporting.

Sect. 2A-4. Standard Thickness Classes

Calculated thicknesses are not used exactly but the Standard Thickness Class, from the Table 2.2, nearest to the calculated thickness (or the next thicker standard thickness class in case the calculated thickness is halfway between two standard thicknesses) is used in order to avoid an endless number of different thicknesses varying by small intervals.

TABLF 2.1

Minimum Thicknesses for Cast Iron Pit Cast Pipe

DIAMETER OF PIPE, INCHES	MINIMUM THICKNESS, INCHES
3	.37
4	.40
6	.43
8	.46
10	.50
12	.54
Larger than 12	As computed for 50 lb. static pressure plus water hammer, with trench load for cover of 5 feet and Field Condition B.**

** Note: In cases of the 24″, 36″, 54″, and 60″ pipe, there is a difference of .01 inch between the minimum computed as above and the actual minimum used.

TABLE 2.2

Standard Thickness Classes for Pit Cast Pipe

NOMINAL DIAMETER, INCHES	NUMBER AND PIPE WALL THICKNESSES OF STANDARD THICKNESS CLASSES													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3	.37	.40	.43	.46	.50	.54	.58	.63	.68	.73	.79	.85	.92	.99
4	.40	.43	.46	.50	.54	.58	.63	.68	.73	.79	.85	.92	.99	1.07
6	.43	.46	.50	.54	.58	.63	.68	.73	.79	.85	.92	.99	1.07	1.16
8	.46	.50	.54	.58	.63	.68	.73	.79	.85	.92	.99	1.07	1.16	1.25
10	.50	.54	.58	.63	.68	.73	.79	.85	.92	.99	1.07	1.16	1.25	1.35
12	.54	.58	.63	.68	.73	.79	.85	.92	.99	1.07	1.16	1.25	1.35	1.46
14	.54	.58	.63	.68	.73	.79	.85	.92	.99	1.07	1.16	1.25	1.35	1.46
16	.58	.63	.68	.73	.79	.85	.92	.99	1.07	1.16	1.25	1.35	1.46	1.58
18	.63	.68	.73	.79	.85	.92	.99	1.07	1.16	1.25	1.35	1.46	1.58	1.71
20	.66	.71	.77	.83	.90	.97	1.05	1.13	1.22	1.32	1.43	1.54	1.66	1.79
24	.74	.80	.86	.93	1.00	1.08	1.17	1.26	1.36	1.47	1.59	1.72	1.86	2.01
30	.87	.94	1.02	1.10	1.19	1.29	1.39	1.50	1.62	1.75	1.89	2.04	2.20	2.38
36	.97	1.05	1.13	1.22	1.32	1.43	1.54	1.66	1.79	1.93	2.08	2.25	2.43	2.62
42	1.07	1.16	1.25	1.35	1.46	1.58	1.71	1.85	2.00	2.16	2.33	2.52	2.72	2.94
48	1.18	1.27	1.37	1.48	1.60	1.73	1.87	2.02	2.18	2.35	2.54	2.74	2.96	3.20
54	1.30	1.40	1.51	1.63	1.76	1.90	2.05	2.21	2.39	2.58	2.79	3.01	3.25	3.51
60	1.39	1.50	1.62	1.75	1.89	2.04	2.20	2.38	2.57	2.78	3.00	3.24	3.50	3.78

Each class is made 8 per cent heavier than the preceding class, starting with class 1 as the base class. Class 1 is fixed as in Table 2.1 above.

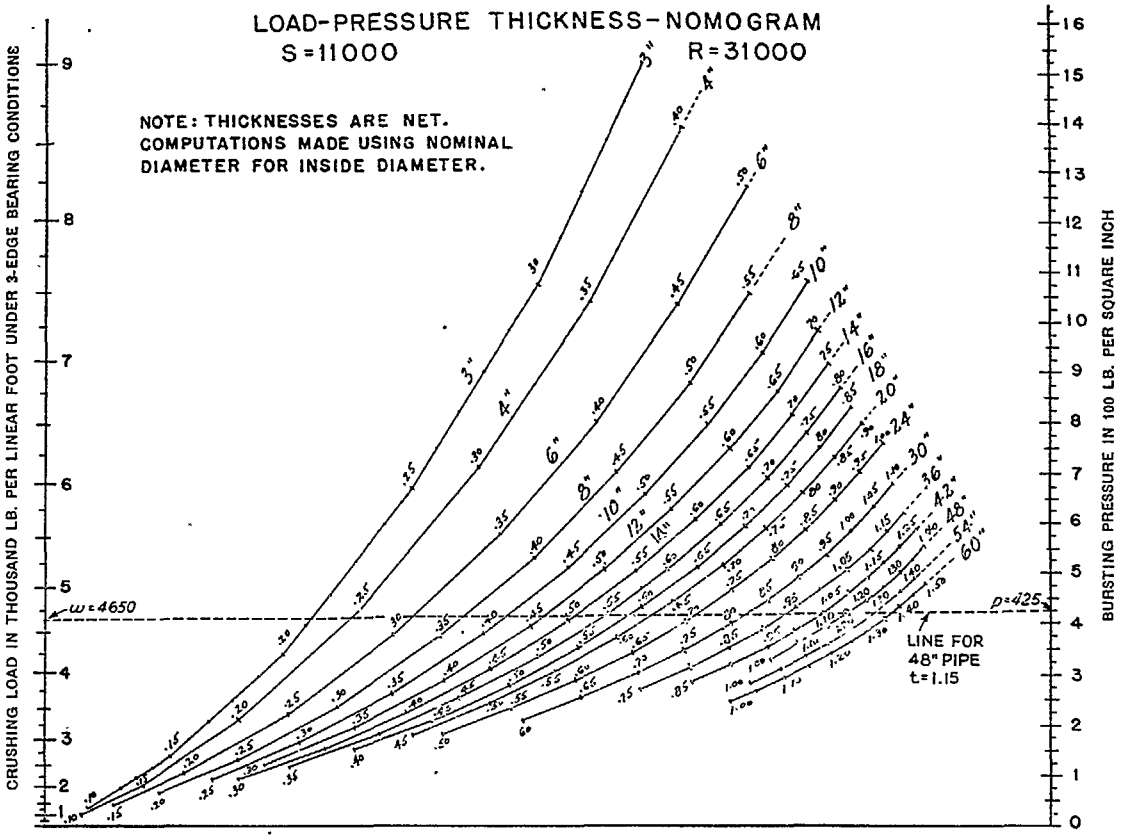

FIG. 2.1. Nomogram. See Example in Sect. 1–11 (g) and Fig. 12 in Manual.

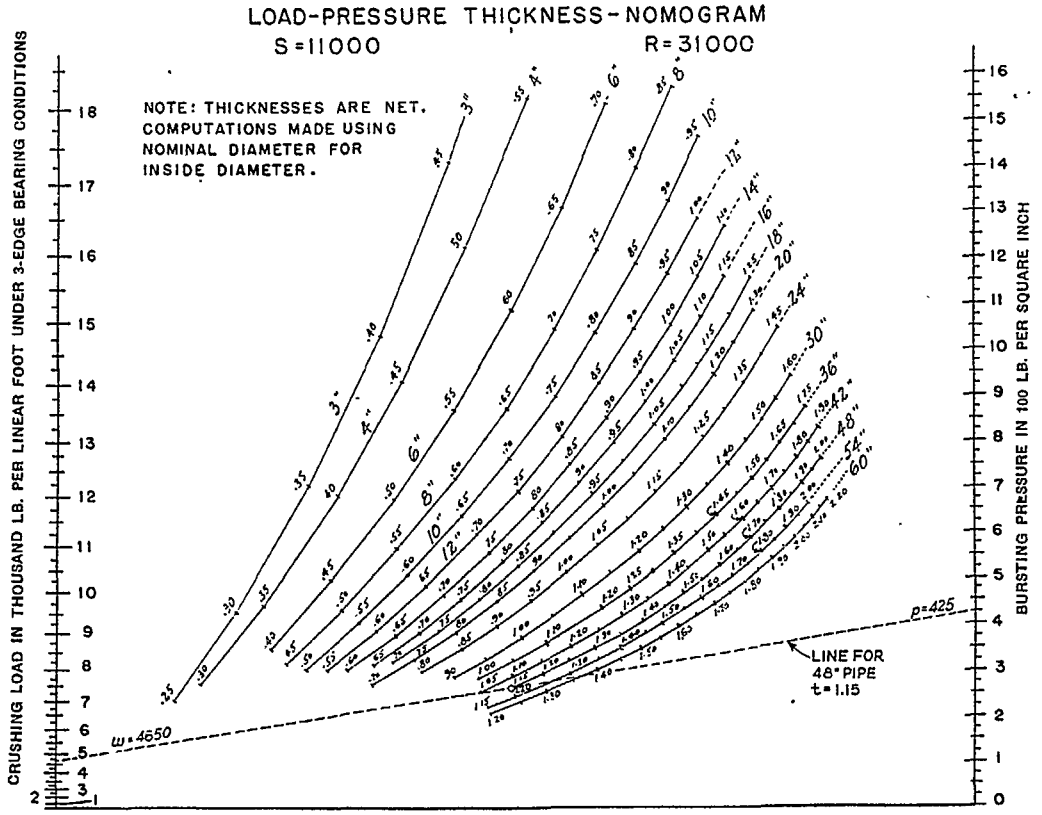

FIG. 2.2. Nomogram. See Example in Sect. 1–11 (g) and Fig. 12 in Manual.

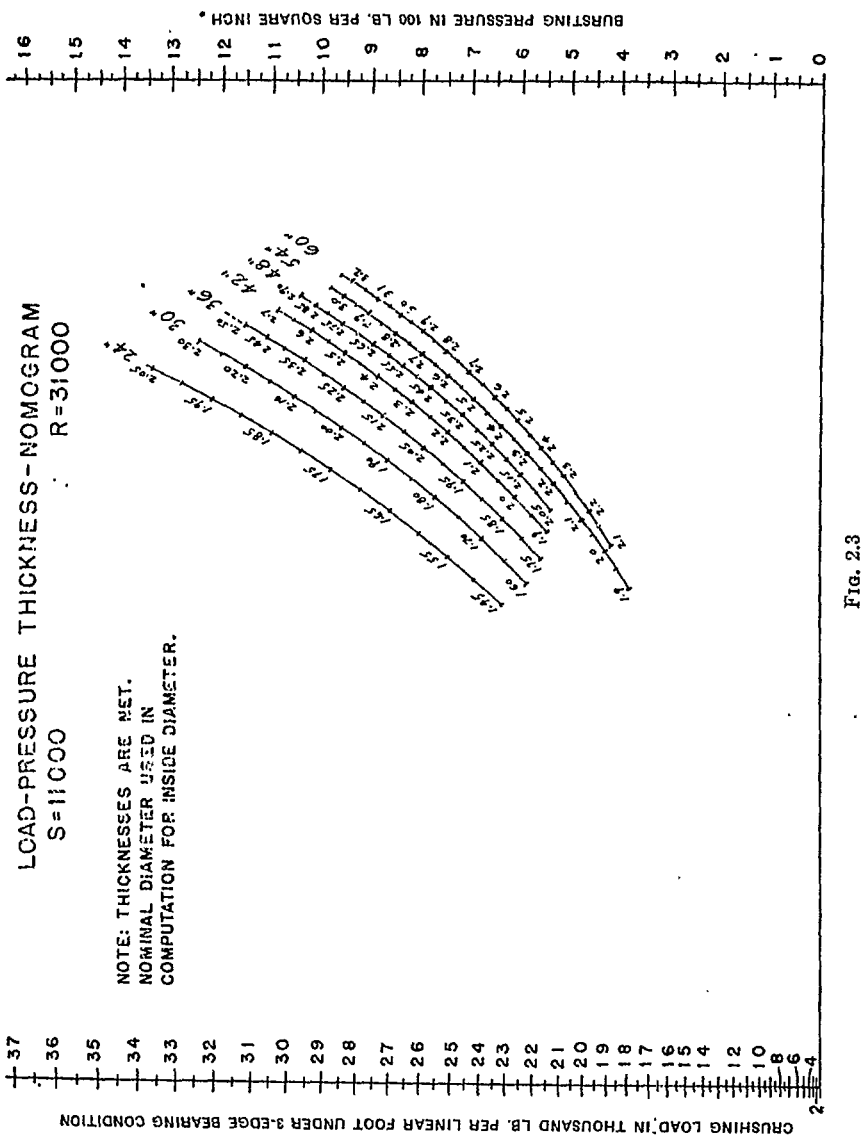

Fig. 2.3

APPENDIX 2A

TABLE 2A.1*

Schedule of Barrel Thicknesses—Field Condition A

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
3	2½	Calc. Thick.	*.24	*.25	*.26	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.37	.37	.37	.37	.37	.37	.37
	3½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.37	.37	.37	.37	.37	.37	.37
	5	Calc. Thick.	.25	.26	.26	.27	.29	.31	.32
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.37	.37	.37	.37	.37	.37	.37
	8	Calc. Thick.	.27	.27	.29	.30	.31	.32	.33
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.37	.37	.37	.37	.37	.37	.37
	12	Calc. Thick.	.29	.30	.31	.32	.33	.34	.35
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.37	.37	.37	.37	.37	.37	.37
	16	Calc. Thick.	.31	.32	.33	.34	.35	.35	.36
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.37	.37	.37	.37	.37	.37	.37
4	2½	Calc. Thick.	*.27	*.28	.30	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.40	.40	.40	.40	.40	.40	.40
	3½	Calc. Thick.	*.27	*.28	.30	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.40	.40	.40	.40	.40	.40	.40
	5	Calc. Thick.	.29	.30	.31	.32	.34	.36	.38
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.40	.40	.40	.40	.40	.40	.40
	8	Calc. Thick.	.31	.32	.33	.34	.36	.37	.39
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.40	.40	.40	.40	.40	.40	.40
	12	Calc. Thick.	.34	.35	.36	.37	.38	.40	.41
		Use Thickness Class.	1	1	1	1	1	1	1
		Thickness.	.40	.40	.40	.40	.40	.40	.40
	16	Calc. Thick.	.37	.37	.38	.39	.40	.41	.43
		Use Thickness Class.	1	1	1	1	1	1	2
		Thickness.	.40	.40	.40	.40	.40	.40	.43
6	2½	Calc. Thick.	*.33	*.34	*.35	*.37	.41	.44	.47
		Use Thickness Class.	1	1	1	1	1	1	2
		Thickness.	.43	.43	.43	.43	.43	.43	.46
	3½	Calc. Thick.	*.32	*.33	.36	.38	.41	.45	.48
		Use Thickness Class.	1	1	1	1	1	2	3
		Thickness.	.43	.43	.43	.43	.43	.46	.50
	5	Calc. Thick.	.34	.36	.38	.40	.42	.45	.48
		Use Thickness Class.	1	1	1	1	1	2	3
		Thickness.	.43	.43	.43	.43	.43	.46	.50
	8	Calc. Thick.	.38	.40	.41	.43	.45	.48	.51
		Use Thickness Class.	1	1	1	1	2	3	3
		Thickness.	.43	.43	.43	.43	.46	.50	.50
	12	Calc. Thick.	.43	.44	.45	.47	.49	.51	.53
		Use Thickness Class.	1	1	2	2	3	3	4
		Thickness.	.43	.43	.46	.46	.50	.50	.54
	16	Calc. Thick.	.46	.48	.49	.51	.52	.54	.56
		Use Thickness Class.	2	3	3	3	4	4	5
		Thickness.	.46	.50	.50	.50	.54	.54	.58

*Asterisks preceding calculated thicknesses indicate that in such cases truck load rather than water hammer was controlling.

TABLE 2A.1 (*cont'd*)

Field Condition A

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
8	2½	Calc. Thick.	*.39	*.40	*.42	.46	.50	.54	.58
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	3½	Calc. Thick.	*.38	*.40	.43	.46	.50	.54	.59
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	5	Calc. Thick.	.41	.43	.46	.49	.52	.56	.60
		Use Thickness Class.	1	1	1	2	3	4	4
		Use Thickness.	.46	.46	.46	.50	.54	.58	.58
	8	Calc. Thick.	.45	.47	.49	.52	.55	.58	.61
		Use Thickness Class.	1	1	2	3	3	4	5
		Use Thickness.	.46	.46	.50	.54	.54	.58	.63
	12	Calc. Thick.	.51	.52	.55	.57	.60	.62	.65
		Use Thickness Class.	2	3	3	4	4	5	5
		Use Thickness.	.50	.54	.54	.58	.58	.63	.63
	16	Calc. Thick.	.55	.56	.58	.60	.63	.65	.68
		Use Thickness Class.	3	4	4	4	5	5	6
		Use Thickness.	.54	.58	.58	.58	.63	.63	.68
10	2½	Calc. Thick.	*.46	*.48	*.50	.54	.58	.64	.69
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	3½	Calc. Thick.	*.44	*.46	.50	.55	.60	.65	.70
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	5	Calc. Thick.	.47	.50	.53	.57	.62	.66	.71
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.50	.50	.54	.58	.63	.68	.73
	8	Calc. Thick.	.53	.56	.59	.62	.66	.70	.74
		Use Thickness Class.	2	3	3	4	5	5	6
		Use Thickness.	.54	.58	.58	.63	.68	.68	.73
	12	Calc. Thick.	.60	.62	.65	.68	.71	.74	.78
		Use Thickness Class.	3	4	4	5	6	6	7
		Use Thickness.	.58	.63	.63	.68	.73	.73	.79
	16	Calc. Thick.	.63	.65	.67	.70	.73	.76	.80
		Use Thickness Class.	4	4	5	5	6	7	7
		Use Thickness.	.63	.63	.68	.68	.73	.79	.79
12	2½	Calc. Thick.	*.51	*.53	*.56	*.60	.66	.72	.79
		Use Thickness Class.	1	1	2	2	4	5	6
		Use Thickness.	.54	.54	.58	.58	.68	.73	.79
	3½	Calc. Thick.	*.49	*.52	.56	.61	.67	.73	.80
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.54	.54	.58	.63	.68	.73	.79
	5	Calc. Thick.	.52	.55	.60	.64	.70	.75	.81
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.54	.54	.58	.63	.68	.73	.79
	8	Calc. Thick.	.60	.63	.66	.70	.74	.79	.84
		Use Thickness Class.	2	3	4	4	5	6	7
		Use Thickness.	.58	.63	.68	.68	.73	.79	.85
	12	Calc. Thick.	.66	.69	.72	.75	.79	.84	.88
		Use Thickness Class.	4	4	5	5	6	7	7
		Use Thickness.	.68	.68	.73	.73	.79	.85	.85
	16	Calc. Thick.	.69	.72	.76	.78	.82	.86	.91
		Use Thickness Class.	4	5	5	6	7	7	8
		Use Thickness.	.68	.73	.73	.79	.85	.85	.92

TABLE 2A.1 (*cont'd*)

Field Condition A

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
14	2½	Calc. Thick.	*.55	*.58	*.61	.67	.75	.82	.90
		Use Thickness Class.	1	2	3	4	5	7	8
		Use Thickness.	.54	.58	.63	.68	.73	.85	.92
	3½	Calc. Thick.	*.54	*.57	.62	.69	.76	.83	.90
		Use Thickness Class.	1	2	3	4	6	7	8
		Use Thickness.	.54	.58	.63	.68	.79	.85	.92
	5	Calc. Thick.	.57	.61	.66	.73	.78	.84	.92
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.58	.63	.68	.73	.79	.85	92
	8	Calc. Thick.	.67	.70	.75	.79	.84	.90	.96
		Use Thickness Class.	4	4	5	6	7	8	9
		Use Thickness.	.68	.68	.73	.79	.85	.92	.99
	12	Calc. Thick.	.73	.76	.80	.83	.88	.93	.99
		Use Thickness Class.	5	6	6	7	7	8	9
		Use Thickness.	.73	.79	.79	.85	.85	.92	.99
	16	Calc. Thick.	.76	.79	.83	.87	.91	.96	1.01
		Use Thickness Class.	6	6	7	7	8	9	9
		Use Thickness.	.79	.79	.85	.85	.92	.99	.99
16	2½	Calc. Thick.	*.60	*.63	*.66	.72	.81	.90	.98
		Use Thickness Class.	1	2	3	4	5	7	8
		Use Thickness.	.58	.63	.68	.73	.79	.92	.99
	3½	Calc. Thick.	*.59	*.62	.67	.74	.82	.91	.99
		Use Thickness Class.	1	2	3	4	5	7	8
		Use Thickness.	.58	.63	.68	.73	.79	.92	.99
	5	Calc. Thick.	*.62	.66	.72	.78	.86	.93	1.00
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.63	.68	.73	.79	.85	.92	.99
	8	Calc. Thick.	.71	.76	.80	.86	.91	.97	1.04
		Use Thickness Class.	4	4	5	6	7	8	9
		Use Thickness.	.73	.73	.79	.85	.92	.99	1.07
	12	Calc. Thick.	.78	.82	.86	.91	.96	1.01	1.08
		Use Thickness Class.	5	6	6	7	8	8	9
		Use Thickness.	.79	.85	.85	.92	.99	.99	1.07
	16	Calc. Thick.	.83	.86	.90	.94	.99	1.05	1.11
		Use Thickness Class.	6	6	7	7	8	9	9
		Use Thickness.	.85	.85	.92	.92	.99	1.07	1.07
18	2½	Calc. Thick.	*.65	*.68	.71	.79	.88	.98	1.08
		Use Thickness Class.	1	2	3	4	5	7	8
		Use Thickness.	.63	.68	.73	.79	.85	.99	1.07
	3½	Calc. Thick.	*.64	*.67	.73	.81	.90	.99	1.09
		Use Thickness Class.	1	2	3	4	6	7	8
		Use Thickness.	.63	.68	.73	.79	.92	.99	1.07
	5	Calc. Thick.	*.67	.73	.79	.86	.94	1.02	1.11
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.68	.73	.79	.85	.92	.99	1.07
	8	Calc. Thick.	.77	.82	.87	.93	1.00	1.07	1.15
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.79	.85	.85	.92	.99	1.07	1.16
	12	Calc. Thick.	.84	.89	.93	.98	1.05	1.11	1.19
		Use Thickness Class.	5	6	6	7	8	8	9
		Use Thickness.	.85	.92	.92	.99	1.07	1.07	1.16
	16	Calc. Thick.	.89	.93	.98	1.03	1.09	1.15	1.22
		Use Thickness Class.	6	6	7	8	8	9	10
		Use Thickness.	.92	.92	.99	1.07	1.07	1.16	1.25

TABLE 2A.1 (*cont'd*)

Field Condition A

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
20	2½	Calc. Thick.	*.69	*.72	*.77	.84	.94	1.06	1.16
		Use Thickness Class.	2	2	3	4	6	7	8
		Thickness.	.71	.71	.77	.83	.97	1.05	1.13
	3½	Calc. Thick.	*.68	*.72	.78	.86	.96	1.07	1.18
		Use Thickness Class.	1	2	3	4	6	7	9
		Thickness.	.66	.71	.77	.83	.97	1.05	1.22
	5	Calc. Thick.	.72	.77	.83	.91	1.00	1.11	1.20
		Use Thickness Class.	2	3	4	5	6	8	9
		Thickness.	.71	.77	.83	.90	.97	1.13	1.22
	8	Calc. Thick.	.81	.86	.92	.98	1.06	1.14	1.24
		Use Thickness Class.	4	4	5	6	7	8	9
		Thickness.	.83	.83	.90	.97	1.05	1.13	1.22
	12	Calc. Thick.	.90	.94	.99	1.06	1.12	1.20	1.28
		Use Thickness Class.	5	6	6	7	8	9	10
		Thickness.	.90	.97	.97	1.05	1.13	1.22	1.32
	16	Calc. Thick.	.95	1.00	1.05	1.10	1.17	1.24	1.32
		Use Thickness Class.	6	6	7	8	9	9	10
		Thickness.	.97	.97	1.05	1.13	1.22	1.22	1.32
24	2½	Calc. Thick.	*.78	*.82	*.87	.96	1.08	1.21	1.35
		Use Thickness Class.	2	2	3	4	6	7	9
		Thickness.	.80	.80	.86	.93	1.08	1.17	1.36
	3½	Calc. Thick.	*.76	*.81	.88	.99	1.11	1.23	1.36
		Use Thickness Class.	1	2	3	5	6	8	9
		Thickness.	.74	.80	.86	1.00	1.08	1.26	1.36
	5	Calc. Thick.	*.81	.87	.95	1.05	1.16	1.26	1.38
		Use Thickness Class.	2	3	4	6	7	8	9
		Thickness.	.80	.86	.93	1.08	1.17	1.26	1.36
	8	Calc. Thick.	.98	.98	1.05	1.13	1.22	1.33	1.43
		Use Thickness Class.	4	5	6	7	8	9	10
		Thickness.	.93	1.00	1.08	1.17	1.26	1.36	1.47
	12	Calc. Thick.	1.01	1.07	1.13	1.20	1.28	1.38	1.48
		Use Thickness Class.	5	6	7	7	8	9	10
		Thickness.	1.00	1.08	1.17	1.17	1.26	1.36	1.47
	16	Calc. Thick.	1.08	1.13	1.19	1.26	1.34	1.43	1.53
		Use Thickness Class.	6	7	7	8	9	10	10
		Thickness.	1.08	1.17	1.17	1.26	1.36	1.47	1.47
30	2½	Calc. Thick.	*.91	*.97	*1.05	1.17	1.28	1.48	1.65
		Use Thickness Class.	2	2	3	5	6	8	9
		Thickness.	.94	.94	1.02	1.19	1.29	1.50	1.62
	3½	Calc. Thick.	*.91	*.97	1.06	1.20	1.33	1.50	1.66
		Use Thickness Class.	2	2	4	5	6	8	9
		Thickness.	.94	.94	1.10	1.19	1.29	1.50	1.62
	5	Calc. Thick.	*.97	1.05	1.15	1.26	1.39	1.53	1.68
		Use Thickness Class.	2	3	5	6	7	8	9
		Thickness.	.94	1.02	1.19	1.29	1.39	1.50	1.62
	8	Calc. Thick.	1.09	1.17	1.25	1.35	1.47	1.60	1.74
		Use Thickness Class.	4	5	6	7	8	9	10
		Thickness.	1.10	1.19	1.29	1.39	1.50	1.62	1.75
	12	Calc. Thick.	1.21	1.28	1.36	1.45	1.58	1.67	1.80
		Use Thickness Class.	5	6	7	8	9	9	10
		Thickness.	1.19	1.29	1.39	1.50	1.62	1.62	1.75
	16	Calc. Thick.	1.30	1.37	1.45	1.53	1.63	1.74	1.86
		Use Thickness Class.	6	7	8	9	9	10	11
		Thickness.	1.29	1.39	1.50	1.50	1.62	1.75	1.89

TABLE 2A.1 (*cont'd*)

Field Condition A

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
36	2½	Calc. Thick.	*1.04	*1.11	*1.19	1.34	1.53	1.73	1.93
		Use Thickness Class.	2	3	4	5	7	8	10
		Thickness.	1.05	1.13	1.22	1.32	1.54	1.66	1.93
	3½	Calc. Thick.	*1.04	*1.11	1.20	1.37	1.55	1.75	1.94
		Use Thickness Class.	2	3	4	5	7	9	10
		Thickness.	1.05	1.13	1.22	1.32	1.54	1.79	1.93
	5	Calc. Thick.	*1.08	*1.18	1.32	1.45	1.60	1.76	1.95
		Use Thickness Class.	2	4	5	6	8	9	10
		Thickness.	1.05	1.22	1.32	1.43	1.66	1.79	1.93
	8	Calc. Thick.	1.24	1.33	1.43	1.56	1.70	1.85	2.03
		Use Thickness Class.	4	5	6	7	8	9	11
		Thickness.	1.22	1.32	1.43	1.54	1.66	1.79	2.08
	12	Calc. Thick.	1.39	1.47	1.57	1.67	1.80	1.94	2.10
		Use Thickness Class.	6	6	7	8	9	10	11
		Thickness.	1.43	1.43	1.54	1.66	1.79	1.93	2.08
	16	Calc. Thick.	1.50	1.57	1.66	1.77	1.88	2.03	2.16
		Use Thickness Class.	7	7	8	9	10	11	11
		Thickness.	1.54	1.54	1.66	1.79	1.93	2.08	2.08
42	2½	Calc. Thick.	*1.16	*1.24	*1.34	1.50	1.75	1.95	2.20
		Use Thickness Class.	2	3	4	5	7	9	10
		Thickness.	1.16	1.25	1.35	1.46	1.71	2.00	2.16
	3½	Calc. Thick.	*1.16	*1.24	1.35	1.54	1.76	1.97	2.22
		Use Thickness Class.	2	3	4	6	7	9	10
		Thickness.	1.16	1.25	1.35	1.58	1.71	2.00	2.16
	5	Calc. Thick.	*1.24	*1.32	1.46	1.63	1.81	2.02	2.25
		Use Thickness Class.	3	4	5	6	8	9	11
		Thickness.	1.25	1.35	1.46	1.58	1.85	2.00	2.33
	8	Calc. Thick.	1.38	1.48	1.60	1.74	1.92	2.08	2.33
		Use Thickness Class.	4	5	6	7	8	10	11
		Thickness.	1.35	1.46	1.58	1.71	1.85	2.16	2.33
	12	Calc. Thick.	1.56	1.65	1.76	1.89	2.04	2.22	2.39
		Use Thickness Class.	6	7	7	8	9	10	11
		Thickness.	1.58	1.71	1.71	1.85	2.00	2.16	2.33
	16	Calc. Thick.	1.69	1.78	1.88	2.00	2.15	2.30	2.46
		Use Thickness Class.	7	8	8	9	10	11	12
		Thickness.	1.71	1.85	1.85	2.00	2.16	2.33	2.52
48	2½	Calc. Thick.	*1.28	*1.38	*1.48	1.69	1.96	2.22	2.50
		Use Thickness Class.	2	3	4	6	8	9	11
		Thickness.	1.27	1.37	1.48	1.73	2.02	2.18	2.54
	3½	Calc. Thick.	*1.29	*1.38	1.52	1.74	1.98	2.23	2.51
		Use Thickness Class.	2	3	4	6	8	9	11
		Thickness.	1.27	1.37	1.48	1.73	2.02	2.18	2.54
	5	Calc. Thick.	*1.38	*1.47	1.64	1.83	2.05	2.28	2.54
		Use Thickness Class.	3	4	5	7	8	10	11
		Thickness.	1.37	1.48	1.60	1.87	2.02	2.35	2.54
	8	Calc. Thick.	1.54	1.67	1.80	1.95	2.15	2.38	2.68
		Use Thickness Class.	5	6	7	8	9	10	11
		Thickness.	1.60	1.73	1.87	2.02	2.18	2.35	2.54
	12	Calc. Thick.	1.74	1.84	1.97	2.12	2.32	2.50	2.78
		Use Thickness Class.	6	7	8	9	10	11	12
		Thickness.	1.73	1.87	2.02	2.18	2.35	2.54	2.74
	16	Calc. Thick.	1.90	2.00	2.18	2.34	2.48	2.66	2.75
		Use Thickness Class.	7	8	9	9	10	11	12
		Thickness.	1.87	2.02	2.18	2.18	2.35	2.54	2.74

TABLE 2A.1 (*cont'd*)

Field Condition A

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
54	2½	Calc. Thick.	*1.40	*1.51	*1.63	1.88	2.18	2.48	2.78
		Use Thickness Class.	2	3	4	6	8	9	11
		Use Thickness.	1.40	1.51	1.63	1.90	2.21	2.39	2.79
	3½	Calc. Thick.	*1.43	*1.53	*1.67	1.93	2.20	2.53	2.80
		Use Thickness Class.	2	3	4	6	8	10	11
		Use Thickness.	1.40	1.51	1.63	1.90	2.21	2.58	2.79
	5	Calc. Thick.	*1.50	*1.60	1.80	2.01	2.28	2.56	2.83
		Use Thickness Class.	3	4	5	7	8	10	11
		Use Thickness.	1.51	1.63	1.76	2.05	2.21	2.58	2.79
	8	Calc. Thick.	1.69	1.83	2.00	2.18	2.48	2.64	2.91
		Use Thickness Class.	4	6	7	8	9	10	12
		Use Thickness.	1.63	1.90	2.05	2.21	2.39	2.58	3.01
	12	Calc. Thick.	1.93	2.05	2.19	2.36	2.56	2.78	3.03
		Use Thickness Class.	6	7	8	9	10	11	12
		Use Thickness.	1.90	2.05	2.21	2.39	2.58	2.79	3.01
	16	Calc. Thick.	2.10	2.22	2.36	2.50	2.68	2.88	3.13
		Use* Thickness Class.	7	8	9	10	10	11	13
		Use* Thickness.	2.05	2.21	2.39	2.58	2.58	2.79	3.25
60	2½	Calc. Thick.	*1.50	*1.63	*1.78	2.06	2.36	2.73	3.08
		Use Thickness Class.	2	3	4	6	8	10	11
		Use Thickness.	1.50	1.62	1.75	2.04	2.38	2.78	3.00
	3½	Calc. Thick.	*1.55	*1.68	1.84	2.11	2.45	2.77	3.10
		Use Thickness Class.	2	3	5	6	8	10	11
		Use Thickness.	1.50	1.62	1.89	2.04	2.38	2.78	3.00
	5	Calc. Thick.	*1.64	1.79	1.98	2.20	2.53	2.80	3.13
		Use Thickness Class.	3	4	6	7	9	10	12
		Use Thickness.	1.62	1.75	2.04	2.20	2.57	2.78	3.24
	8	Calc. Thick.	1.85	2.00	2.18	2.38	2.63	2.88	3.21
		Use Thickness Class.	5	6	7	8	9	10	12
		Use Thickness.	1.89	2.04	2.20	2.38	2.57	2.78	3.24
	12	Calc. Thick.	2.10	2.24	2.41	2.58	2.83	3.05	3.33
		Use Thickness Class.	6	7	8	9	10	11	12
		Use Thickness.	2.04	2.20	2.38	2.57	2.78	3.00	3.24
	16	Calc. Thick.	2.29	2.43	2.58	2.75	2.94	3.18	3.41
		Use Thickness Class.	8	8	9	10	11	12	13
		Use Thickness.	2.38	2.38	2.57	2.78	3.00	3.24	3.50

TABLE 2A.2*

Schedule of Barrel Thickness—Field Condition B

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
3	2½	Calc. Thick.	*.24	*.25	*.25	*.26	.31	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	3½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	5	Calc. Thick.	.25	.26	.26	.27	.29	.31	.32
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	8	Calc. Thick.	.26	.27	.28	.29	.30	.32	.33
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	12	Calc. Thick.	.29	.30	.30	.31	.32	.33	.34
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	16	Calc. Thick.	.31	.31	.32	.33	.34	.35	.36
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
4	2½	Calc. Thick.	*.26	*.27	*.28	.30	.32	.34	.36
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	3½	Calc. Thick.	.26	.27	.29	.31	.32	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	5	Calc. Thick.	.26	.27	.29	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	8	Calc. Thick.	.30	.31	.32	.33	.35	.37	.38
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40*	.40
	12	Calc. Thick.	.33	.33	.35	.36	.37	.39	.40
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	16	Calc. Thick.	.35	.36	.37	.38	.39	.41	.42
		Use Thickness Class.	1	1	1	1	1	1	2
		Use Thickness.	.40	.40	.40	.40	.40	.40	.43
6	2½	Calc. Thick.	.33	.33	.35	.38	.41	.44	.47
		Use Thickness Class.	1	1	1	1	1	1	2
		Use Thickness.	.43	.43	.43	.43	.43	.43	.46
	3½	Calc. Thick.	.33	.33	.35	.38	.41	.44	.48
		Use Thickness Class.	1	1	1	1	1	1	3
		Use Thickness.	.43	.43	.43	.43	.43	.43	.50
	5	Calc. Thick.	.33	.35	.37	.40	.43	.45	.48
		Use Thickness Class.	1	1	1	1	1	2	3
		Use Thickness.	.43	.43	.43	.43	.43	.46	.50
	8	Calc. Thick.	.37	.38	.40	.43	.45	.47	.50
		Use Thickness Class.	1	1	1	1	2	2	3
		Use Thickness.	.43	.43	.43	.43	.46	.46	.50
	12	Calc. Thick.	.41	.43	.44	.46	.48	.50	.53
		Use Thickness Class.	1	1	1	2	3	3	4
		Use Thickness.	.43	.43	.43	.46	.50	.50	.54
	16	Calc. Thick.	.44	.46	.47	.49	.51	.53	.55
		Use Thickness Class.	1	2	2	3	3	4	4
		Use Thickness.	.43	.46	.46	.50	.50	.54	.54

* Asterisks preceding calculated thicknesses indicate that in such cases truck load rather than water hammer was controlling.

TABLE 2A.2 (*cont'd*)

Field Condition B

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
8	2½	Calc. Thick.	*.37	.38	.41	.45	.49	.53	.58
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	3½	Calc. Thick.	*.37	*.38	.42	.46	.50	.54	.58
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	5	Calc. Thick.	.39	.41	.44	.47	.51	.55	.59
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	8	Calc. Thick.	.44	.46	.48	.51	.54	.57	.61
		Use Thickness Class.	1	1	2	2	3	4	5
		Use Thickness.	.46	.46	.50	.50	.54	.58	.63
	12	Calc. Thick.	.49	.50	.52	.55	.58	.61	.64
		Use Thickness Class.	2	2	3	3	4	5	5
		Use Thickness.	.50	.50	.54	.54	.58	.63	.63
	16	Calc. Thick	.52	.54	.56	.58	.60	.63	.66
		Use Thickness Class.	3	3	4	4	4	5	6
		Use Thickness.	.54	.54	.58	.58	.58	.63	.68
10	2½	Calc. Thick.	*.43	*.45	*.48	.53	.59	.64	.70
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	3½	Calc. Thick.	*.43	*.44	.49	.54	.59	.65	.70
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	5	Calc. Thick.	.45	.48	.52	.56	.61	.66	.71
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.50	.50	.54	.58	.63	.68	.73
	8	Calc. Thick.	.51	.53	.57	.60	.64	.68	.73
		Use Thickness Class.	1	2	3	3	4	5	6
		Use Thickness.	.50	.54	.58	.58	.63	.68	.73
	12	Calc. Thick.	.57	.59	.62	.65	.68	.72	.75
		Use Thickness Class.	3	3	4	4	5	6	6
		Use Thickness.	.58	.58	.63	.63	.68	.73	.73
	16	Calc. Thick.	.59	.62	.64	.67	.70	.74	.78
		Use Thickness Class.	3	4	4	5	5	6	7
		Use Thickness.	.58	.63	.63	.68	.68	.73	.79
12	2½	Calc. Thick.	*.49	*.51	.54	.59	.66	.72	.79
		Use Thickness Class.	1	1	1	2	4	5	6
		Use Thickness.	.54	.54	.54	.58	.68	.73	.79
	3½	Calc. Thick.	*.47	*.49	.54	.60	.67	.73	.80
		Use Thickness Class.	1	1	1	2	4	5	6
		Use Thickness.	.54	.54	.54	.58	.68	.73	.79
	5	Calc. Thick.	.50	.53	.58	.62	.68	.74	.81
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.54	.54	.58	.63	.68	.73	.79
	8	Calc. Thick.	.57	.60	.63	.68	.72	.77	.83
		Use Thickness Class.	2	2	3	4	5	6	7
		Use Thickness.	.58	.58	.63	.68	.73	.79	.85
	12	Calc. Thick.	.62	.65	.69	.72	.76	.81	.86
		Use Thickness Class.	3	3	4	5	6	6	7
		Use Thickness.	.63	.63	.68	.73	.79	.79	.85
	16	Calc. Thick.	.65	.68	.71	.75	.79	.85	.87
		Use Thickness Class.	3	4	5	5	6	7	7
		Use Thickness.	.63	.68	.73	.73	.79	.85	.85

TABLE 2A.2 (*cont'd*)

Field Condition B

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
14	2½	Calc. Thick.	*.52	*.54	.59	.66	.74	.82	.89
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.54	.54	.58	.68	.73	.85	.92
	3½	Calc. Thick.	*.51	.55	.61	.67	.75	.83	.90
		Use Thickness Class.	1	1	3	4	5	7	8
		Use Thickness.	.54	.54	.63	.68	.73	.85	.92
	5	Thick.	.54	.59	.64	.70	.77	.83	.91
		Use Thickness Class.	1	2	3	4	6	7	8
		Use Thickness.	.54	.58	.63	.68	.79	.85	.92
	8	Calc. Thick.	.63	.66	.71	.76	.81	.87	.93
		Use Thickness Class.	3	4	5	6	6	7	8
		Use Thickness.	.63	.68	.73	.79	.79	.85	.92
	12	Calc. Thick.	.68	.71	.75	.80	.85	.90	.96
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.68	.73	.73	.79	.85	.92	.99
	16	Calc. Thick.	.71	.76	.78	.82	.87	.93	.98
		Use Thickness Class.	5	5	6	7	7	8	9
		Use Thickness.	.73	.73	.79	.85	.85	.92	.99
16	2½	Calc. Thick.	*.56	*.58	.63	.72	.80	.89	.98
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.58	.58	.63	.73	.79	.92	.99
	3½	Calc. Thick.	*.55	.59	.66	.73	.81	.90	.98
		Use Thickness Class.	1	1	3	4	5	7	8
		Use Thickness.	.58	.58	.68	.73	.79	.92	.99
	5	Calc. Thick.	.58	.63	.69	.76	.84	.91	1.00
		Use Thickness Class.	1	2	3	5	6	7	8
		Use Thickness.	.58	.63	.68	.79	.85	.92	.99
	8	Calc. Thick.	.67	.71	.76	.81	.88	.95	1.02
		Use Thickness Class.	3	4	5	5	6	7	8
		Use Thickness.	.68	.73	.79	.79	.85	.92	.99
	12	Calc. Thick.	.73	.77	.81	.86	.93	.98	1.05
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.73	.79	.79	.85	.92	.99	1.07
	16	Calc. Thick.	.77	.81	.85	.89	.95	1.00	1.07
		Use Thickness Class.	5	5	6	7	7	8	9
		Use Thickness.	.79	.79	.85	.92	.92	.99	1.07
18	2½	Calc. Thick.	*.59	*.63	.69	.78	.88	.98	1.08
		Use Thickness Class.	1	1	2	4	6	7	8
		Use Thickness.	.63	.63	.68	.79	.85	.99	1.07
	3½	Calc. Thick.	*.59	.64	.72	.80	.89	.99	1.08
		Use Thickness Class.	1	1	3	4	6	7	8
		Use Thickness.	.63	.63	.73	.79	.92	.99	1.07
	5	Calc. Thick.	.63	.69	.75	.83	.93	1.01	1.10
		Use Thickness Class.	1	2	3	5	6	7	8
		Use Thickness.	.63	.68	.73	.85	.92	.99	1.07
	8	Calc. Thick.	.72	.77	.82	.88	.96	1.03	1.12
		Use Thickness Class.	3	4	5	5	7	8	9
		Use Thickness.	.73	.79	.85	.85	.99	1.07	1.16
	12	Calc. Thick.	.78	.84	.88	.96	1.00	1.08	1.16
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.79	.85	.85	.92	.99	1.07	1.16
	16	Calc. Thick.	.83	.87	.91	.97	1.03	1.10	1.17
		Use Thickness Class.	5	5	6	7	8	8	9
		Use Thickness.	.85	.85	.92	.99	1.07	1.07	1.16

TABLE 2A.2 (*cont'd*)
Field Condition B
S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
20	2½	Calc. Thick.	*.63	*.67	.78	.83	.94	1.05	1.16
		Use Thickness Class.	1	1	2	4	6	7	8
		Use Thickness.	.66	.66	.71	.83	.97	1.05	1.13
	3½	Calc. Thick.	*.63	.67	.76	.85	.95	1.06	1.17
		Use Thickness Class.	1	1	3	4	6	7	8
		Use Thickness.	.66	.66	.77	.83	.97	1.05	1.13
	5	Calc. Thick.	.66	.73	.80	.89	.98	1.08	1.18
		Use Thickness Class.	1	2	4	5	6	7	9
		Use Thickness.	.66	.71	.83	.90	.97	1.05	1.22
	8	Calc. Thick.	.76	.81	.87	.94	1.02	1.11	1.21
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.77	.83	.90	.97	1.05	1.13	1.22
	12	Calc. Thick.	.83	.88	.93	.99	1.07	1.15	1.24
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.83	.90	90	.97	1.05	1.13	1.22
	16	Calc. Thick.	.87	.92	.97	1.04	1.10	1.18	1.26
		Use Thickness Class.	5	5	6	7	8	9	9
		Use Thickness.	.90	.90	.97	1.05	1.13	1.22	1.22
24	2½	Calc. Thick.	*.69	*.75	.88	.95	1.08	1.21	1.34
		Use Thickness Class.	1	1	2	4	6	7	9
		Use Thickness.	.74	.74	.80	.93	1.08	1.17	1.36
	3½	Calc. Thick.	*.69	.75	.85	.97	1.09	1.23	1.36
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.74	.74	.86	1.00	1.08	1.26	1.36
	5	Calc. Thick.	.75	.88	.91	1.01	1.18	1.24	1.36
		Use Thickness Class.	1	2	4	5	6	8	9
		Use Thickness.	.74	.80	.93	1.00	1.08	1.26	1.36
	8	Calc. Thick.	.83	.91	.98	1.07	1.17	1.28	1.39
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.86	.93	1.00	1.08	1.17	1.26	1.36
	12	Calc. Thick.	.91	.98	1.05	1.13	1.21	1.38	1.43
		Use Thickness Class.	4	5	6	7	7	9	10
		Use Thickness.	.93	1.00	1.08	1.17	1.17	1.36	1.47
	16	Calc. Thick.	.98	1.04	1.10	1.18	1.26	1.36	1.46
		Use Thickness Class.	5	6	6	7	8	9	10
		Use Thickness.	1.00	1.08	1.08	1.17	1.26	1.36	1.47
30	2½	Calc. Thick.	*.81	*.87	.99	1.15	1.31	1.48	1.64
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.87	.87	1.02	1.19	1.29	1.50	1.62
	3½	Calc. Thick.	*.81	.88	1.02	1.17	1.32	1.49	1.65
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.87	.87	1.02	1.19	1.29	1.50	1.62
	5	Calc. Thick.	.87	.96	1.08	1.21	1.35	1.51	1.66
		Use Thickness Class.	1	2	4	5	7	8	9
		Use Thickness.	.87	.94	1.10	1.19	1.39	1.50	1.62
	8	Calc. Thick.	.98	1.06	1.16	1.27	1.40	1.55	1.69
		Use Thickness Class.	3	4	5	6	7	8	10
		Use Thickness.	1.02	1.10	1.19	1.29	1.39	1.50	1.75
	12	Calc. Thick.	1.09	1.16	1.25	1.35	1.46	1.60	1.73
		Use Thickness Class.	4	5	6	7	8	9	10
		Use Thickness.	1.10	1.19	1.29	1.39	1.50	1.62	1.75
	16	Calc. Thick.	1.16	1.23	1.30	1.40	1.51	1.64	1.76
		Use Thickness Class.	5	5	6	7	8	9	10
		Use Thickness.	1.19	1.19	1.29	1.39	1.50	1.62	1.75

TABLE 2A.2 (*cont'd*)
Field Condition B
S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
36	2½	Calc. Thick.	*.91	*.98	1.13	1.31	1.52	1.73	1.93
		Use Thickness Class.	1	1	3	5	7	8	10
		Use Thickness.	.97	.97	1.13	1.32	1.54	1.66	1.93
	3½	Calc. Thick.	*.91	.99	1.15	1.34	1.52	1.73	1.93
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	.97	.97	1.13	1.32	1.54	1.79	1.93
	5	Calc. Thick.	.98	1.09	1.25	1.38	1.54	1.75	1.94
		Use Thickness Class.	1	2	4	6	7	9	10
		Use Thickness.	.97	1.05	1.22	1.43	1.54	1.79	1.93
	8	Calc. Thick.	1.10	1.20	1.32	1.46	1.62	1.78	1.98
		Use Thickness Class.	3	4	5	6	8	9	10
		Use Thickness.	1.13	1.22	1.32	1.43	1.66	1.79	1.93
	12	Calc. Thick.	1.22	1.31	1.42	1.54	1.68	1.84	2.03
		Use Thickness Class.	4	5	6	7	8	9	11
		Use Thickness.	1.22	1.32	1.4°	1.54	1.66	1.79	2.08
	16	Calc. Thick.	1.30	1.39	1.49	1.61	1.73	1.88	2.05
		Use Thickness Class.	5	6	7	8	9	10	11
		Use Thickness.	1.32	1.43	1.54	1.66	1.79	1.93	2.08
42	2½	Calc. Thick.	*1.00	*1.09	1.26	1.48	1.71	1.94	2.18
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	1.07	1.07	1.25	1.46	1.71	2.00	2.16
	3½	Calc. Thick.	*1.01	1.10	1.29	1.50	1.73	1.97	2.21
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	1.07	1.07	1.25	1.46	1.71	2.00	2.16
	5	Calc. Thick.	1.07	1.21	1.38	1.55	1.76	1.97	2.23
		Use Thickness Class.	1	3	4	6	7	9	10
		Use Thickness.	1.07	1.25	1.35	1.58	1.71	2.00	2.16
	8	Calc. Thick.	1.20	1.33	1.47	1.63	1.82	2.02	2.25
		Use Thickness Class.	3	4	5	6	8	9	11
		Use Thickness.	1.25	1.35	1.46	1.58	1.85	2.00	2.33
	12	Calc. Thick.	1.36	1.48	1.58	1.73	1.90	2.08	2.29
		Use Thickness Class.	4	5	6	7	8	10	11
		Use Thickness.	1.35	1.46	1.58	1.71	1.85	2.16	2.33
	16	Calc. Thick.	1.45	1.54	1.67	1.80	1.97	2.16	2.34
		Use Thickness Class.	5	6	7	8	9	10	11
		Use Thickness.	1.46	1.58	1.71	1.85	2.00	2.16	2.33
48	2½	Calc. Thick.	*1.08	*1.20	1.42	1.68	1.93	2.21	2.48
		Use Thickness Class.	1	1	3	6	7	9	11
		Use Thickness.	1.18	1.18	1.37	1.73	1.87	2.18	2.54
	3½	Calc. Thick.	*1.10	1.23	1.45	1.70	1.95	2.22	2.49
		Use Thickness Class.	1	2	4	6	8	9	11
		Use Thickness.	1.18	1.27	1.48	1.73	2.02	2.18	2.54
	5	Calc. Thick.	1.18	1.33	1.53	1.74	1.98	2.23	2.56
		Use Thickness Class.	1	3	4	6	8	9	11
		Use Thickness.	1.18	1.37	1.48	1.73	2.02	2.18	2.54
	8	Calc. Thick.	1.34	1.47	1.64	1.83	2.04	2.31	2.56
		Use Thickness Class.	3	4	5	7	8	10	11
		Use Thickness.	1.37	1.48	1.60	1.87	2.02	2.35	2.54
	12	Calc. Thick.	1.50	1.63	1.77	1.94	2.13	2.36	2.59
		Use Thickness Class.	4	5	6	7	9	10	11
		Use Thickness.	1.48	1.60	1.73	1.87	2.18	2.35	2.54
	16	Calc. Thick.	1.62	1.74	1.87	2.03	2.23	2.43	2.64
		Use Thickness Class.	5	6	7	8	9	10	12
		Use Thickness.	1.60	1.73	1.87	2.02	2.18	2.35	2.74

TABLE 2A.2 (*cont'd*)

Field Condition B

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
54	2½	Calc. Thick.	*1.19	*1.31	1.57	1.88	2.16	2.48	2.78
		Use {Thickness Class.	1	1	4	6	8	9	11
		{Thickness.	1.30	1.30	1.63	1.90	2.21	2.39	2.79
	3½	Cal. Thick.	*1.22	1.36	1.60	1.89	2.18	2.48	2.78
		Use {Thickness Class.	1	2	4	6	8	9	11
		{Thickness..	1.30	1.40	1.63	1.90	2.21	2.39	2.79
	5	Calc. Thick.	1.29	1.48	1.68	1.96	2.22	2.58	2.80
		Use {Thickness Class.	1	3	4	6	8	10	11
		{Thickness.	1.30	1.51	1.63	1.90	2.21	2.58	2.79
	8	Calc. Thick.	1.46	1.62	1.80	2.03	2.29	2.56	2.83
		Use {Thickness Class.	3	4	5	7	8	10	11
		{Thickness.	1.51	1.63	1.76	2.05	2.21	2.58	2.79
	12	Calc. Thick.	1.63	1.78	1.95	2.15	2.39	2.63	2.89
		Use {Thickness Class.	4	5	6	8	9	10	11
		{Thickness.	1.63	1.76	1.90	2.21	2.39	2.58	2.79
	16	Calc. Thick.	1.77	1.92	2.06	2.28	2.46	2.68	2.95
		Use {Thickness Class.	5	6	7	8	9	10	12
		{Thickness.	1.76	1.90	2.05	2.21	2.39	2.58	3.01
60	2½	Calc. Thick.	*1.28	1.42	1.73	2.05	2.38	2.73	3.08
		Use {Thickness Class.	1	1	4	6	8	10	11
		{Thickness.	1.39	1.39	1.75	2.04	2.38	2.78	3.00
	3½	Calc. Thick.	*1.32	1.47	1.78	2.07	2.39	2.73	3.08
		Use {Thickness Class.	1	2	4	6	8	10	11
		{Thickness.	1.39	1.50	1.75	2.04	2.38	2.78	3.00
	5	Calc. Thick.	1.40	1.59	1.84	2.12	2.43	2.75	3.08
		Use {Thickness Class.	1	3	5	7	8	10	11
		{Thickness.	1.39	1.62	1.89	2.20	2.38	2.78	3.00
	8	Calc. Thick.	1.59	1.77	1.98	2.22	2.49	2.79	3.12
		Use {Thickness Class.	3	4	6	7	9	10	12
		{Thickness.	1.62	1.75	2.04	2.20	2.57	2.78	3.24
	12	Calc. Thick.	1.80	1.95	2.13	2.36	2.60	2.87	3.18
		Use {Thickness Class.	4	5	7	8	9	10	12
		{Thickness.	1.75	1.89	2.20	2.38	2.57	2.78	3.24
	16	Calc. Thick.	1.93	2.08	2.26	2.46	2.68	2.95	3.26
		Use {Thickness Class.	5	6	7	8	10	11	12
		{Thickness.	1.89	2.04	2.20	2.38	2.78	3.00	3.24

TABLE 2A.3*

Schedule of Barrel Thicknesses—Field Condition C

Blocks Having Average Spacing of 6 feet

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
3	2½	Calc. Thick.	*.36	*.36	*.37	*.37	*.38	*.39	*.39
		Use {Thickness Class.	1	1	1	1	1	2	2
		{Thickness.	.37	.37	.37	.37	.37	.40	.40
	3½	Calc. Thick.	*.36	*.36	*.37	*.37	*.38	*.38	*.39
		Use {Thickness Class.	1	1	1	1	1	1	2
		{Thickness.	.37	.37	.37	.37	.37	.37	.40
	5	Calc. Thick.	*.38	*.38	*.39	*.39	*.40	*.40	*.41
		Use {Thickness Class.	1	1	2	2	2	2	2
		{Thickness.	.37	.37	.40	.40	.40	.40	.40
	8	Calc. Thick.	.43	.43	.44	.44	.45	.46	.47
		Use {Thickness Class.	3	3	3	3	4	4	4
		{Thickness.	.43	.43	.43	.43	.40	.46	.46
	12	Calc. Thick. Std. Class No. Std. Class Thick.	See page 21 for thickness classes required.					.52 6 .54	.52 6 .54
	16	Calc. Thick. Std. Class No. Std. Class Thick.	See page 21 for thickness classes required.						
4	2½	Calc. Thick.	*.40	*.41	*.41	*.42	*.43	*.44	*.45
		Use {Thickness Class.	1	1	1	2	2	2	3
		{Thickness.	.40	.40	.40	.43	.43	.43	.46
	3½	Calc. Thick.	*.40	*.40	*.41	*.42	*.43	*.44	*.45
		Use {Thickness Class.	1	1	1	2	2	2	3
		{Thickness.	.40	.40	.40	.43	.43	.43	.46
	5	Calc. Thick.	*.42	*.43	*.44	*.44	*.45	*.46	*.47
		Use {Thickness Class.	2	2	2	2	3	3	3
		{Thickness.	.43	.43	.43	.43	.46	.46	.46
	8	Calc. Thick.	.48	.49	.50	.50	.51	.52	.53
		Use {Thickness Class	4	4	4	4	4	5	5
		{Thickness.	.50	.50	.50	.50	.50	.54	.54
	12	Calc. Thick.	.56	.56	.57	.58	.59	.60	.60
		Use {Thickness Class.	6	6	6	6	6	6	6
		{Thickness.	.58	.58	.58	.58	.58	.58	.58
	16	Calc. Thick.	.62	.63	.64	.64	.65	.66	.67
		Use {Thickness Class.	7	7	7	7	7	8	8
		{Thickness.	.63	.63	.63	.63	.63	.68	.68

All thicknesses given above for 3-inch and 4-inch pipe are safe for the most favorable block spacing, viz. 30 inches from each end of 12-foot length of pipe or, if longer lengths are used, spacing which does not give greater beam moments, and which averages not over 6 feet. In many cases thicknesses given for 3-inch and 4-inch pipe are not safe for less favorable block spacings. For thicknesses required with less favorable block spacings with 12-foot lengths of pipe, see page 21.

* Asterisks preceding calculated thicknesses indicate that in such cases truck load rather than water hammer was controlling.

TABLE 2A.3 (*cont'd*)

Schedule of Barrel Thicknesses—Field Condition C

Blocks Having Average Spacing of 6 feet

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
6	2½	Calc. Thick.	*.46	*.47	*.48	*.50	*.51	*.52	*.54
		Use Thickness Class.	2	2	3	3	3	4	4
		Use Thickness.	.46	.46	.50	.50	.50	.54	.54
	3½	Calc. Thick.	*.46	*.47	*.48	*.49	*.51	*.52	*.54
		Use Thickness Class.	2	2	3	3	3	4	4
		Use Thickness.	.46	.46	.50	.50	.50	.54	.54
	5	Calc. Thick.	*.49	*.50	*.51	*.52	*.53	*.55	.57
		Use Thickness Class.	3	3	3	4	4	4	5
		Use Thickness.	.50	.50	.50	.54	.54	.54	.58
	8	Calc. Thick.	.56	.57	.58	.60	.62	.63	.64
		Use Thickness Class.	5	5	5	5	6	6	6
		Use Thickness.	.58	.58	.58	.58	.63	.63	.63
	12	Calc. Thick.	.65	.66	.67	.68	.70	.71	.73
		Use Thickness Class.	y8	7	7	7	7	8	8
		Use Thickness.	.63	.68	.68	.68	.68	.73	.73
	16	Calc. Thick.	.73	.74	.75	.76	.77	.79	.80
		Use Thickness Class.	y8	y8	y8·	y9	y9	y9	y9
		Use Thickness.	.73	.73	.73	.79	.79	.79	.79
8	2½	Calc. Thick.	*.52	*.53	*.54	*.56	*.58	*.60	*.62
		Use Thickness Class.	3	3	3	4	4	4	5
		Use Thickness.	.54	.54	.54	.58	.58	.58	.63
	3½	Calc. Thick.	*.51	*.52	*.54	*.56	*.58	*.61	*.63
		Use Thickness Class.	2	3	3	4	4	5	5
		Use Thickness.	.50	.54	.54	.58	.58	.63	.63
	5	Calc. Thick.	*.54	*.55	*.57	.59	.61	.64	.67
		Use Thickness Class.	3	3	4	4	5	5	6
		Use Thickness.	.54	.54	.58	.58	.63	.63	.68
	8	Calc. Thick.	.62	.64	.66	.68	.69	.72	.74
		Use Thickness Class.	5	5	6	6	6	7	7
		Use Thickness.	.63	.63	.68	.68	.68	.73	.73
	12	Calc. Thick.	.73	.74	.76	.78	.79	.82	.84
		Use Thickness Class.	7	7	8	8	8	9	9
		Use Thickness.	.73	.73	.79	.79	.79	.85	.85
	16	Calc. Thick.	.79	.81	.82	.84	.86	.88	.90
		Use Thickness Class.	8	8	9	9	9	9	10
		Use Thickness.	.79	.79	.85	.85	.85	.85	.92

Thicknesses of 6-inch pipe marked y are not safe for all block spacings though safe for the most favorable block spacing (see note page 19). For thicknesses required with 12-foot lengths in cases marked y see page 19.

TABLE 2A.3 (*cont'd*)

SUPPLEMENTARY THICKNESS TABLE

For Small Pipe Acting as Beams Spanning between Blocks in Field Condition C

Modulus of Rupture of Iron in Pipe as Beam—26,000 lb. per sq. in.

Explanatory Note. This table contains thickness classes computed as required for pipe as beams spanning between blocks, assuming no support from the untamped backfill which will run under the pipe. Net thicknesses, i.e., thicknesses with combined foundry tolerance and corrosion allowances of 0.15 inch deducted from standard thickness, are used in computing beam strengths. Required thickness classes are given for both favorable and unfavorable block spacings. Thickness classes here given should be used where they are larger than those shown in the previous sheets in which the pipe were computed as rings subjected to water pressure and fill loads, disregarding beam.

DISTANCES OF BLOCKS FROM ENDS OF 12-FOOT LENGTHS OF PIPE, INCHES	NOMINAL DIAMETER OF PIPE, INCHES	DEPTH OF COVER—FEET 2½	3½	5	8	12	16
21	3	6**	6**	9**	x	x	x
	4	2†	2†	4**	10**	x	x
	6	1	1	1	3	7†	x
	8	1	1	1	1	2	4
30 (most favorable)	3	1	1	1	2	6†	x
	4	1	1	1	1	3	7
	6	1	1	1	1	1	1
	8	1	1	1	1	1	1
36	3	1	1	2†	6	x	x
	4	1	1	1	3	8	x
	6	1	1	1	1	1	4
	8	1	1	1	1	1	1
12 & 30	3	6**	6**	9**	x	x	x
	4	1	1	4**	9**	x	x
	6	1	1	1	2	7†	x
	8	1	1	1	1	2	4

** Heavier than required for pipe as ring with same cover and all water pressures up to and including 350 lb.

† Heavier than required for pipe computed as a ring with the same cover and one or more of the several water pressures.

x No class heavy enough.

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
10	2½	Calc. Thick.	*.57	*.59	*.61	*.63	*.65	*.68	*.71
		Use Thickness Class.	3	3	4	4	4	5	6
		Use Thickness.	.58	.58	.63	.63	.63	.68	.73
	3½	Calc. Thick.	*.56	*.58	*.60	*.62	*.65	*.69	*.73
		Use Thickness Class.	3	3	3	4	4	5	6
		Use Thickness.	.58	.58	.58	.63	.63	.68	.73
	5	Calc. Thick.	*.59	*.61	.64	.67	.70	.74	.78
		Use Thickness Class.	3	4	4	5	5	6	7
		Use Thickness.	.58	.63	.63	.68	.68	.73	.79
	8	Calc. Thick.	.69	.71	.73	.76	.79	.81	.84
		Use Thickness Class.	5	6	6	7	7	7	8
		Use Thickness.	.68	.73	.73	.79	.79	.79	.85
	12	Calc. Thick.	.80	.81	.84	.86	.88	.91	.94
		Use Thickness Class.	7	7	8	8	8	9	9
		Use Thickness.	.79	.79	.85	.85	.85	.92	.92
	16	Calc. Thick	.84	.86	.88	.90	.93	.95	.98
		Use Thickness Class.	8	8	8	9	9	9	10
		Use Thickness.	.85	.85	.85	.92	.92	.92	.99

TABLE 2A.3 (*cont'd*)

Field Condition C

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
12	2½	Calc. Thick.	*.61	*.63	*.65	*.68	*.71	.75	.81
		Use Thickness Class.	3	3	3	4	5	5	6
		Use Thickness.	.63	.63	.63	.68	.73	.73	.79
	3½	Calc. Thick.	*.60	*.62	*.64	*.67	.71	.77	.82
		Use Thickness Class.	2	3	3	4	5	6	7
		Use Thickness.	.58	.63	.63	.68	.73	.79	.85
	5	Calc. Thick.	*.63	*.66	.69	.72	.76	.81	.86
		Use Thickness Class.	3	3	4	5	6	6	7
		Use Thickness.	.63	.63	.68	.73	.79	.79	.85
	8	Calc. Thick.	.74	.76	.79	.82	.86	.89	.94
		Use Thickness Class.	5	6	6	7	7	8	8
		Use Thickness.	.73	.79	.79	.85	.85	.92	.92
	12	Calc. Thick.	.82	.84	.87	.91	.94	.97	1.01
		Use Thickness Class.	7	7	7	8	8	9	9
		Use Thickness.	.85	.85	.85	.92	.92	.99	.99
	16	Calc. Thick.	.87	.90	.92	.96	.98	1.01	1.05
		Use Thickness Class.	7	8	8	8	9	9	10
		Use Thickness.	.85	.92	.92	.92	.99	.99	1.07
14	2½	Calc. Thick.	*.65	*.67	*.70	*.73	*.77	.83	.91
		Use Thickness Class.	3	4	4	5	6	7	8
		Use Thickness.	.63	.68	.68	.73	.79	.85	.92
	3½	Calc. Thick.	*.64	*.67	*.70	.73	.79	.85	.92
		Use Thickness Class.	3	4	4	5	6	7	8
		Use Thickness.	.63	.68	.68	.73	.79	.85	.92
	5	Calc. Thick.	*.68	.71	.76	.79	.85	.90	.96
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.68	.73	.73	.79	.85	.92	.99
	8	Calc. Thick.	.80	.83	.86	.90	.94	.99	1.04
		Use Thickness Class.	6	7	7	8	8	9	10
		Use Thickness.	.79	.85	.85	.92	.92	.99	1.07
	12	Calc. Thick.	.87	.90	.93	.97	1.01	1.05	1.10
		Use Thickness Class.	7	8	8	9	9	10	10
		Use Thickness.	.85	.92	.92	.99	.99	1.07	1.07
	16	Calc. Thick.	.92	.95	.98	1.02	1.05	1.09	1.14
		Use Thickness Class.	8	8	9	9	10	10	11
		Use Thickness.	.92	.92	.99	.99	1.07	1.07	1.16
16	2½	Calc. Thick.	*.68	*.71	*.74	*.78	*.83	.90	1.00
		Use Thickness Class.	3	4	4	5	6	7	8
		Use Thickness.	.68	.73	.73	.79	.85	.92	.99
	3½	Calc. Thick.	*.68	*.71	*.75	.78	.85	.92	1.01
		Use Thickness Class.	3	4	4	5	6	7	8
		Use Thickness.	.68	.73	.73	.79	.85	.92	.99
	5	Calc. Thick.	*.72	*.76	.79	.85	.91	.97	1.04
		Use Thickness Class.	4	4	5	6	7	8	9
		Use Thickness.	.73	.73	.79	.85	.92	.99	1.07
	8	Calc. Thick.	.83	.87	.91	.95	1.00	1.06	1.12
		Use Thickness Class.	6	6	7	7	8	9	10
		Use Thickness.	.85	.85	.92	.92	.99	1.07	1.16
	12	Calc. Thick.	.92	.95	.99	1.03	1.07	1.12	1.18
		Use Thickness Class.	7	7	8	9	9	10	10
		Use Thickness.	.92	.92	.99	1.07	1.07	1.16	1.16
	16	Calc. Thick.	.97	1.00	1.04	1.08	1.12	1.17	1.22
		Use Thickness Class.	8	8	9	9	10	10	11
		Use Thickness.	.99	.99	1.07	1.07	1.16	1.16	1.25

TABLE 2A.3 (*cont'd*)

Field Condition C

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
18	2½	Calc. Thick.	*.73	*.76	*.80	*.84	.90	.99	1.09
		Use Thickness Class.	3	4	4	5	6	7	8
		Use Thickness.	.73	.79	.79	.85	.92	.99	1.07
	3½	Calc. Thick.	*.72	*.75	*.79	.85	.93	1.02	1.11
		Use Thickness Class.	3	3	4	5	6	7	8
		Use Thickness.	.73	.73	.79	.85	.92	.99	1.07
	5	Calc. Thick.	*.77	*.80	.86	.92	.99	1.06	1.14
		Use Thickness Class.	4	4	5	6	7	8	9
		Use Thickness.	.79	.79	.85	.92	.99	1.07	1.16
	8	Calc. Thick.	.88	.92	.97	1.02	1.08	1.14	1.21
		Use Thickness Class.	5	6	7	7	8	9	10
		Use Thickness.	.85	.92	.99	.99	1.07	1.16	1.25
	12	Calc. Thick.	.96	1.01	1.05	1.10	1.16	1.21	1.27
		Use Thickness Class.	7	7	8	8	9	10	10
		Use Thickness.	.99	.99	1.07	1.07	1.16	1.25	1.25
	16	Calc. Thick.	1.03	1.07	1.11	1.15	1.20	1.26	1.32
		Use Thickness Class.	8	8	8	9	9	10	11
		Use Thickness.	1.07	1.07	1.07	1.16	1.16	1.25	1.35
20	2½	Calc. Thick.	*.77	*.81	*.85	*.90	.96	1.06	1.17
		Use Thickness Class.	3	4	4	5	6	7	8
		Use Thickness.	.77	.83	.83	.90	.97	1.05	1.13
	3½	Calc. Thick.	*.77	*.81	*.86	.90	.99	1.08	1.19
		Use Thickness Class.	3	4	4	5	6	7	9
		Use Thickness.	.77	.83	.83	.90	.97	1.05	1.22
	5	Calc. Thick.	*.81	*.85	.91	.97	1.06	1.14	1.23
		Use Thickness Class.	4	4	5	6	7	8	9
		Use Thickness.	.83	.83	.90	.97	1.05	1.13	1.22
	8	Calc. Thick.	.91	.96	1.02	1.07	1.14	1.21	1.29
		Use Thickness Class.	5	6	7	7	8	9	10
		Use Thickness.	.90	.97	1.05	1.05	1.13	1.22	1.32
	12	Calc. Thick.	1.02	1.06	1.11	1.16	1.22	1.29	1.36
		Use Thickness Class.	7	7	8	8	9	10	10
		Use Thickness.	1.05	1.05	1.13	1.13	1.22	1.32	1.32
	16	Calc. Thick.	1.09	1.13	1.17	1.22	1.28	1.35	1.41
		Use Thickness Class.	8	8	8	9	10	10	11
		Use Thickness.	1.13	1.13	1.13	1.22	1.32	1.32	1.43
24	2½	Calc. Thick.	*.85	*.89	*.94	*1.00	1.10	1.23	1.35
		Use Thickness Class.	3	3	4	5	6	8	9
		Use Thickness.	.86	.86	.93	1.00	1.08	1.26	1.36
	3½	Calc. Thick.	*.85	*.89	*.94	1.02	1.13	1.25	1.37
		Use Thickness Class.	3	3	4	5	7	8	9
		Use Thickness.	.86	.86	.93	1.00	1.17	1.26	1.36
	5	Calc. Thick.	*.89	*.94	1.02	1.10	1.19	1.30	1.41
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.86	.93	1.00	1.08	1.17	1.26	1.36
	8	Calc. Thick.	1.01	1.06	1.12	1.20	1.28	1.37	1.48
		Use Thickness Class.	5	6	6	7	8	9	10
		Use Thickness.	1.00	1.08	1.08	1.17	1.26	1.36	1.47
	12	Calc. Thick.	1.13	1.18	1.24	1.30	1.37	1.46	1.55
		Use Thickness Class.	7	7	8	8	9	10	11
		Use Thickness.	1.17	1.17	1.26	1.26	1.36	1.47	1.59
	16	Calc. Thick.	1.20	1.26	1.31	1.37	1.44	1.52	1.60
		Use Thickness Class.	7	8	9	9	10	10	11
		Use Thickness.	1.17	1.26	1.36	1.36	1.47	1.47	1.59

TABLE 2A.3 (*cont'd*)
Field Condition C
S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
30	2½	Calc. Thick.	*.99	*1.05	*1.11	1.19	1.33	1.49	1.66
		Use Thickness Class.	3	3	4	5	6	8	9
		Thickness.	1.02	1.02	1.10	1.19	1.29	1.50	1.62
	3½	Calc. Thick.	*.99	*1.04	*1.11	1.21	1.36	1.61	1.67
		Use Thickness Class.	3	3	4	5	7	8	9
		Thickness.	1.02	1.02	1.10	1.19	1.39	1.50	1.62
	5	Calc. Thick.	*1.04	*1.13	1.21	1.32	1.46	1.58	1.73
		Use Thickness Class.	3	4	5	6	8	9	10
		Thickness.	1.02	1.10	1.19	1.29	1.50	1.62	1.75
	8	Calc. Thick.	1.18	1.25	1.35	1.43	1.54	1.66	1.78
		Use Thickness Class.	5	6	7	7	8	9	10
		Thickness.	1.19	1.29	1.39	1.39	1.50	1.62	1.75
	12	Calc. Thick.	1.38	1.38	1.46	1.54	1.63	1.74	1.87
		Use Thickness Class.	6	7	8	8	9	10	11
		Thickness.	1.29	1.39	1.50	1.50	1.62	1.75	1.89
	16	Calc. Thick.	1.41	1.48	1.55	1.62	1.71	1.81	1.98
		Use Thickness Class.	7	8	8	9	10	10	11
		Thickness.	1.39	1.50	1.50	1.62	1.75	1.75	1.89
36	2½	Calc. Thick.	*1.11	*1.18	*1.26	1.36	1.53	1.75	1.93
		Use Thickness Class.	3	4	4	5	7	9	10
		Thickness.	1.13	1.22	1.22	1.32	1.54	1.79	1.93
	3½	Calc. Thick.	*1.11	*1.18	*1.26	1.40	1.58	1.74	1.94
		Use Thickness Class.	3	4	4	6	7	9	10
		Thickness.	1.13	1.22	1.22	1.43	1.54	1.79	1.93
	5	Calc. Thick.	*1.18	*1.25	1.35	1.44	1.65	1.81	2.01
		Use Thickness Class.	4	4	5	6	8	9	11
		Thickness.	1.22	1.22	1.32	1.43	1.66	1.79	2.08
	8	Calc. Thick.	1.31	1.40	1.50	1.62	1.75	1.90	2.08
		Use Thickness Class.	5	6	7	8	9	10	11
		Thickness.	1.32	1.43	1.54	1.66	1.79	1.93	2.08
	12	Calc. Thick.	1.49	1.56	1.65	1.76	1.88	2.01	2.15
		Use Thickness Class.	7	7	8	9	10	11	11
		Thickness.	1.54	1.54	1.66	1.79	1.93	2.08	2.08
	16	Calc. Thick.	1.61	1.68	1.77	1.87	1.98	2.09	2.25
		Use Thickness Class.	8	8	9	10	10	11	12
		Thickness.	1.66	1.66	1.79	1.93	1.93	2.08	2.25
42	2½	Calc. Thick.	*1.23	*1.31	*1.40	1.52	1.74	1.96	2.23
		Use Thickness Class.	3	4	4	6	7	9	10
		Thickness.	1.25	1.35	1.35	1.58	1.71	2.00	2.16
	3½	Calc. Thick.	*1.25	*1.33	*1.41	1.58	1.78	1.98	2.23
		Use Thickness Class.	3	4	5	6	8	9	10
		Thickness.	1.25	1.35	1.46	1.58	1.85	2.00	2.16
	5	Calc. Thick.	*1.33	*1.40	1.51	1.66	1.84	2.05	2.28
		Use Thickness Class.	4	4	5	7	8	9	11
		Thickness.	1.35	1.35	1.46	1.71	1.85	2.00	2.33
	8	Calc. Thick.	1.47	1.57	1.68	1.81	1.97	2.16	2.36
		Use Thickness Class.	5	6	7	8	9	10	11
		Thickness.	1.46	1.58	1.71	1.85	2.00	2.16	2.33
	12	Calc. Thick.	1.65	1.74	1.85	1.97	2.11	2.28	2.45
		Use Thickness Class.	7	7	8	9	10	11	12
		Thickness.	1.71	1.71	1.85	2.00	2.16	2.33	2.52
	16	Calc. Thick.	1.80	1.88	1.98	2.09	2.23	2.38	2.54
		Use Thickness Class.	8	8	9	10	10	11	12
		Thickness.	1.85	1.85	2.00	2.16	2.16	2.33	2.52

TABLE 2A.3 (*cont'd*)
Field Condition C
S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
48	2½	Calc. Thick.	*1.34	*1.44	*1.55	1.71	1.96	2.25	2.50
		Use Thickness Class.	3	4	5	6	8	9	11
		Thickness.	1.37	1.48	1.60	1.73	2.02	2.18	2.54
	3½	Calc. Thick.	*1.35	*1.45	*1.56	1.76	1.99	2.25	2.52
		Use Thickness Class.	3	4	5	6	8	9	11
		Thickness.	1.37	1.48	1.60	1.73	2.02	2.18	2.54
	5	Calc. Thick.	*1.45	*1.55	1.69	1.87	2.08	2.32	2.57
		Use Thickness Class.	4	5	6	7	8	10	11
		Thickness.	1.48	1.60	1.73	1.87	2.02	2.35	2.54
	8	Calc. Thick.	1.63	1.74	1.88	2.03	2.22	2.42	2.65
		Use Thickness Class.	5	6	7	8	9	10	12
		Thickness.	1.60	1.73	1.87	2.02	2.18	2.35	2.74
	12	Calc. Thick.	1.85	1.95	2.07	2.22	2.38	2.56	2.76
		Use Thickness Class.	7	8	8	9	10	11	12
		Thickness.	1.87	2.02	2.02	2.18	2.35	2.54	2.74
	16	Calc. Thick.	2.03	2.13	2.24	2.36	2.50	2.68	2.84
		Use Thickness Class.	8	9	9	10	11	12	12
		Thickness.	2.02	2.18	2.18	2.35	2.54	2.74	2.74
54	2½	Calc. Thick.	*1.48	*1.58	*1.72	1.91	2.18	2.48	2.78
		Use Thickness Class.	3	4	5	6	8	9	11
		Thickness.	1.51	1.63	1.76	1.90	2.21	2.39	2.79
	3½	Calc. Thick.	*1.52	*1.63	*1.75	1.98	2.23	2.53	2.80
		Use Thickness Class.	3	4	5	7	8	10	11
		Thickness.	1.51	1.63	1.76	2.05	2.21	2.58	2.79
	5	Calc. Thick.	*1.60	*1.70	1.87	2.08	2.33	2.58	2.85
		Use Thickness Class.	4	5	6	7	9	10	11
		Thickness.	1.63	1.76	1.90	2.05	2.39	2.58	2.79
	8	Calc. Thick.	1.79	1.93	2.08	2.26	2.46	2.69	2.95
		Use Thickness Class.	5	6	7	8	9	11	12
		Thickness.	1.76	1.90	2.05	2.21	2.39	2.79	3.01
	12	Calc. Thick.	2.03	2.15	2.28	2.46	2.65	2.84	3.08
		Use Thickness Class.	7	8	8	9	10	11	12
		Thickness.	2.05	2.21	2.21	2.39	2.58	2.79	3.01
	16	Calc. Thick.	2.23	2.34	2.47	2.61	2.78	2.98	3.19
		Use Thickness Class.	8	9	9	10	11	12	13
		Thickness.	2.21	2.39	2.39	2.58	2.79	3.01	3.25
60	2½	Calc. Thick.	*1.68	*1.78	*1.87	2.08	2.43	2.73	3.08
		Use Thickness Class.	3	4	5	6	8	10	11
		Thickness.	1.62	1.75	1.89	2.04	2.38	2.78	3.00
	3½	Calc. Thick.	*1.64	*1.78	*1.91	2.16	2.47	2.78	3.09
		Use Thickness Class.	3	4	5	7	8	10	11
		Thickness.	1.62	1.75	1.89	2.20	2.38	2.78	3.00
	5	Calc. Thick.	*1.73	*1.85	2.04	2.28	2.53	2.83	3.13
		Use Thickness Class.	4	5	6	7	9	10	12
		Thickness.	1.75	1.89	2.04	2.20	2.57	2.78	3.24
	8	Calc. Thick.	1.95	2.10	2.27	2.46	2.71	2.95	3.24
		Use Thickness Class.	5	6	7	8	10	11	12
		Thickness.	1.89	2.04	2.20	2.38	2.78	3.00	3.24
	12	Calc. Thick.	2.24	2.38	2.52	2.69	2.89	3.14	3.38
		Use Thickness Class.	7	8	9	10	11	12	13
		Thickness.	2.20	2.38	2.57	2.78	3.00	3.24	3.50
	16	Calc. Thick.	2.43	2.56	2.70	2.86	3.05	3.28	3.52
		Use Thickness Class.	8	9	10	10	11	12	13
		Thickness.	2.38	2.57	2.78	2.78	3.00	3.24	3.50

TABLE 2A.4*

Schedule of Barrel Thicknesses—Field Condition D

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
3	2½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	3½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	5	Calc. Thick.	.25	.26	.26	.27	.29	.31	.32
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	8	Calc. Thick.	.27	.27	.29	.30	.31	.32	.33
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	12	Calc. Thick.	.29	.30	.31	.31	.32	.33	.35
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	16	Calc. Thick.	.31	.32	.32	.33	.34	.35	.36
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
4	2½	Calc. Thick.	*.26	*.27	.29	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	3½	Calc. Thick.	*.27	*.28	.30	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	5	Calc. Thick.	*.27	.28	.30	.32	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	8	Calc. Thick.	.31	.32	.32	.33	.35	.37	.40
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	12	Calc. Thick.	.32	.33	.35	.36	.37	.39	.40
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	16	Calc. Thick.	.36	.37	.38	.39	.40	.41	.42
		Use Thickness Class.	1	1	1	1	1	1	2
		Use Thickness.	.40	.40	.40	.40	.40	.40	.43
6	2½	Calc. Thick.	*.33	*.34	*.35	.38	.41	.44	.47
		Use Thickness Class.	1	1	1	1	1	1	2
		Use Thickness.	.43	.43	.43	.43	.43	.43	.46
	3½	Calc. Thick.	.33	.35	.36	.38	.41	.44	.47
		Use Thickness Class.	1	1	1	1	1	1	2
		Use Thickness.	.43	.43	.43	.43	.43	.43	.46
	5	Calc. Thick.	.33	.35	.37	.40	.43	.46	.49
		Use Thickness Class.	1	1	1	1	1	2	3
		Use Thickness.	.43	.43	.43	.43	.43	.46	.50
	8	Calc. Thick.	.38	.40	.41	.43	.45	.47	.50
		Use Thickness Class.	1	1	1	1	2	2	3
		Use Thickness.	.43	.43	.43	.43	.46	.46	.50
	12	Calc. Thick.	.42	.43	.45	.47	.48	.50	.53
		Use Thickness Class.	1	1	2	2	3	3	4
		Use Thickness.	.43	.43	.46	.46	.50	.50	.54
	16	Calc. Thick.	.46	.47	.48	.50	.51	.53	.55
		Use Thickness Class.	2	2	3	3	3	4	4
		Use Thickness.	.46	.46	.50	.50	.50	.54	.54

* Asterisks preceding calculated thicknesses indicate that in such cases truck load rather than water hammer was controlling.

TABLE 2A.4 (*cont'd*)

Field Condition D

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
8	2½	Calc. Thick.	*.40	*.42	*.43	.46	.50	.54	.58
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	3½	Calc. Thick.	*.39	*.41	.44	.48	.51	.55	.59
		Use Thickness Class.	1	1	1	2	2	3	4
		Use Thickness.	.46	.46	.46	.50	.50	.54	.58
	5	Calc. Thick.	.42	.44	.46	.49	.53	.56	.60
		Use Thickness Class.	1	1	1	2	3	4	4
		Use Thickness.	.46	.46	.46	.50	.54	.58	.58
	8	Calc. Thick.	.47	.49	.51	.53	.56	.59	.62
		Use Thickness Class.	1	2	2	3	4	4	5
		Use Thickness.	.46	.50	.50	.54	.58	.58	.63
	12	Calc. Thick.	.52	.54	.56	.58	.61	.63	.66
		Use Thickness Class.	3	3	4	4	5	5	6
		Use Thickness.	.54	.54	.58	.58	.63	.63	.68
	16	Calc. Thick.	.57	.59	.61	.63	.66	.68	.70
		Use Thickness Class.	4	4	5	5	5	6	6
		Use Thickness.	.58	.58	.63	.63	.63	.68	.68
10	2½	Calc. Thick.	*.48	*.49	*.51	*.54	.59	.65	.70
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	3½	Calc. Thick.	*.46	*.47	.51	.55	.60	.65	.70
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	5	Calc. Thick.	*.48	.51	.54	.58	.62	.67	.72
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.50	.50	.54	.58	.63	.68	.73
	8	Calc. Thick.	.55	.57	.60	.63	.67	.71	.75
		Use Thickness Class.	2	3	3	4	5	6	6
		Use Thickness.	.54	.58	.58	.63	.68	.73	.73
	12	Calc. Thick.	.62	.64	.67	.69	.72	.76	.80
		Use Thickness Class.	4	4	5	5	6	7	7
		Use Thickness.	.63	.63	.68	.68	.73	.79	.79
	16	Calc. Thick.	.68	.70	.72	.75	.78	.81	.84
		Use Thickness Class.	5	5	6	6	7	7	8
		Use Thickness.	.68	.68	.73	.73	.79	.79	.85
12	2½	Calc. Thick.	*.53	*55	*.57	.61	.67	.73	.80
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.54	.54	.58	.63	.68	.73	.79
	3½	Calc. Thick.	*.51	*.53	.57	.62	.67	.73	.80
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.54	.54	.58	.63	.68	.73	.79
	5	Calc. Thick.	*.53	.57	.61	.66	.71	.76	.82
		Use Thickness Class.	1	2	3	4	5	6	7
		Use Thickness.	.54	.58	.63	.68	.73	.79	.85
	8	Calc. Thick.	.61	.64	.67	.71	.75	.80	.85
		Use Thickness Class.	3	3	4	5	5	6	7
		Use Thickness.	.63	.63	.68	.73	.73	.79	.85
	12	Calc. Thick.	.70	.72	.76	.79	.82	.87	.92
		Use Thickness Class.	4	5	5	6	7	7	8
		Use Thickness.	.68	.73	.73	.79	.85	.85	.92
	16	Calc. Thick	.76	.78	.81	.84	.88	.92	.96
		Use Thickness Class.	6	6	6	7	7	8	9
		Use Thickness.	.79	.79	.79	.85	.85	.92	.99

TABLE 2A.4 (*cont'd*)

Field Condition D

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
14	2½	Calc. Thick.	*.58	*.60	*.63	*.67	.75	.82	.90
		Use Thickness Class.	2	2	3	4	5	7	8
		Use Thickness.	.58	.58	.63	.68	.73	.85	.92
	3½	Calc. Thick.	*.57	*.60	.64	.70	.77	.84	.91
		Use Thickness Class.	2	2	3	4	6	7	8
		Use Thickness.	.58	.58	.63	.68	.79	.85	.92
	5	Calc. Thick.	.60	.64	.68	.73	.79	.86	.93
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.58	.63	.68	.73	.79	.85	.92
	8	Calc. Thick.	.70	.73	.77	.81	.86	.91	.97
		Use Thickness Class.	4	5	6	6	7	8	9
		Use Thickness.	.68	.73	.79	.79	.85	.92	.99
	12	Calc. Thick.	.78	.81	.85	.89	.92	.97	1.03
		Use Thickness Class.	6	6	7	8	8	9	10
		Use Thickness.	.79	.79	.85	.92	.92	.99	1.07
	16	Calc. Thick.	.88	.86	.90	.93	.97	1.01	1.06
		Use Thickness Class.	7	7	8	8	9	9	10
		Use Thickness.	.85	.85	.92	.92	.99	.99	1.07
16	2½	Calc. Thick.	*.63	*.65	*.68	*.73	.81	.90	.99
		Use Thickness Class.	2	2	3	4	5	7	8
		Use Thickness.	.63	.63	.68	.73	.79	.92	.99
	3½	Calc. Thick.	*.62	*.65	*.68	.75	.83	.91	.99
		Use Thickness Class.	2	2	3	4	6	7	8
		Use Thickness.	.63	.63	.68	.73	.85	.92	.99
	5	Calc. Thick.	*.64	.68	.74	.80	.86	.92	1.00
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.63	.68	.73	.79	.85	.92	.99
	8	Calc. Thick.	.76	.79	.83	.88	.93	.99	1.06
		Use Thickness Class.	4	5	6	6	7	8	9
		Use Thickness.	.73	.79	.85	.85	.92	.99	1.07
	12	Calc. Thick.	.84	.87	.91	.95	1.00	1.06	1.12
		Use Thickness Class.	6	6	7	7	8	9	10
		Use Thickness.	.85	.85	.92	.92	.99	1.07	1.16
	16	Calc. Thick.	.88	.91	.95	1.00	1.04	1.10	1.15
		Use Thickness Class.	6	7	7	8	9	9	10
		Use Thickness.	.85	.92	.92	.99	1.07	1.07	1.16
18	2½	Calc. Thick.	*.67	*.70	*.74	*.79	.89	.98	1.08
		Use Thickness Class.	2	2	3	4	6	7	8
		Use Thickness.	.68	.68	.73	.79	.92	.99	1.07
	3½	Calc. Thick.	*.66	*.69	.74	.82	.91	1.00	1.09
		Use Thickness Class.	2	2	3	5	6	7	8
		Use Thickness.	.68	.68	.73	.85	.92	.99	1.07
	5	Calc. Thick.	.70	.74	.80	.87	.95	1.03	1.10
		Use Thickness Class.	2	3	4	5	6	8	8
		Use Thickness.	.68	.73	.79	.85	.92	1.07	1.07
	8	Calc. Thick.	.81	.85	.90	.96	1.02	1.09	1.17
		Use Thickness Class.	4	5	6	7	7	8	9
		Use Thickness.	.79	.85	.92	.99	.99	1.07	1.16
	12	Calc. Thick.	.89	.93	.98	1.03	1.08	1.15	1.22
		Use Thickness Class.	6	6	7	8	8	9	10
		Use Thickness.	.92	.92	.99	1.07	1.07	1.16	1.25
	16	Calc. Thick.	.94	.98	1.03	1.08	1.15	1.20	1.27
		Use Thickness Class.	6	7	8	8	9	9	10
		Use Thickness.	.92	.99	1.07	1.07	1.16	1.16	1.25

TABLE 2A.4 (*cont'd*)

Field Condition D

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
20	2½	Calc. Thick.	*.71	*.75	*.79	*.85	.95	1.05	1.16
		Use Thickness Class.	2	3	3	4	6	7	8
		Use Thickness.	.71	.77	.77	.83	.97	1.05	1.13
	3½	Calc. Thick.	*.71	*.75	*.79	.87	.97	1.07	1.19
		Use Thickness Class.	2	3	3	5	6	7	9
		Use Thickness.	.71	.77	.77	.90	.97	1.05	1.22
	5	Calc. Thick.	*.75	.80	.86	.93	1.02	1.11	1.21
		Use Thickness Class.	3	4	4	5	7	8	9
		Use Thickness.	.77	.83	.83	.90	1.05	1.13	1.22
	8	Calc. Thick.	.85	.90	.96	1.02	1.09	1.17	1.26
		Use Thickness Class.	4	5	6	7	8	8	9
		Use Thickness.	.83	.90	.97	1.05	1.13	1.13	1.22
	12	Calc. Thick.	.94	.99	1.04	1.09	1.15	1.25	1.31
		Use Thickness Class.	6	6	7	8	8	9	10
		Use Thickness.	.97	.97	1.03	1.13	1.13	1.22	1.32
	16	Calc. Thick.	1.00	1.04	1.09	1.14	1.21	1.27	1.35
		Use Thickness Class.	6	7	8	8	9	10	10
		Use Thickness.	.97	1.05	1.13	1.13	1.22	1.32	1.32
24	2½	Calc. Thick.	*.79	*.83	*.88	.96	1.08	1.21	1.35
		Use Thickness Class.	2	3	3	4	6	7	9
		Use Thickness.	.80	.86	.86	.93	1.08	1.17	1.36
	3½	Calc. Thick.	*.78	*.83	*.88	.99	1.11	1.24	1.36
		Use Thickness Class.	2	3	3	5	6	8	9
		Use Thickness.	.80	.86	.86	1.00	1.08	1.26	1.36
	5	Calc. Thick.	*.84	.90	.97	1.06	1.16	1.28	1.39
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.86	.93	1.00	1.08	1.17	1.26	1.36
	8	Calc. Thick.	.92	.99	1.06	1.14	1.22	1.33	1.44
		Use Thickness Class.	4	5	6	7	8	9	10
		Use Thickness.	.93	1.00	1.08	1.17	1.26	1.36	1.47
	12	Calc. Thick.	1.04	1.10	1.16	1.23	1.31	1.40	1.50
		Use Thickness Class.	6	6	7	8	9	9	10
		Use Thickness.	1.08	1.08	1.17	1.26	1.36	1.36	1.47
	16	Calc. Thick.	1.11	1.16	1.22	1.28	1.36	1.45	1.54
		Use Thickness Class.	6	7	8	8	9	10	11
		Use Thickness.	1.08	1.17	1.26	1.26	1.36	1.47	1.59
30	2½	Calc. Thick.	*.91	*.97	*1.04	1.17	1.28	1.48	1.64
		Use Thickness Class.	2	2	3	5	6	8	9
		Use Thickness.	.94	.94	1.02	1.19	1.29	1.50	1.62
	3½	Calc. Thick.	*.91	*.97	1.06	1.20	1.34	1.50	1.66
		Use Thickness Class.	2	2	4	5	7	8	9
		Use Thickness.	.94	.94	1.10	1.19	1.39	1.50	1.62
	5	Calc. Thick.	*.97	1.05	1.15	1.27	1.39	1.53	1.68
		Use Thickness Class.	2	3	5	6	7	8	9
		Use Thickness.	.94	1.02	1.19	1.29	1.39	1.50	1.62
	8	Calc. Thick.	1.09	1.17	1.26	1.35	1.47	1.60	1.73
		Use Thickness Class.	4	5	6	7	8	9	10
		Use Thickness.	1.10	1.19	1.29	1.39	1.50	1.62	1.75
	12	Calc. Thick.	1.22	1.29	1.37	1.45	1.56	1.68	1.81
		Use Thickness Class.	5	6	7	8	9	9	10
		Use Thickness.	1.19	1.29	1.39	1.50	1.62	1.62	1.75
	16	Calc. Thick.	1.30	1.37	1.46	1.55	1.63	1.74	1.85
		Use Thickness Class.	6	7	8	8	9	10	11
		Use Thickness.	1.29	1.39	1.50	1.50	1.62	1.75	1.89

TABLE 2A.4 (*cont'd*)

Field Condition D

S = 11,000 lb. per sq. in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
36	2½	Calc. Thick.	*1.01	*1.09	*1.18	1.33	1.53	1.73	1.92
		Use Thickness Class.	2	3	4	5	7	9	10
		Use Thickness.	1.05	1.13	1.22	1.32	1.54	1.79	1.93
	3½	Calc. Thick.	*1.01	*1.09	1.20	1.36	1.54	1.73	1.92
		Use Thickness Class.	2	3	4	5	7	9	10
		Use Thickness.	1.05	1.13	1.22	1.32	1.54	1.79	1.93
	5	Calc. Thick.	*1.08	1.16	1.28	1.43	1.60	1.78	1.98
		Use Thickness Class.	2	3	5	6	8	9	10
		Use Thickness.	1.05	1.13	1.32	1.43	1.66	1.79	1.93
	8	Calc. Thick.	1.23	1.31	1.42	1.54	1.69	1.84	2.03
		Use Thickness Class.	4	5	6	7	8	9	11
		Use Thickness.	1.22	1.32	1.43	1.54	1.66	1.79	2.08
	12	Calc. Thick.	1.37	1.45	1.56	1.66	1.78	1.93	2.09
		Use Thickness Class.	5	6	7	8	9	10	11
		Use Thickness.	1.32	1.43	1.54	1.66	1.79	1.93	2.08
	16	Calc. Thick.	1.47	1.55	1.64	1.76	1.87	2.00	2.14
		Use Thickness Class.	6	7	8	9	10	10	11
		Use Thickness.	1.43	1.54	1.66	79	1.93	1.93	2.08
42	2½	Calc. Thick.	*1.13	*1.21	*1.31	1.50	1.72	1.95	2.20
		Use Thickness Class.	2	3	4	5	7	9	10
		Use Thickness.	1.16	1.25	1.35	1.46	1.71	2.00	2.16
	3½	Calc. Thick.	*1.13	*1.21	1.34	1.53	1.74	1.97	2.22
		Use Thickness Class.	2	3	4	6	7	9	10
		Use Thickness.	1.16	1.25	1.35	1.58	1.71	2.00	2.16
	5	Calc. Thick.	*1.21	1.30	1.44	1.61	1.80	2.01	2.24
		Use Thickness Class.	3	4	5	6	8	9	10
		Use Thickness.	1.25	1.35	1.46	1.58	1.85	2.00	2.16
	8	Calc. Thick.	1.35	1.43	1.58	1.72	1.90	2.08	2.28
		Use Thickness Class.	4	5	6	7	8	10	11
		Use Thickness.	1.35	1.46	1.58	1.71	1.85	2.16	2.33
	12	Calc. Thick.	1.51	1.61	1.73	1.85	2.01	2.19	2.36
		Use Thickness Class.	5	6	7	8	9	10	11
		Use Thickness.	1.46	1.58	1.71	1.85	2.00	2.16	2.33
	16	Calc. Thick.	1.63	1.73	1.84	1.96	2.12	2.27	2.44
		Use Thickness Class.	6	7	8	9	10	11	12
		Use Thickness.	1.58	1.71	1.85	2.00	2.16	2.33	2.52
48	2½	Calc. Thick.	*1.25	*1.33	*1.45	1.68	1.94	2.21	2.48
		Use Thickness Class.	2	3	4	6	7	9	11
		Use Thickness.	1.27	1.37	1.48	1.73	1.87	2.18	2.54
	3½	Calc. Thick.	*1.24	*1.33	1.50	1.73	1.97	2.23	2.49
		Use Thickness Class.	2	3	4	6	8	9	11
		Use Thickness.	1.27	1.37	1.48	1.73	2.02	2.18	2.54
	5	Calc. Thick.	*1.33	1.44	1.60	1.80	2.03	2.27	2.53
		Use Thickness Class.	3	4	5	7	8	10	11
		Use Thickness.	1.37	1.48	1.60	1.87	2.02	2.35	2.54
	8	Calc. Thick.	1.48	1.61	1.76	1.93	2.13	2.34	2.58
		Use Thickness Class.	4	5	6	7	9	10	11
		Use Thickness.	1.48	1.60	1.73	1.87	2.18	2.35	2.54
	12	Calc. Thick.	1.68	1.80	1.92	2.08	2.26	2.45	2.67
		Use Thickness Class.	6	7	7	8	9	11	12
		Use Thickness.	1.73	1.87	1.87	2.02	2.18	2.54	2.74
	16	Calc. Thick.	1.82	1.93	2.05	2.21	2.37	2.55	2.74
		Use Thickness Class.	7	7	8	9	10	11	12
		Use Thickness.	1.87	1.87	2.02	2.18	2.35	2.54	2.74

TABLE 2A.4 (*cont'd*)

Field Condition D

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
54	2½	Calc. Thick.	*1.33	*1.44	1.60	1.88	2.18	2.47	2.77
		Use Thickness Class.	1	2	4	6	8	9	11
		Use Thickness.	1.30	1.40	1.63	1.90	2.21	2.39	2.79
	3½	Calc. Thick.	*1.38	*1.48	1.64	1.93	2.20	2.49	2.78
		Use Thickness Class.	2	3	4	6	8	10	11
		Use Thickness.	1.40	1.51	1.63	1.90	2.21	2.58	2.79
	5	Calc. Thick.	*1.43	1.57	1.77	2.00	2.28	2.65	2.81
		Use Thickness Class.	2	4	5	7	8	10	11
		Use Thickness.	1.40	1.63	1.76	2.05	2.21	2.58	2.79
	8	Calc. Thick.	1.63	1.77	1.94	2.16	2.36	2.61	2.88
		Use Thickness Class.	4	5	6	8	9	10	11
		Use Thickness.	1.63	1.76	1.90	2.21	2.39	2.58	2.79
	12	Calc. Thick.	1.85	1.98	2.12	2.31	2.50	2.72	2.98
		Use Thickness Class.	6	7	7	9	10	11	12
		Use Thickness.	1.90	2.05	2.05	2.39	2.58	2.79	3.01
	16	Calc. Thick.	2.01	2.13	2.28	2.43	2.62	2.82	3.05
		Use Thickness Class.	7	8	8	9	10	11	12
		Use Thickness.	2.05	2.21	2.21	2.39	2.58	2.79	3.01
60	2½	Calc. Thick.	*1.43	*1.55	1.75	2.06	2.40	2.73	3.07
		Use Thickness Class.	1	2	4	6	8	10	11
		Use Thickness.	1.39	1.50	1.75	2.04	2.38	2.78	3.00
	3½	Calc. Thick.	*1.48	*1.60	1.81	2.11	2.41	2.73	3.07
		Use Thickness Class.	2	3	4	6	8	10	11
		Use Thickness.	1.50	1.62	1.75	2.04	2.38	2.78	3.00
	5	Calc. Thick.	*1.55	*1.77	1.94	2.19	2.48	2.80	3.12
		Use Thickness Class.	2	4	5	7	9	10	12
		Use Thickness.	1.50	1.75	1.89	2.20	2.57	2.78	3.24
	8	Calc. Thick.	1.77	1.92	2.10	2.33	2.58	2.86	3.17
		Use Thickness Class.	4	5	6	8	9	10	12
		Use Thickness.	1.75	1.89	2.04	2.38	2.57	2.78	3.24
	12	Calc. Thick.	2.00	2.14	2.32	2.51	2.73	2.98	3.28
		Use Thickness Class.	6	7	8	9	10	11	12
		Use Thickness.	2.04	2.20	2.38	2.57	2.78	3.00	3.24
	16	Calc. Thick.	2.16	2.30	2.46	2.65	2.86	3.08	3.34
		Use Thickness Class.	7	8	8	9	10	11	12
		Use Thickness.	2.20	2.38	2.38	2.57	2.78	3.00	3.24

TABLE 2A.5 *

Schedule of Barrel Thicknesses—Field Condition E

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
3	2½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	3½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	5	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	8	Calc. Thick.	.26	.27	.28	.29	.30	.31	.32
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	12	Calc. Thick.	.27	.28	.29	.30	.31	.32	.33
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
	16	Calc. Thick.	.30	.30	.31	.32	.33	.34	.35
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.37	.37	.37	.37	.37	.37	.37
4	2½	Calc. Thick.	.27	.28	.30	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	3½	Calc. Thick.	.27	.28	.30	.31	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	5	Calc. Thick.	.27	.29	.30	.32	.33	.35	.37
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	8	Calc. Thick.	.30	.31	.32	.33	.35	.36	.38
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	40	.40	.40	.40
	12	Calc. Thick.	.31	.32	.33	.35	.36	.38	.40
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
	16	Calc. Thick.	.34	.35	.36	.37	.38	.40	.41
		Use Thickness Class.	1	1	1	1	1	1	1
		Use Thickness.	.40	.40	.40	.40	.40	.40	.40
6	2½	Calc. Thick.	.28	.33	.35	.38	.41	.45	.48
		Use Thickness Class.	1	1	1	1	1	2	3
		Use Thickness.	.43	.43	.43	.43	.43	.46	.50
	3½	Calc. Thick.	.32	.33	.35	.38	.41	.45	.48
		Use Thickness Class.	1	1	1	1	1	2	3
		Use Thickness.	.43	.43	.43	.43	.43	.46	.50
	5	Calc. Thick.	.33	.35	.37	.39	.42	.45	.48
		Use Thickness Class.	1	1	1	1	1	2	3
		Use Thickness.	.43	.43	.43	.43	.43	.46	.50
	8	Calc. Thick.	.36	.38	.40	.42	.44	.47	.49
		Use Thickness Class.	1	1	1	1	1	2	3
		Use Thickness.	.43	.43	.43	.43	.43	.46	.50
	12	Calc. Thick.	.39	.41	.42	.44	.46	.49	.51
		Use Thickness Class.	1	1	1	1	2	3	3
		Use Thickness.	.43	.43	.43	.43	.46	.50	.50
	16	Calc. Thick.	.43	.44	.46	.47	.49	.61	.63
		Use Thickness Class.	1	1	2	2	3	3	4
		Use Thickness.	.43	.43	.46	.46	.50	.50	.54

* Asterisks preceding calculated thicknesses indicate that in such cases truck load rather than water hammer was controlling.

TABLE 2A.5 (*cont'd*)

Field Condition E

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
8	2½	Calc. Thick.	*.36	*.38	.41	.45	.49	.53	.58
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	3½	Calc. Thick.	*.35	*.37	.41	.45	.49	.53	.58
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	5	Calc. Thick.	.38	.41	.44	.47	.50	.55	.59
		Use Thickness Class.	1	1	1	1	2	3	4
		Use Thickness.	.46	.46	.46	.46	.50	.54	.58
	8	Calc. Thick.	.43	.45	.48	.50	.53	.57	.61
		Use Thickness Class.	1	1	2	2	3	4	5
		Use Thickness.	.46	.46	.50	.50	.54	.58	.63
	12	Calc. Thick.	.47	.49	.51	.53	.56	.59	.62
		Use Thickness Class.	1	2	2	3	4	4	5
		Use Thickness.	.46	.50	.50	.54	.58	.58	.63
	16	Calc. Thick.	.50	.52	.54	.57	.59	.62	.65
		Use Thickness Class.	2	3	3	4	4	5	5
		Use Thickness.	.50	.54	.54	.58	.58	.63	.63
10	2½	Calc. Thick.	*.43	*.44	.48	.53	.59	.64	.69
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	3½	Calc. Thick.	.42	.45	.50	.55	.59	.64	.70
		Use Thickness Class.	1	1	1	2	3	4	5
		Use Thickness.	.50	.50	.50	.54	.58	.63	.68
	5	Calc. Thick.	.44	.47	.51	.55	.60	.66	.71
		Use Thickness Class.	1	1	1	2	3	5	6
		Use Thickness.	.50	.50	.50	.54	.58	.68	.73
	8	Calc. Thick.	.50	.52	.55	.59	.63	.68	.73
		Use Thickness Class.	1	2	2	3	4	5	6
		Use Thickness.	.50	.54	.54	.58	.63	.68	.73
	12	Calc. Thick.	.56	.58	.61	.64	.67	.71	.76
		Use Thickness Class.	3	3	4	4	5	6	7
		Use Thickness.	.58	.58	.63	.63	.68	.73	.79
	16	Calc. Thick.	.58	.60	.63	.66	.69	.73	.77
		Use Thickness Class.	3	3	4	5	5	6	7
		Use Thickness.	.58	.58	.63	.68	.68	.73	.79
12	2½	Calc. Thick.	*.47	.49	.53	.59	.66	.72	.79
		Use Thickness Class.	1	1	1	2	4	5	6
		Use Thickness.	.54	.54	.54	.58	.68	.73	.79
	3½	Calc. Thick.	*.46	.49	.55	.60	.67	.72	.80
		Use Thickness Class.	1	1	1	2	4	5	6
		Use Thickness.	.54	.54	.54	.58	.68	.73	.79
	5	Calc. Thick.	.49	.52	.57	.62	.68	.74	.80
		Use Thickness Class.	1	1	2	3	4	5	6
		Use Thickness.	.54	.54	.58	.63	.68	.73	.79
	8	Calc. Thick.	.55	.59	.63	.67	.71	.77	.82
		Use Thickness Class.	1	2	3	4	5	6	7
		Use Thickness.	.54	.58	.63	.68	.73	.79	.85
	12	Calc. Thick.	.61	.64	.67	.71	.75	.80	.85
		Use Thickness Class.	3	3	4	5	5	6	7
		Use Thickness.	.63	.63	.68	.73	.73	.79	.85
	16	Calc. Thick.	.64	.66	.70	.75	.77	.82	.87
		Use Thickness Class.	3	4	4	5	6	7	7
		Use Thickness.	.63	.68	.68	.73	.79	.85	.85

TABLE 2A.5 (*cont'd*)

Field Condition E

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
14	2½	Calc. Thick.	*.51	*.53	.59	.66	.74	.81	.89
		Use Thickness Class.	1	1	2	4	5	6	8
		Use Thickness.	.54	.54	.58	.68	.73	.79	.92
	3½	Calc. Thick.	*.50	.55	.61	.67	.75	.82	.90
		Use Thickness Class.	1	1	3	4	5	7	8
		Use Thickness.	.54	.54	.63	.68	.73	.85	.92
	5	Calc. Thick.	.54	.58	.64	.70	.76	.83	.91
		Use Thickness Class.	1	2	3	4	6	7	8
		Use Thickness.	.54	.58	.63	.68	.79	.85	.92
	8	Calc. Thick.	.62	.65	.70	.76	.81	.87	.93
		Use Thickness Class.	3	3	4	5	6	7	8
		Use Thickness.	.63	.63	.68	.73	.79	.85	.92
	12	Calc. Thick.	.67	.70	.74	.79	.84	.90	.95
		Use Thickness Class.	4	4	5	6	7	8	8
		Use Thickness.	.68	.68	.73	.79	.85	.92	.92
	16	Calc. Thick.	.70	.73	.77	.81	.86	.92	.97
		Use Thickness Class.	4	5	6	6	7	8	9
		Use Thickness.	.68	.73	.79	.79	.85	.92	.99
16	2½	Calc. Thick.	*.55	*.57	.64	.72	.80	.89	.98
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.58	.58	.63	.73	.79	.92	.99
	3½	Calc. Thick.	*.54	.58	.66	.73	.81	.90	.98
		Use Thickness Class.	1	1	3	4	5	7	8
		Use Thickness.	.58	.58	.68	.73	.79	.92	.99
	5	Calc. Thick.	.58	.63	.69	.76	.83	.91	.99
		Use Thickness Class.	1	2	3	5	6	7	8
		Use Thickness.	.58	.63	.68	.79	.85	.92	.99
	8	Calc. Thick.	.66	.70	.76	.81	.87	.94	1.01
		Use Thickness Class.	3	3	5	5	6	7	8
		Use Thickness.	.68	.68	.79	.79	.85	.92	.99
	12	Calc. Thick.	.73	.76	.80	.85	.91	.98	1.05
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.73	.79	.79	.85	.92	.99	1.07
	16	Calc. Thick.	.76	.79	.83	.88	.94	1.00	1.07
		Use Thickness Class.	5	5	6	6	7	8	9
		Use Thickness.	.79	.79	.85	.85	.92	.99	1.07
18	2½	Calc. Thick.	*.59	*.62	.69	.78	.88	.98	1.09
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.63	.63	.68	.79	.85	.99	1.07
	3½	Calc. Thick.	*.59	.63	.71	.80	.89	.99	1.10
		Use Thickness Class.	1	1	3	4	6	7	8
		Use Thickness.	.63	.63	.73	.79	.92	.99	1.07
	5	Calc. Thick.	.62	.68	.75	.83	.91	1.00	1.11
		Use Thickness Class.	1	2	3	5	6	7	8
		Use Thickness.	.63	.68	.73	.85	.92	.99	1.07
	8	Calc. Thick.	.71	.76	.81	.88	.96	1.03	1.13
		Use Thickness Class.	3	4	4	5	6	7	9
		Use Thickness.	.73	.79	.79	.85	.92	.99	1.16
	12	Calc. Thick.	.77	.82	.87	.93	1.00	1.07	1.15
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.79	.85	.85	.92	.99	1.07	1.16
	16	Calc. Thick.	.81	.86	.91	.96	1.02	1.10	1.18
		Use Thickness Class.	4	5	6	7	7	8	9
		Use Thickness.	.79	.85	.92	.99	.99	1.07	1.16

TABLE 2A.5 (*cont'd*)

Field Condition E

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
20	2½	Calc. Thick.	*.62	*.66	.73	.83	.93	1.05	1.17
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.66	.66	.71	.83	.90	1.05	1.13
	3½	Calc. Thick.	*.62	.67	.76	.85	.95	1.06	1.18
		Use Thickness Class.	1	1	3	4	6	7	9
		Use Thickness.	.66	.66	.77	.83	.97	1.05	1.22
	5	Calc. Thick.	.67	.73	.80	.88	.97	1.08	.19
		Use Thickness Class.	1	2	4	5	6	7	9
		Use Thickness.	.66	.71	.83	.90	.97	1.05	1.22
	8	Calc. Thick.	.75	.80	.86	.92	1.02	1.10	1.21
		Use Thickness Class.	3	4	4	5	7	8	9
		Use Thickness.	.77	.83	.83	.90	1.05	1.13	1.22
	12	Calc. Thick.	.82	.87	.92	.99	1.06	1.15	1.24
		Use Thickness Class.	4	5	5	6	7	8	9
		Use Thickness.	.83	.90	.90	.97	1.05	1.13	1.22
	16	Calc. Thick.	.87	.91	.97	1.03	1.09	1.18	1.27
		Use Thickness Class.	5	5	6	7	8	9	10
		Use Thickness.	.90	.90	.97	1.05	1.13	1.22	1.32
24	2½	Calc. Thick.	*.70	*.74	.82	.95	1.08	1.22	1.36
		Use Thickness Class.	1	1	2	4	6	8	9
		Use Thickness.	.74	.74	.80	.93	1.08	1.26	1.36
	3½	Calc. Thick.	*.70	.76	.86	.97	1.09	1.23	1.36
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.74	.74	.86	1.00	1.08	1.26	1.36
	5	Calc. Thick.	.75	.82	.91	1.01	1.12	1.24	1.37
		Use Thickness Class.	1	2	4	5	6	8	9
		Use Thickness.	.74	.80	.93	1.00	1.08	1.26	1.36
	8	Calc. Thick.	.84	.90	.98	1.07	1.17	1.27	1.40
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.86	.93	1.00	1.08	1.17	1.26	1.36
	12	Calc. Thick.	.92	.98	1.05	1.15	1.21	1.32	1.43
		Use Thickness Class.	4	5	6	7	7	9	10
		Use Thickness.	.93	1.00	1.08	1.17	1.17	1.36	1.47
	16	Calc. Thick.	.98	1.04	1.10	1.18	1.27	1.36	1.47
		Use Thickness Class.	5	6	6	7	8	9	10
		Use Thickness.	1.00	1.08	1.08	1.17	1.26	1.36	1.47
30	2½	Calc. Thick.	*.85	*.89	.99	1.15	1.30	1.48	1.66
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.87	.87	1.02	1.19	1.29	1.50	1.62
	3½	Calc. Thick.	*.85	*.89	1.03	1.17	1.32	1.49	1.66
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.87	.87	1.02	1.19	1.29	1.50	1.62
	5	Calc. Thick.	.89	.98	1.09	1.22	1.36	1.50	1.67
		Use Thickness Class.	1	3	4	5	7	8	9
		Use Thickness.	.87	1.02	1.10	1.19	1.39	1.50	1.62
	8	Calc. Thick.	1.01	1.08	1.18	1.29	1.42	1.56	1.70
		Use Thickness Class.	3	4	5	6	7	9	10
		Use Thickness.	1.02	1.10	1.19	1.29	1.39	1.62	1.75
	12	Calc. Thick.	1.11	1.18	1.25	1.36	1.48	1.61	1.74
		Use Thickness Class.	4	5	6	7	8	9	10
		Use Thickness.	1.10	1.19	1.29	1.39	1.50	1.62	1.75
	16	Calc. Thick.	1.18	1.24	1.32	1.42	1.53	1.64	1.78
		Use Thickness Class.	5	6	6	7	8	9	10
		Use Thickness.	1.19	1.29	1.29	1.39	1.50	1.62	1.75

TABLE 2A.5 (*cont'd*)

Field Condition E.

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
36	2½	Calc. Thick.	*.94	*1.01	1.13	1.32	1.53	1.75	1.98
		Use Thickness Class.	1	2	3	5	7	9	10
		Use Thickness.	.97	1.05	1.13	1.32	1.54	1.79	1.93
	3½	Calc. Thick.	*.94	*1.01	1.18	1.36	1.53	1.75	1.95
		Use Thickness Class.	1	2	4	5	7	9	10
		Use Thickness.	.97	1.05	1.22	1.32	1.54	1.79	1.93
	5	Calc. Thick.	1.03	1.18	1.24	1.40	1.58	1.76	1.93
		Use Thickness Class.	2	3	4	6	7	9	10
		Use Thickness.	1.05	1.13	1.22	1.43	1.54	1.79	1.93
	8	Calc. Thick.	1.13	1.23	1.36	1.47	1.64	1.80	1.96
		Use Thickness Class.	3	4	5	6	8	9	10
		Use Thickness.	1.13	1.22	1.32	1.43	1.66	1.79	1.93
	12	Calc. Thick.	1.27	1.36	1.44	1.57	1.71	1.86	2.05
		Use Thickness Class.	5	5	6	7	8	9	11
		Use Thickness.	1.32	1.32	1.43	1.54	1.66	1.79	2.08
	16	Calc. Thick.	1.34	1.43	1.53	1.64	1.78	1.93	2.10
		Use Thickness Class.	5	6	7	8	9	10	11
		Use Thickness.	1.32	1.43	1.54	1.66	1.79	1.93	2.08
42	2½	Calc. Thick.	*1.05	*1.13	1.27	1.48	1.71	1.93	2.23
		Use Thickness Class.	1	2	3	5	7	9	10
		Use Thickness.	1.07	1.16	1.25	1.46	1.71	2.00	2.16
	3½	Calc. Thick.	*1.06	*1.13	1.31	1.50	1.74	1.95	2.24
		Use Thickness Class.	1	2	4	5	7	9	10
		Use Thickness.	1.07	1.16	1.35	1.46	1.71	2.00	2.16
	5	Calc. Thick.	*1.12	1.23	1.38	1.57	1.78	1.98	2.25
		Use Thickness Class.	2	3	4	6	7	9	11
		Use Thickness.	1.16	1.25	1.35	1.58	1.71	2.00	2.33
	8	Calc. Thick.	1.26	1.37	1.50	1.65	1.85	2.05	2.28
		Use Thickness Class.	3	4	5	7	8	9	11
		Use Thickness.	1.25	1.35	1.46	1.71	1.85	2.00	2.33
	12	Calc. Thick.	1.41	1.51	1.63	1.76	1.95	2.10	2.33
		Use Thickness Class.	5	5	6	7	9	10	11
		Use Thickness.	1.46	1.46	1.58	1.71	2.00	2.16	2.33
	16	Calc. Thick.	1.53	61	1.73	1.86	2.02	2.18	2.38
		Use Thickness Class.	6	* 6	7	8	9	10	11
		Use Thickness.	1.58	1.58	1.71	1.85	2.00	2.16	2.33
48	2½	Calc. Thick.	*1.15	*1.25	1.43	1.68	1.94	2.19	2.50
		Use Thickness Class.	1	2	4	6	7	9	11
		Use Thickness.	1.18	1.27	1.48	1.73	1.87	2.18	2.54
	3½	Calc. Thick.	*1.16	1.27	1.47	1.70	1.95	2.20	2.51
		Use Thickness Class.	1	2	4	6	8	9	11
		Use Thickness.	1.18	1.27	1.48	1.73	2.02	2.18	2.54
	5	Calc. Thick.	*1.23	1.38	1.56	1.76	2.00	2.28	2.58
		Use Thickness Class.	2	3	5	6	8	10	11
		Use Thickness.	1.27	1.37	1.60	1.73	2.02	2.35	2.54
	8	Calc. Thick.	1.40	1.53	1.69	1.88	2.08	2.33	2.56
		Use Thickness Class.	3	4	6	7	8	10	11
		Use Thickness.	1.37	1.48	1.73	1.87	2.02	2.35	2.54
	12	Calc. Thick.	1.57	1.68	1.82	1.98	2.18	2.41	2.68
		Use Thickness Class.	5	6	7	8	9	10	11
		Use Thickness.	1.60	1.73	1.87	2.02	2.18	2.35	2.54
	16	Calc. Thick.	1.70	1.80	1.94	2.09	2.28	2.47	2.68
		Use Thickness Class.	6	7	7	8	10	11	12
		Use Thickness.	1.73	1.87	1.87	2.02	2.35	2.54	2.74

TABLE 2A.5 (*cont'd*)

Field Condition E

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
54	2½	Calc. Thick.	*1.26	*1.38	1.58	1.87	2.16	2.47	2.78
		Use Thickness Class.	1	2	4	6	8	9	11
		Use Thickness.	1.30	1.40	1.63	1.90	2.21	2.39	2.79
	3½	Calc. Thick.	*1.29	*1.40	1.58	1.90	2.18	2.48	2.79
		Use Thickness Class.	1	2	4	6	8	9	11
		Use Thickness.	1.30	1.40	1.63	1.90	2.21	2.39	2.79
	5	Calc. Thick.	*1.36	1.51	1.78	1.98	2.20	2.55	2.80
		Use Thickness Class.	2	3	5	7	8	10	11
		Use Thickness.	1.40	1.51	1.76	2.05	2.21	2.58	2.79
	8	Calc. Thick.	1.51	1.68	1.87	2.08	2.35	2.58	2.85
		Use Thickness Class.	3	4	6	7	9	10	11
		Use Thickness.	1.51	1.63	1.90	2.05	2.39	2.58	2.79
	12	Calc. Thick.	1.74	1.87	2.04	2.21	2.43	2.67	2.98
		Use Thickness Class.	5	6	7	8	9	10	12
		Use Thickness.	1.76	1.90	2.05	2.21	2.39	2.58	3.01
	16	Calc. Thick.	1.88	2.01	2.16	2.34	2.53	2.73	2.98
		Use Thickness Class.	6	7	8	9	10	11	12
		Use Thickness.	1.90	2.05	2.21	2.39	2.58	2.79	3.01
60	2½	Calc. Thick.	*1.36	*1.48	1.73	2.04	2.38	2.73	3.08
		Use Thickness Class.	1	2	4	6	8	10	11
		Use Thickness.	1.39	1.50	1.75	2.04	2.38	2.78	3.00
	3½	Calc. Thick.	*1.40	1.53	1.78	2.08	2.39	2.74	3.09
		Use Thickness Class.	1	2	4	6	8	10	11
		Use Thickness.	1.39	1.50	1.75	2.04	2.38	2.78	3.00
	5	Calc. Thick.	*1.47	1.65	1.88	2.15	2.45	2.78	3.10
		Use Thickness Class.	2	3	5	7	8	10	11
		Use Thickness.	1.50	1.62	1.89	2.20	2.38	2.78	3.00
	8	Calc. Thick.	1.68	1.84	2.03	2.28	2.55	2.83	3.13
		Use Thickness Class.	3	5	6	7	9	10	12
		Use Thickness.	1.62	1.89	2.04	2.20	2.57	2.78	3.24
	12	Calc. Thick.	1.90	2.04	2.23	2.43	2.68	2.93	3.23
		Use Thickness Class.	5	6	7	8	10	11	12
		Use Thickness.	1.89	2.04	2.20	2.38	2.78	3.00	3.24
	16	Calc. Thick.	2.07	2.20	2.38	2.56	2.78	3.03	3.30
		Use Thickness Class.	6	7	8	9	10	11	12
		Use Thickness.	2.04	2.20	2.38	2.57	2.78	3.00	3.24

TABLE 2A.6*

Schedule of Barrel Thicknesses—Field Condition F

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
3	2½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.37	.37	.37	.37	.37	.37	.37
	3½	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.37	.37	.37	.37	.37	.37	.37
	5	Calc. Thick.	*.24	*.25	*.25	*.26	.28	.30	.31
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.37	.37	.37	.37	.37	.37	.37
	8	Calc. Thick.	.25	.26	.26	.27	.29	.31	.32
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.37	.37	.37	.37	.37	.37	.37
	12	Calc. Thick.	.27	.27	.29	.30	.31	.32	.33
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.37	.37	.37	.37	.37	.37	.37
	16	Calc. Thick.	.29	.30	.30	.31	.32	.33	.34
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.37	.37	.37	.37	.37	.37	.37
4	2½	Calc. Thick.	.27	.28	.30	.31	.33	.36	.37
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.40	.40	.40	.40	.40	.40	.40
	3½	Calc. Thick.	.27	.28	.30	.31	.33	.36	.37
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.40	.40	.40	.40	.40	.40	.40
	5	Calc. Thick.	.27	.29	.30	.32	.33	.36	.37
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.40	.40	.40	.40	.40	.40	.40
	8	Calc. Thick.	.30	.31	.32	.33	.35	.36	.38
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.40	.40	.40	.40	.40	.40	.40
	12	Calc. Thick.	.31	.32	.33	.35	.36	.38	.39
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.40	.40	.40	.40	.40	.40	.40
	16	Calc. Thick.	.32	.33	.35	.36	.37	.39	.40
		Use {Thickness Class.	1	1	1	1	1	1	1
		{Thickness.	.40	.40	.40	.40	.40	.40	.40
6	2½	Calc. Thick.	.32	.33	.35	.38	.41	.45	.48
		Use {Thickness Class.	1	1	1	1	1	2	3
		{Thickness.	.43	.43	.43	.43	.43	.46	.50
	3½	Calc. Thick.	.32	.33	.35	.38	.41	.45	.48
		Use {Thickness Class.	1	1	1	1	1	2	3
		{Thickness.	.43	.43	.43	.43	.43	.46	.50
	5	Calc. Thick.	.32	.33	.35	.38	.41	.45	.48
		Use {Thickness Class.	1	1	1	1	1	2	3
		{Thickness.	.43	.43	.43	.43	.43	.46	.50
	8	Calc. Thick.	.35	.36	.38	.40	.43	.46	.49
		Use {Thickness Class.	1	1	1	1	1	2	3
		{Thickness.	.43	.43	.43	.43	.43	.46	.50
	12	Calc. Thick.	.38	.40	.41	.43	.46	.48	.51
		Use {Thickness Class.	1	1	1	1	2	3	3
		{Thickness.	.43	.43	.43	.43	.46	.50	.50
	16	Calc. Thick.	.41	.42	.44	.46	.48	.50	.52
		Use {Thickness Class.	1	1	1	2	3	3	4
		{Thickness.	.43	.43	.43	.46	.50	.50	.54

* Asterisks preceding calculated thicknesses indicate that in such cases truck load rather than water hammer was controlling.

TABLE 2A.6 (*cont'd*)

Field Condition F

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
8	2½	Calc. Thick.	.35	.37	.41	.45	.49	.53	.58
		Use {Thickness Class.	1	1	1	1	2	3	4
		{Thickness.	.46	.46	.46	.46	.50	.54	.58
	3½	Calc. Thick.	.35	.37	.41	.45	.49	.53	.58
		Use {Thickness Class.	1	1	1	1	2	3	4
		{Thickness.	.46	.46	.46	.46	.50	.54	.58
	5	Calc. Thick.	.37	.40	.43	.46	.50	.55	.59
		Use {Thickness Class.	1	1	1	1	2	3	4
		{Thickness.	.46	.46	.46	.46	.50	.54	.58
	8	Calc. Thick.	.41	.43	.46	.49	.52	.56	.60
		Use {Thickness Class.	1	1	1	2	3	4	4
		{Thickness.	.46	.46	.46	.50	.54	.58	.58
	12	Calc. Thick.	.45	.47	.50	.52	.55	.58	.62
		Use {Thickness Class.	1	1	2	3	3	4	5
		{Thickness.	.46	.46	.50	.54	.54	.58	.63
	16	Calc. Thick.	.48	.50	.52	.54	.57	.60	.63
		Use {Thickness Class.	2	2	3	3	4	4	5
		{Thickness.	.50	.50	.54	.54	.58	.58	.63
10	2½	Calc. Thick.	.41	.44	.48	.53	.59	.64	.69
		Use {Thickness Class.	1	1	1	2	3	4	5
		{Thickness.	.50	.50	.50	.54	.58	.63	.68
	3½	Calc. Thick.	.41	.44	.49	.53	.58	.64	.70
		Use {Thickness Class.	1	1	1	2	3	4	5
		{Thickness.	.50	.50	.50	.54	.58	.63	.68
	5	Calc. Thick.	.43	.46	.50	.55	.60	.65	.70
		Use {Thickness Class.	1	1	1	2	3	4	5
		{Thickness.	.50	.50	.50	.54	.58	.63	.68
	8	Calc. Thick.	.48	.51	.54	.57	.62	.67	.71
		Use {Thickness Class.	1	1	2	3	4	5	6
		{Thickness.	.50	.50	.54	.58	.63	.68	.73
	12	Calc. Thick.	.52	.55	.58	.61	.65	.69	.73
		Use {Thickness Class.	1	2	3	4	4	5	6
		{Thickness.	.50	.54	.58	.63	.63	.68	.73
	16	Calc. Thick.	.55	.57	.60	.63	.67	.71	.76
		Use {Thickness Class.	2	3	3	4	5	6	6
		{Thickness.	.54	.58	.58	.63	.68	.73	.73
12	2½	Calc. Thick.	*.44	.48	.53	.59	.66	.72	.79
		Use {Thickness Class.	1	1	1	2	4	5	6
		{Thickness.	.54	.54	.54	.58	.68	.73	.79
	3½	Calc. Thick.	.44	.48	.54	.60	.66	.72	.79
		Use {Thickness Class.	1	1	1	2	4	5	6
		{Thickness.	.54	.54	.54	.58	.68	.73	.79
	5	Calc. Thick.	.47	.51	.56	.61	.67	.73	.80
		Use {Thickness Class.	1	1	2	3	4	5	6
		{Thickness.	.54	.54	.58	.63	.68	.73	.79
	8	Calc. Thick.	.53	.58	.60	.65	.70	.76	.81
		Use {Thickness Class.	1	2	2	3	4	5	6
		{Thickness.	.54	.58	.58	.63	.68	.73	.79
	12	Calc. Thick.	.57	.60	.64	.68	.73	.78	.83
		Use {Thickness Class.	2	2	3	4	5	6	7
		{Thickness.	.58	.58	.63	.68	.73	.79	.85
	16	Calc. Thick.	.60	.63	.66	.70	.74	.79	.84
		Use {Thickness Class.	2	3	4	4	5	6	7
		{Thickness.	.58	.63	.68	.68	.73	.79	.85

TABLE 2A.6 (*cont'd*)

Field Condition F

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
14	2½	Calc. Thick.	*.48	.58	.59	.66	.74	.81	.89
		Use Thickness Class.	1	1	2	4	5	6	8
		Use Thickness.	.54	.54	.58	.68	.73	.79	.92
	3½	Calc. Thick.	.48	.54	.60	.66	.74	.82	.90
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.54	.54	.58	.68	.73	.85	.92
	5	Calc. Thick.	.51	.56	.62	.68	.76	.82	.90
		Use Thickness Class.	1	2	3	4	5	7	8
		Use Thickness.	.54	.58	.63	.68	.73	.85	.92
	8	Calc. Thick.	.58	.62	.66	.72	.78	.85	.92
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.58	.63	.68	.73	.79	.85	.92
	12	Calc. Thick.	.63	.66	.71	.76	.81	.87	.93
		Use Thickness Class.	3	4	5	6	6	7	8
		Use Thickness.	.63	.68	.73	.79	.79	.85	.92
	16	Calc. Thick.	.65	.69	.73	.77	.83	.88	.94
		Use Thickness Class.	3	4	5	6	7	7	8
		Use Thickness.	.63	.68	.73	.79	.85	.85	.92
16	2½	Calc. Thick.	*.51	.56	.63	.72	.80	.89	.98
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.58	.58	.63	.73	.79	.92	.99
	3½	Calc. Thick.	.51	.57	.64	.72	.81	.89	.98
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.58	.58	.63	.73	.79	.92	.99
	5	Calc. Thick.	.55	.60	.67	.74	.81	.90	.99
		Use Thickness Class.	1	1	3	4	5	7	8
		Use Thickness.	.58	.58	.68	.73	.79	.92	.99
	8	Calc. Thick.	.61	.66	.72	.78	.85	.92	1.00
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.63	.68	.73	.79	.85	.92	.99
	12	Calc. Thick.	.66	.71	.76	.81	.88	.95	1.01
		Use Thickness Class.	3	4	5	5	6	7	8
		Use Thickness.	.68	.73	.79	.79	.85	.92	.99
	16	Calc. Thick.	.70	.74	.79	.84	.90	.97	1.03
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.68	.73	.79	.85	.92	.99	1.07
18	2½	Calc. Thick.	*.54	.61	.68	.78	.88	.98	1.09
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.63	.63	.68	.79	.85	.99	1.07
	3½	Calc. Thick.	*.54	.61	.70	.78	.88	.98	1.10
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.63	.63	.68	.79	.85	.99	1.07
	5	Calc. Thick.	.60	.66	.72	.81	.90	.99	1.10
		Use Thickness Class.	1	2	3	4	6	7	8
		Use Thickness.	.63	.68	.73	.79	.92	.99	1.07
	8	Calc. Thick.	.66	.71	.77	.85	.92	1.01	1.11
		Use Thickness Class.	2	3	4	5	6	7	8
		Use Thickness.	.68	.73	.79	.85	.92	.99	1.07
	12	Calc. Thick.	.71	.76	.82	.89	.96	1.04	1.13
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.73	.79	.85	.92	.99	1.07	1.16
	16	Calc. Thick.	.75	.80	.86	.91	.98	1.06	1.15
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.73	.79	.85	.92	.99	1.07	1.16

TABLE 2A.6 (*cont'd*)

Field Condition F

S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN. 50	100	150	200	250	300	350
			Barrel thicknesses in inches						
20	2½	Calc. Thick.	*.57	.62	.72	.82	.93	1.05	1.16
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.66	.66	.71	.83	.90	1.05	1.13
	3½	Calc. Thick.	*.57	.64	.73	.83	.93	1.05	1.17
		Use Thickness Class.	1	1	2	4	5	7	8
		Use Thickness.	.66	.66	.71	.83	.90	1.05	1.13
	5	Calc. Thick.	.62	.69	.77	.86	.96	1.06	1.18
		Use Thickness Class.	1	2	3	4	6	7	9
		Use Thickness.	.66	.71	.77	.83	.97	1.05	1.22
	8	Calc. Thick.	.69	.76	.82	.90	.98	1.08	1.19
		Use Thickness Class.	2	3	4	5	6	7	9
		Use Thickness.	.71	.77	.83	.90	.97	1.05	1.22
	12	Calc. Thick.	.76	.81	.87	.94	1.02	1.10	1.21
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.77	.83	.90	.97	1.05	1.13	1.22
	16	Calc. Thick.	.80	.85	.91	.97	1.05	1.13	1.23
		Use Thickness Class.	4	4	5	6	7	8	9
		Use Thickness.	.83	.83	.90	.97	1.05	1.13	1.22
24	2½	Calc. Thick.	*.64	.71	.82	.95	1.08	1.22	1.35
		Use Thickness Class.	1	1	2	4	6	8	9
		Use Thickness.	.74	.74	.80	.93	1.08	1.26	1.36
	3½	Calc. Thick.	*.64	.71	.83	.96	1.08	1.23	1.36
		Use Thickness Class.	1	1	3	4	6	8	9
		Use Thickness.	.74	.74	.86	.93	1.08	1.26	1.36
	5	Calc. Thick.	.69	.78	.88	.98	1.10	1.24	1.37
		Use Thickness Class.	1	2	3	5	6	8	9
		Use Thickness.	.74	.80	.86	1.00	1.08	1.26	1.36
	8	Calc. Thick.	.76	.84	.92	1.02	1.13	1.26	1.39
		Use Thickness Class.	1	3	4	5	7	8	9
		Use Thickness.	.74	.86	.93	1.00	1.17	1.26	1.36
	12	Calc. Thick.	.84	.91	.98	1.07	1.17	1.28	1.40
		Use Thickness Class.	3	4	5	6	7	8	9
		Use Thickness.	.86	.93	1.00	1.08	1.17	1.26	1.36
	16	Calc. Thick.	.89	.95	1.02	1.11	1.20	1.31	1.42
		Use Thickness Class.	3	4	5	6	7	9	10
		Use Thickness.	.86	.93	1.00	1.08	1.17	1.36	1.47
30	2½	Calc. Thick.	*.74	.83	.98	1.14	1.30	1.48	1.64
		Use Thickness Class.	1	1	3	4	6	8	9
		Use Thickness.	.87	.87	1.02	1.10	1.29	1.50	1.62
	3½	Calc. Thick.	*.74	.87	1.00	1.16	1.31	1.49	1.64
		Use Thickness Class.	1	1	3	5	6	8	9
		Use Thickness.	.87	.87	1.02	1.19	1.29	1.50	1.62
	5	Calc. Thick.	.83	.93	1.05	1.18	1.33	1.50	1.65
		Use Thickness Class.	1	2	3	5	6	8	9
		Use Thickness.	.87	.94	1.02	1.19	1.29	1.50	1.62
	8	Calc. Thick.	.91	1.00	1.10	1.25	1.37	1.52	1.67
		Use Thickness Class.	2	3	4	5	7	8	9
		Use Thickness.	.94	1.02	1.10	1.19	1.39	1.50	1.62
	12	Calc. Thick.	1.00	1.08	1.17	1.28	1.42	1.55	1.70
		Use Thickness Class.	3	4	5	6	7	8	10
		Use Thickness.	1.02	1.10	1.19	1.29	1.39	1.50	1.75
	16	Calc. Thick.	1.04	1.13	1.23	1.33	1.44	1.58	1.75
		Use Thickness Class.	3	4	5	6	7	9	10
		Use Thickness.	1.02	1.10	1.19	1.29	1.39	1.62	1.75

TABLE 2A.6 (*cont'd*)
Field Condition F
S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
36	2½	Calc. Thick.	*.83	.93	1.12	1.33	1.58	1.73	1.93
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	.97	.97	1.13	1.32	1.54	1.79	1.93
	3½	Calc. Thick.	.86	.98	1.13	1.33	1.58	1.73	1.93
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	.97	.97	1.13	1.32	1.54	1.79	1.93
	5	Calc. Thick.	.93	1.03	1.18	1.36	1.58	1.74	1.93
		Use Thickness Class.	1	2	4	5	7	9	10
		Use Thickness.	.97	1.05	1.22	1.32	1.54	1.79	1.93
	8	Calc. Thick.	1.02	1.13	1.26	1.40	1.58	1.76	1.95
		Use Thickness Class.	2	3	4	6	7	9	10
		Use Thickness.	1.05	1.13	1.22	1.43	1.54	1.79	1.93
	12	Calc. Thick.	1.12	1.22	1.33	1.47	1.62	1.80	1.98
		Use Thickness Class.	3	4	5	6	8	9	10
		Use Thickness.	1.13	1.22	1.32	1.43	1.66	1.79	1.93
	16	Calc. Thick.	1.19	1.29	1.40	1.52	1.66	1.83	2.03
		Use Thickness Class.	4	5	6	7	8	9	11
		Use Thickness.	1.22	1.32	1.43	1.54	1.66	1.79	2.08
42	2½	Calc. Thick.	*.89	*1.03	1.24	*1.48	1.70	1.94	2.23
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	1.07	1.07	1.25	1.46	1.71	2.00	2.16
	3½	Calc. Thick.	*.92	1.06	1.27	1.48	1.73	1.95	2.23
		Use Thickness Class.	1	1	3	5	7	9	10
		Use Thickness.	1.07	1.07	1.25	1.46	1.71	2.00	2.16
	5	Calc. Thick.	1.01	1.16	1.31	1.51	1.74	1.96	2.24
		Use Thickness Class.	1	2	4	5	7	9	10
		Use Thickness.	1.07	1.16	1.35	1.46	1.71	2.00	2.16
	8	Calc. Thick.	1.12	1.24	1.38	1.57	1.78	1.98	2.25
		Use Thickness Class.	2	3	4	6	8	9	11
		Use Thickness.	1.16	1.25	1.35	1.58	1.85	2.00	2.33
	12	Calc. Thick.	1.23	1.35	1.48	1.66	1.84	2.03	2.27
		Use Thickness Class.	3	4	5	7	8	9	11
		Use Thickness.	1.25	1.35	1.46	1.71	1.85	2.00	2.33
	16	Calc. Thick.	1.32	1.43	1.55	1.70	1.88	2.06	2.30
		Use Thickness Class.	4	5	6	7	8	9	11
		Use Thickness.	1.35	1.46	1.58	1.71	1.85	2.00	2.33
48	2½	Calc. Thick.	*.98	1.18	1.43	1.68	1.93	2.19	2.60
		Use Thickness Class.	1	1	4	6	7	9	11
		Use Thickness.	1.18	1.18	1.48	1.73	1.87	2.18	2.54
	3½	Calc. Thick.	*.98	1.18	1.43	1.68	1.93	2.20	2.60
		Use Thickness Class.	1	1	4	6	7	9	11
		Use Thickness.	1.18	1.18	1.48	1.73	1.87	2.18	2.54
	5	Calc. Thick.	1.12	1.27	1.48	1.71	1.95	2.21	2.61
		Use Thickness Class.	1	2	4	6	8	9	11
		Use Thickness.	1.18	1.27	1.48	1.73	2.02	2.18	2.54
	8	Calc. Thick.	1.25	1.38	1.56	1.76	2.00	2.28	2.63
		Use Thickness Class.	2	3	5	6	8	10	11
		Use Thickness.	1.27	1.37	1.60	1.73	2.02	2.35	2.54
	12	Calc. Thick.	1.36	1.50	1.66	1.85	2.05	2.32	2.66
		Use Thickness Class.	3	4	5	7	8	10	11
		Use Thickness.	1.37	1.48	1.60	1.87	2.02	2.35	2.54
	16	Calc. Thick.	1.46	1.59	1.74	1.91	2.12	2.34	2.68
		Use Thickness Class.	4	5	6	7	9	10	11
		Use Thickness.	1.48	1.60	1.73	1.87	2.18	2.35	2.54

TABLE 2A.6 (*cont'd*)
Field Condition F
S = 11,000 lb. per sq.in. R = 31,000 lb. per sq.in.

NOMINAL DIAM., INCH	DEPTH OF COVER, FEET		INTERNAL PRESSURE—LB. PER SQ.IN.						
			50	100	150	200	250	300	350
			Barrel thicknesses in inches						
54	2½	Calc. Thick.	*1.05	1.23	1.58	1.87	2.16	2.48	2.78
		Use Thickness Class.	1	1	4	6	8	9	11
		Use Thickness.	1.30	1.30	1.63	1.90	2.21	2.39	2.79
	3½	Calc. Thick.	1.10	1.33	1.58	1.87	2.17	2.48	2.78
		Use Thickness Class.	1	1	4	6	8	9	11
		Use Thickness.	1.30	1.30	1.63	1.90	2.21	2.39	2.79
	5	Calc. Thick.	1.20	1.40	1.61	1.90	2.18	2.49	2.79
		Use Thickness Class.	1	2	4	6	8	10	11
		Use Thickness.	1.30	1.40	1.63	1.90	2.21	2.58	2.79
	8	Calc. Thick.	1.36	1.58	1.72	1.97	2.25	2.55	2.82
		Use Thickness Class.	2	3	5	6	8	10	11
		Use Thickness.	1.40	1.51	1.76	1.90	2.21	2.58	2.79
	12	Calc. Thick.	1.49	1.64	1.86	2.05	2.31	2.58	2.84
		Use Thickness Class.	3	4	6	7	9	10	11
		Use Thickness.	1.51	1.63	1.90	2.05	2.39	2.58	2.79
	16	Calc. Thick.	1.61	1.75	1.93	2.13	2.37	2.62	2.88
		Use Thickness Class.	4	5	6	8	9	10	11
		Use Thickness.	1.63	1.76	1.90	2.21	2.39	2.58	2.79
60	2½	Calc. Thick.	*1.13	1.40	1.70	2.03	2.38	2.78	3.08
		Use Thickness Class.	1	1	4	6	8	10	11
		Use Thickness.	1.39	1.39	1.75	2.04	2.38	2.78	3.00
	3½	Calc. Thick.	*1.18	1.43	1.72	2.05	2.39	2.73	3.09
		Use Thickness Class.	1	1	4	6	8	10	11
		Use Thickness.	1.39	1.39	1.75	2.04	2.38	2.78	3.00
	5	Calc. Thick.	1.30	1.53	1.78	2.08	2.43	2.74	3.09
		Use Thickness Class.	1	2	4	6	8	10	11
		Use Thickness.	1.39	1.50	1.75	2.04	2.38	2.78	3.00
	8	Calc. Thick.	1.46	1.66	1.88	2.16	2.47	2.76	3.10
		Use Thickness Class.	2	3	5	7	8	10	11
		Use Thickness.	1.50	1.62	1.89	2.20	2.38	2.78	3.00
	12	Calc. Thick.	1.63	1.80	2.00	2.24	2.53	2.83	3.14
		Use Thickness Class.	3	4	6	7	9	10	12
		Use Thickness.	1.62	1.75	2.04	2.20	2.57	2.78	3.24
	16	Calc. Thick.	1.76	1.92	2.10	2.33	2.58	2.86	3.17
		Use Thickness Class.	4	5	6	8	9	10	12
		Use Thickness.	1.75	1.89	2.04	2.38	2.57	2.78	3.24

COPY FORM	INITIALS	DATE
	CSP	10-19-99

BOX NUMBER	SEGMENT NO.	REQUESTING PARTY
04-1913		BWB

NOTES