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Pipe Hanger Design & Engineering

January 2024

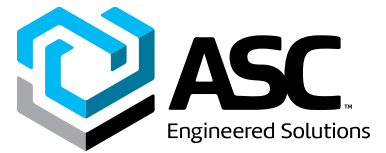
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We're in the solutions business. That means we go beyond a product portfolio of unmatched quality and breadth. A solution involved much more than products: it takes expertise, reliable availability and dependable partnership. Providing engineered solutions means solving customer challenges – and that's why we exist.

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One focus.

Your success.



Piping and Pipe Hanger Design and Engineering

Weights of Piping Materials

The material in this booklet has been compiled to furnish pipe hanger engineers with the necessary data and procedures to determine pipe hanger loads and thermal movements of the pipe at each hanger location.

The tabulation of weights has been arranged for convenient selection of data that formerly consumed considerable time to develop. In many instances this information was not available for general distribution. This made it necessary to develop average or approximate weights that may be substituted with actual weights whenever practical.

Load Calculation Problem

The "Hanger Load Calculation Problem" is typical of the actual steps required in the solution of any pipe hanger installation.

Great care was taken in collecting and printing data in this booklet to assure accuracy throughout. However, no representation or warranty of accuracy of the contents of this booklet is made by Anvil. The only warranties made by Anvil are those contained in sales contracts for design services or products.

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Introduction

To avoid confusion, it is necessary to define the terms pipe hanger and pipe support and clarify the difference between the two.

Pipe hangers are generally considered to be those metal elements which carry the weight from above with the supporting members being mainly in tension. Pipe supports are considered to be those elements which carry the weight from below with the supporting members being mainly in compression.

It has become widely recognized that the selection and design of pipe hangers is an important part of the engineering study of any modern steam generating or process installation. Problems of pipe design for high temperature, high pressure installations have become critical to a point where it is imperative that such aspects of design as the effect of concentrated hanger loads on building structure, pipe weight loads on equipment connections, and physical clearances of the hanger components with piping and structure be taken into account at the early design stages of a project.

Engineers specializing in the design of pipe hangers have established efficient methods of performing the work required to arrive at appropriate hanger designs. However, the engineer who devotes varying portions of his time to the design of pipe hangers often must gather a considerable amount of reference data peculiar only to the hanger calculations for his current project.

It is the purpose of this article to present a compilation of all information necessary for the design of hangers, including a technical section devoted to the listing of piping material, weights, and thermal expansion data. Also, the discussions of the various steps involved in designing supports, presented here in their proper sequence, should serve as a good reference source for the engineer who only occasionally becomes involved in the essentials of hanger design.

The first of these steps is that of determining and obtaining the necessary amount of basic information before proceeding with calculations and detailing of the pipe supports. No design is complete unless the engineer has had the opportunity to review the equivalent of the following project data:

- The pipe hanger specification, when available (A typical hanger specification is shown on pages 22 and 23).
- A complete set of piping drawings.
- A complete set of steel and structural drawings including equipment foundation and boiler structure details.
- A complete set of drawings showing the location of ventilating ducts, electrical trays, pumps, tanks, etc.
- The appropriate piping specifications and data, which will include pipe sizes and composition identification, wall thicknesses, and operating temperatures.
- A copy of the insulation specifications with densities.
- Valve and special fittings lists, which will indicate weights.
- The movements of all critical equipment connections such as boiler headers, steam drums, turbine connections, etc.
- The results of the stress, flexibility and movement calculation performed for critical systems such as Main Steam, High Temperature Reheat, etc.

The steps in which the engineer applies this information are:

- 1 Determine hanger locations.
- 2 Calculate hanger loads.
- 3 Determine thermal movement of the piping at each hanger location.
- 4 Select hanger types: spring assembly, either constant support, variable spring type, rigid assembly, etc.
- 5 Check clearance between the hanger components and nearby piping, electrical cable trays, conduits, ventilating ducts, and equipment.

The final step will not be discussed to any great degree. This aspect of design is governed solely by the requirements and layouts of the individual job. Instead, attention will be devoted to steps 1 to 4, where the scope of good hanger practice can be generally defined for any installation.

Recognizing that each new piping design presents many new challenges to the engineer, no attempt is made to state fixed rules and limits applicable to every hanger design. Rather, the intention is to illustrate ideas which will serve as a guide to a simple, practical solution to any pipe support problem.

Integral Attachments

Integral attachments are fabricated so that the attachment is an integral part of the piping component. Examples of integral attachments include ears, shoes, lugs, cylindrical attachments, rings and skirts. Integral attachments are used in conjunction with restraints or braces where multi-axial restraint in a single member is required. Of particular importance is the localized stresses induced into the piping or piping component by the integral attachments. Several methods to determine the local stresses are available including relatively simple hand/ cookbook calculations provided in Welding Research Council (WRC) Bulletins 107, 198, and 297, ASME Code Cases N-318 and N-392, or through a detailed finite element analysis. Section 121 of ASME B31.1 discusses additional considerations for integral attachments.

Hanger Spans

Support locations are dependent on pipe size, piping configuration, the location of heavy valves and fittings, and the structure that is available for the support of the piping.

No firm rules or limits exist which will positively fix the location of each support on a piping system. Instead, the engineer must exercise his own judgement in each case to determine the appropriate hanger location.

The suggested maximum spans between hangers listed in table below reflect the practical considerations involved in determining support spacings on straight runs of standard wall pipe. They are normally used for the support spacings of critical systems.

Span Between Reports

| Nom. Pipe Size (In.) | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 | 30 |
|-----------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Span Water (Ft.) | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 19 | 22 | 23 | 25 | 27 | 28 | 30 | 32 | 33 |
| Steam, Gas, Air (Ft.) | 9 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 21 | 24 | 26 | 30 | 32 | 35 | 37 | 39 | 42 | 44 |



The Design of Pipe Hangers

The spans in table are in accordance with MSS Standard Practice SP-69. They do not apply where concentrated weights such as valves or heavy fittings or where changes in direction of the piping system occur between hangers.

For concentrated loads, supports should be placed as close as possible to the load in order to minimize bending stresses.

Where changes in direction of the piping of any critical system occur between hangers, it is considered good practice to keep the total length of pipe between the supports less than $\frac{3}{4}$ the full spans in table below.

When practical, a hanger should be located immediately adjacent to any change in direction of the piping.

Sample Problem

In the sample problem (Figure 1) seven supports are shown on the 12 inch line, and two on the 6 inch pipe.

Note that the hanger H-1 has been placed adjacent to the valve weight concentration. The proximity of the hanger to the valve is helpful in keeping the load at terminal connection A to a minimum. Also, the bending stresses induced in the pipe by the valve weight are kept to a minimum.

The selection of the location for hanger H-2 entails a change in direction of the pipe between two hangers. In order to avoid excessive overhang of the pipe between hangers H-1 and H-2, the length of pipe between these hangers is made less than three fourths the suggested maximum span shown in the table on the previous page.

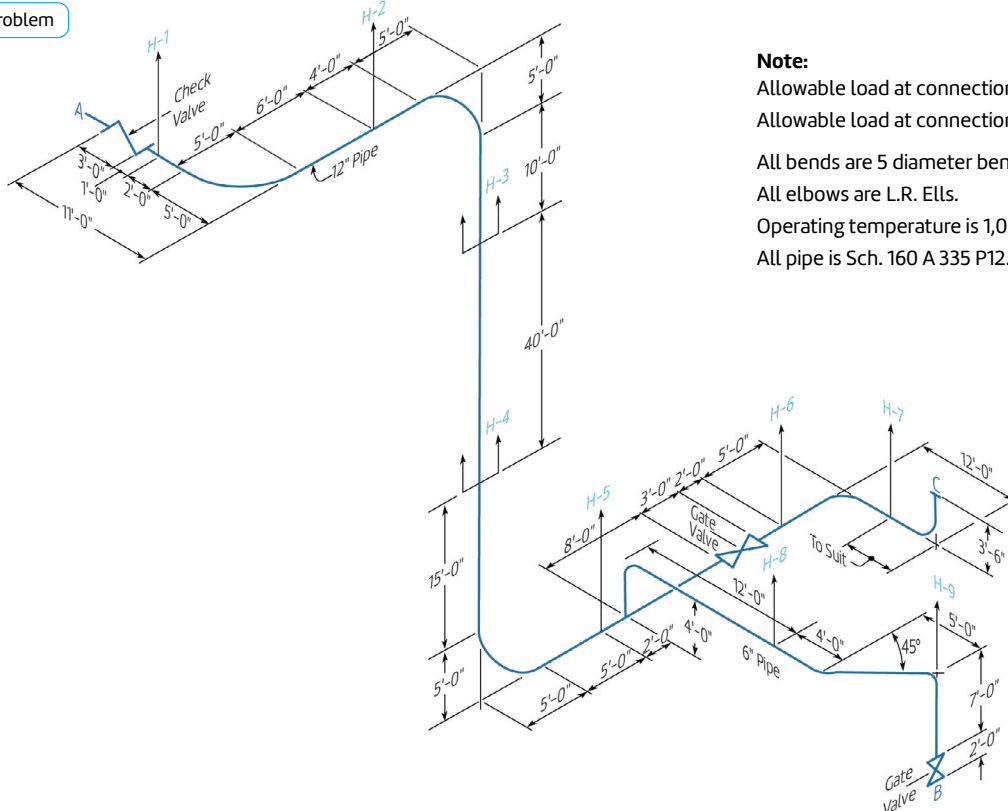
In considering the vertical section of the pipe on which H-3 and H-4 are shown, it should first be noted that this section of the pipe could be supported by one hanger rather than two as indicated. Two hangers will certainly provide greater stability than will a single hanger. Another deciding factor as to whether one hanger or a multiple hangers should be used is the strength of the supporting steel members of the structure. The use of two hangers will permit the total riser weight to be proportioned to two elevations of the structure, avoiding the concentration of all the riser load at one building elevation.

The locations for hangers H-5 and H-6 are governed by the suggested maximum span as well as the position of the concentrated valve weight. Consequently, H-6 has been located adjacent to the valve, and H-5 at a convenient location between the valve and the 12 inch riser.

The location of hanger H-7 will be determined by calculation to satisfy the condition that no pipe load is to be applied to terminal connection C. It is obvious that by moving the hanger along the 12 foot section of pipe, the amount of load on connection C will vary. One support location exists where the entire section will be "balanced", and the load at C equal to zero.

The calculations to determine the exact location of H-7 are shown in the section entitled "Hanger Load Calculation".

FIGURE 1 – Sample Problem



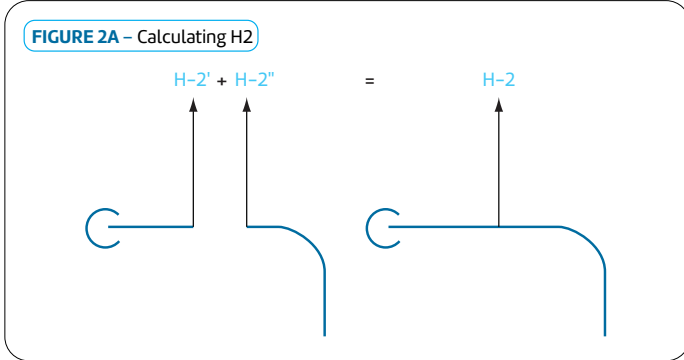
Note:

Allowable load at connection A is 500 lbs.
Allowable load at connection B and C is zero.

All bends are 5 diameter bends.
All elbows are L.R. Ells.
Operating temperature is 1,050°F.
All pipe is Sch. 160 A 335 P12.

Hanger Load Calculations

Note that the value for $H-2$ on this section of the piping system represents only a part of the total hanger force at $H-2$. For clarity, we have labeled this force $H-2'$. In the calculations for the next section of pipe beginning at $H-2$, we will call the hanger force at this point $H-2''$.



Also, note that we have considered the weight of the 90° bend acting at the center of gravity of the bend. The distance B is determined from the Chart on page 11 which has been drawn for convenience:

$$B = \text{Radius} \times .637, \text{ or } 5 \text{ ft.} \times .637 = 3.185 \text{ ft.}$$

Step 1 – Taking moments about axis Y-Y' (Figure 2)

$$\begin{aligned} \sum M_{y-y'} = 0, & \quad 1.81(1418) + 8(1084) - 11(H-2') = 0 \\ & \quad 2,567 + 8,672 = 11(H-2') \\ & \quad H-2' = 1,022 \text{ lb.} \end{aligned}$$

Step 2 – Taking moments about axis X-X' (Figure 2)

$$\begin{aligned} \sum M_{x-x'} = 0, & \quad 1.81(1418) + 6.5(542) - 7(H-1) + 9.5(3,533) - 11(A) = 0 \\ & \quad 2,567 + 3,523 + 33,564 = 7(H-1) + 11(A) \\ & \quad 39,564 = 7(H-1) + 11(A) \end{aligned}$$

Step 3 – Adding Forces $\sum V = 0$,

$$\begin{aligned} A + H-1 + H-2' - 3,533 - 542 - 1,418 - 1,084 &= 0 \\ A + H-1 + H-2' &= 6,577 \text{ lb.} \end{aligned}$$

Substituting the value $H-2'$, calculated as 1,022 lb. in Step 1,

$$\begin{aligned} A + H-1 + 1,022 &= 6,577 \text{ lb.} \\ A &= 5,555 - H-1 \end{aligned}$$

Step 4 – Solving the Three Equations

- | | |
|-------------------------------|----------|
| (1) $H-2' = 1,022$ | Step I |
| (2) $39,654 = 7(H-1) + 11(A)$ | Step II |
| (3) $A = 5,555 - (H-1)$ | Step III |

Solving Equation (2) by substituting for $A = 5555 - H-1$,

$$\begin{aligned} 39,654 &= 7(H-1) + 11(5,555 - H-1) \\ H-1 &= 5,363 \text{ lb.} \end{aligned}$$

Substituting for $H-1$ in Equation 3,

$$A = 5,555 \text{ lb.} - 5,363 \text{ lb.}$$

$A = 192 \text{ lb.}$; which is below the allowable load at A of 500 lb.

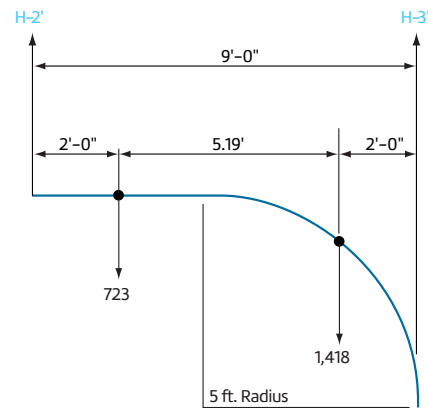
Next, consider the section of pipe between $H-2$ and $H-3$ to determine the weight distribution, between these two points, of the 4ft. section of pipe and the five diameter bend.

$$\begin{aligned} \sum M_{H-2} = 0, & \quad 2(723) + 7.19(1418) - 9(H-3') = 0 \\ & \quad H-3' = 1,293 \text{ lb.} \end{aligned}$$

$$\begin{aligned} \sum M_{H-3} = 0, & \quad 1.81(1,418) + 7(723) - 9(H-2'') = 0 \\ & \quad H-2'' = 848 \text{ lb.} \end{aligned}$$

$$H-2 = H-2' + H-2'' = 1,022 \text{ lb.} + 848 \text{ lb.} = 1,870 \text{ lb.}$$

FIGURE 3 – Elevation View



In the next free body diagram (Figure 4) consider the 65 ft. vertical section of the piping system to determine the supporting forces for $H-3''$ and $H-4'$.

It is apparent that the combined forces $H-3''$ and $H-4'$ equals 65 ft. x 180.7 lb./ft. Further, both $H-3''$ and $H-4'$ could be any value, provided the relationship

$$H-3'' + H-4' = 11,746 \text{ lb.}$$

is maintained. It is not recommended, however, to select arbitrary values for these two forces; instead, the load for each hanger should be such that the elevation of the pipe attachment is above the midpoint of the length of pipe supported by the hanger. Thus, the support will be located above the point where one could consider the weight of the pipe column acting, thereby avoiding a condition where the location of the support lends itself to the "tipping" tendency of the pipe when the support is located below this point.

Since there is 10 ft. of vertical pipe above $H-3''$ and 40 ft. of pipe between $H-3''$ and $H-4'$, let $H-3''$ support 10 ft. plus 30 ft. of pipe load:

$$H-3'' = (10 \text{ ft.} + 30 \text{ ft.}) (180.7 \text{ lb./ft.}) = 7,228 \text{ lb.}$$

Since $H-3 = H-3' + H-3''$ and $H-3' = 1293 \text{ lb.}$ (see Figure 3),

$$H-3 = 1,293 \text{ lb.} + 7,228 \text{ lb.} = 8,521 \text{ lb.}$$

$$H-4' = (10 \text{ ft.} + 15 \text{ ft.}) (180.7 \text{ lb./ft.}) = 4,518 \text{ lb.}$$

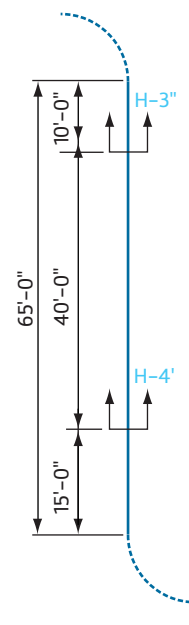
Consider the piping between $H-4'$ and $H-5$ to determine the weight distribution of the 5 diameter bend and the 5 ft. of horizontal pipe:

$$\begin{aligned} \sum M_{H-4} = 0 & \quad 1.81(1,418) + 7.5(904) - 10(H-5') = 0 \\ & \quad H-5' = 935 \text{ lb.} \end{aligned}$$

$$\begin{aligned} \sum M_{H-5} = 0 & \quad 2.5(904) + 8.19(148) - 10(H-4'') = 0 \\ & \quad H-4'' = 1,387 \text{ lb.} \end{aligned}$$

$$H-4 = H-4' + H-4'' = 4,518 \text{ lb.} + 1,387 \text{ lb.} = 5,905 \text{ lb.}$$

FIGURE 4 – Elevation View



Hanger Load Calculations

FIGURE 5

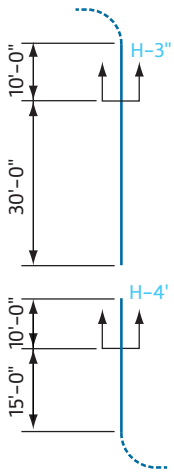


FIGURE 6 – Elevation View

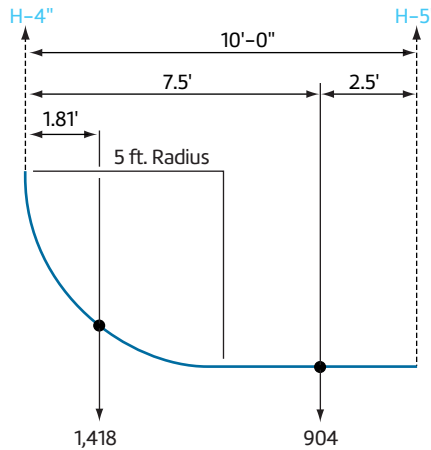
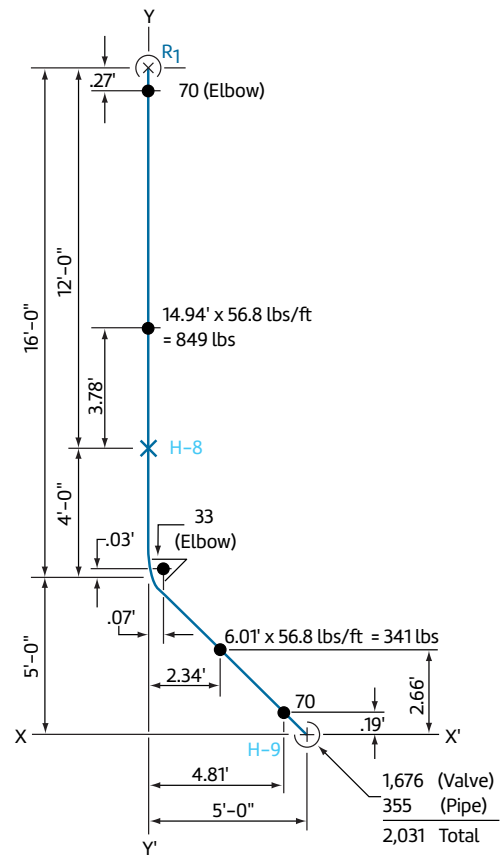


FIGURE 7 – Plan View



It is obvious that some portion of the weight of the 6 in. pipe between the 12 in. line and H-8 must be supported by H-5 and H-6. Therefore, before proceeding through H-5 and H-6, calculate this pipe weight load R₁, and introduce it into the free body diagram for H-5 and H-6.

$$\sum M_{y-y} = 0 \quad .07(33) + 2.34(341) + 4.81(70) + 5(2,031) - 5(H-9) = 0$$

$$H-9 = 2,258 \text{ lb.}$$

$$\sum M_{x-x'} = 0 \quad 19(70) + 2.66(341) + 5.03(33) - 9(H-8) + 12.78(849) + 20.73(70) - 21R_1 = 0$$

$$13,387 = 9(H-8) - 21(R_1)$$

$$\sum V = 0, \quad R_1 + H-8 + H-9 - 2,031 - 70 - 341 - 33 - 849 - 70 = 0$$

$$R_1 + H-8 + H-9 = 3,394 \text{ lb.}$$

Since H-9 has been calculated as 2,258 lb.

$$R_1 + H-8 = 3,394 \text{ lb.} - 2,258 \text{ lb.} = 1,136 \text{ lb.}$$

$$H-8 = 1,136 \text{ lb.} - R_1$$

Substituting this value for H-8 in the Equation

$$13,387 = 9(H-8) + 21R_1$$

$$13,387 = 9(1,136 \text{ lb.} - R_1) + 21(R_1)$$

$$R_1 = 264 \text{ lb.}$$

$$H-8 = 1,136 - R_1 = 1136 \text{ lb.} - 264 \text{ lb} = 872 \text{ lb.}$$

FIGURE 8 – Elevation View

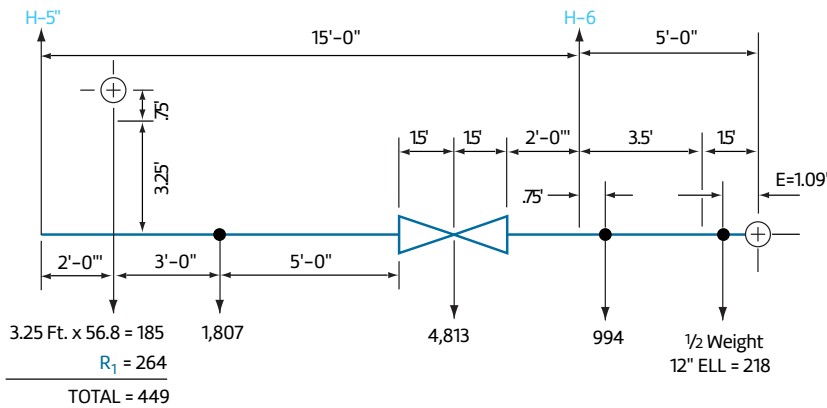
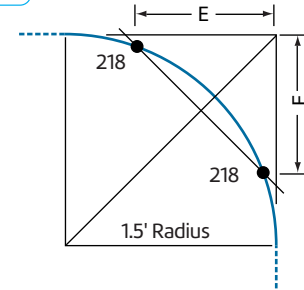


FIGURE 9



Dimension E is determined from the Chart on page 11.

For the sample problem,
 $E = .726 \times 1.5 \text{ ft.} = 1.09 \text{ ft.}$

The free body diagram shown in Figure 8 extends from H-5 through the 12 in. 90° elbow. This is intended to illustrate that the weight of the 90° elbow may be considered as supported on a beam which passes through the center of gravity of the elbow and rests on the extensions of the tangents as shown in Figure 9.

In Figure 8,

$$\Sigma M_{H-5} = 0, \quad 2(449) + 5(1,807) + 11.5(4,813) - 15(H-6) + 15.75(994) + 18.91(218) = 0$$

$$H-6 = 5,671 \text{ lb.}$$

$$\Sigma M_{H-6} = 0, \quad 3.5(4,813) + 10(1,807) + 13(449) - .75(994) - 3.91(218) - 15(H-5) = 0$$

$$H-5 = 2,610 \text{ lb.}$$

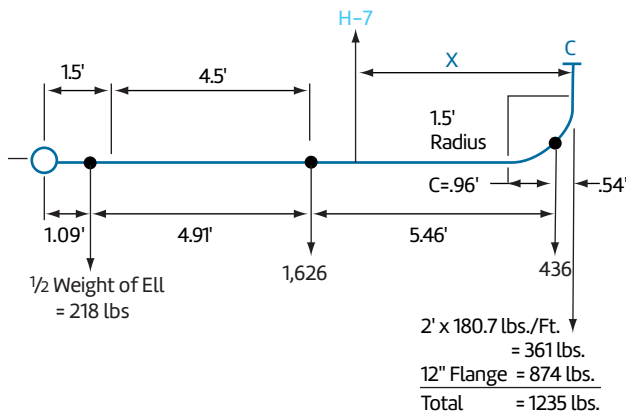
$$H-5 = H-5' + H-5'' = 935 \text{ lb.} + 2,610 \text{ lb.} = 3,545 \text{ lb.}$$

Solving for distance X,

$$\begin{aligned} \Sigma M_C = 0, \\ .54(436) - X(H-7) + 6(1,626) + 10.91(218) = 0 \\ X(H-7) = 12,369 \\ X(3515) = 12,369 \\ X = 3.52 \text{ ft.} \end{aligned}$$

As a final step, check to ensure that the weight of the entire piping system is equal to the total supporting forces of the hangers plus the pipe weight load to be supported by the equipment connections:

FIGURE 10 – Elevation View



The Figure 10 diagram shows a method for arriving at the location of H-7 which will allow zero load on connection C.

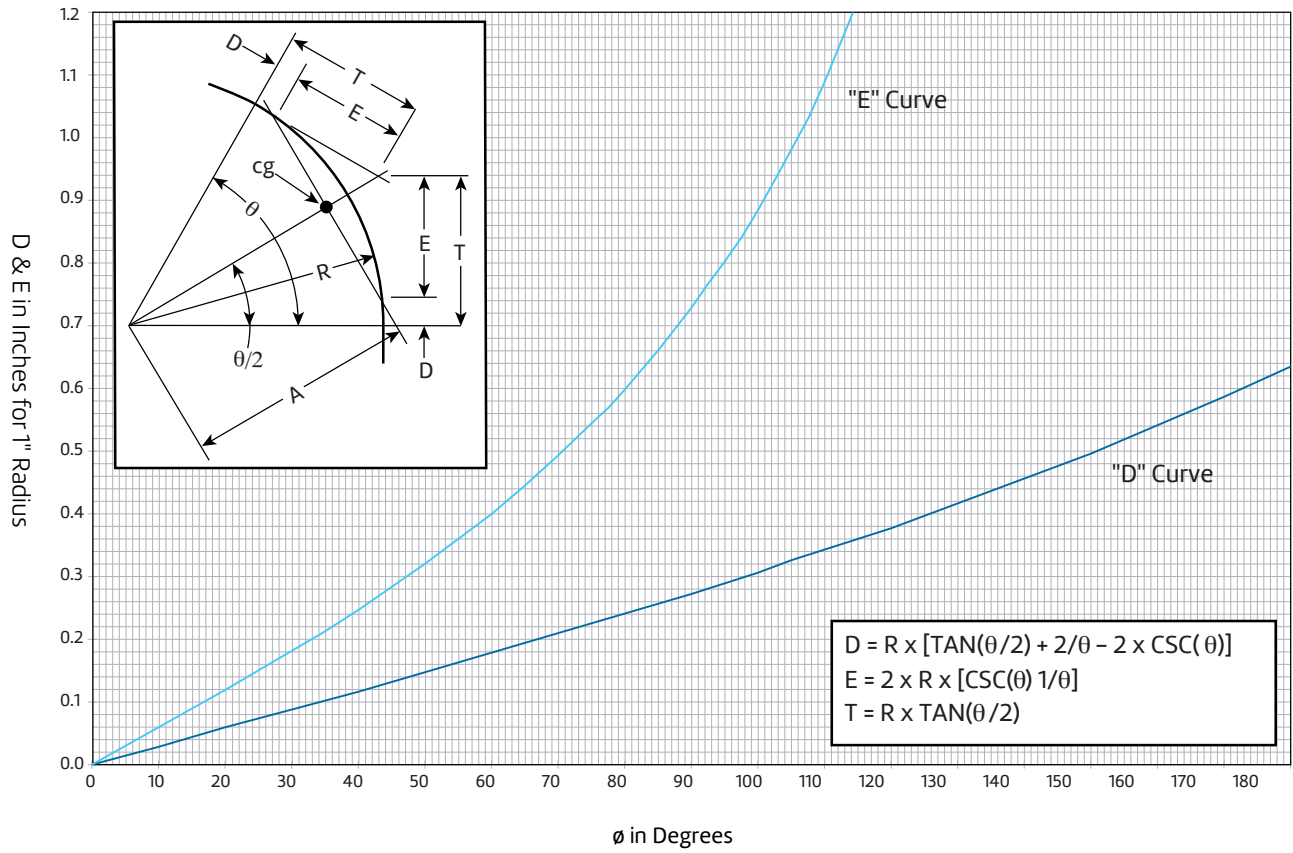
The value of H-7 is equal to the weight of the piping section:

$$H-7 = 218 \text{ lb.} + 1,626 \text{ lb.} + 436 \text{ lb.} + 1,235 \text{ lb.} = 3,515 \text{ lb.}$$

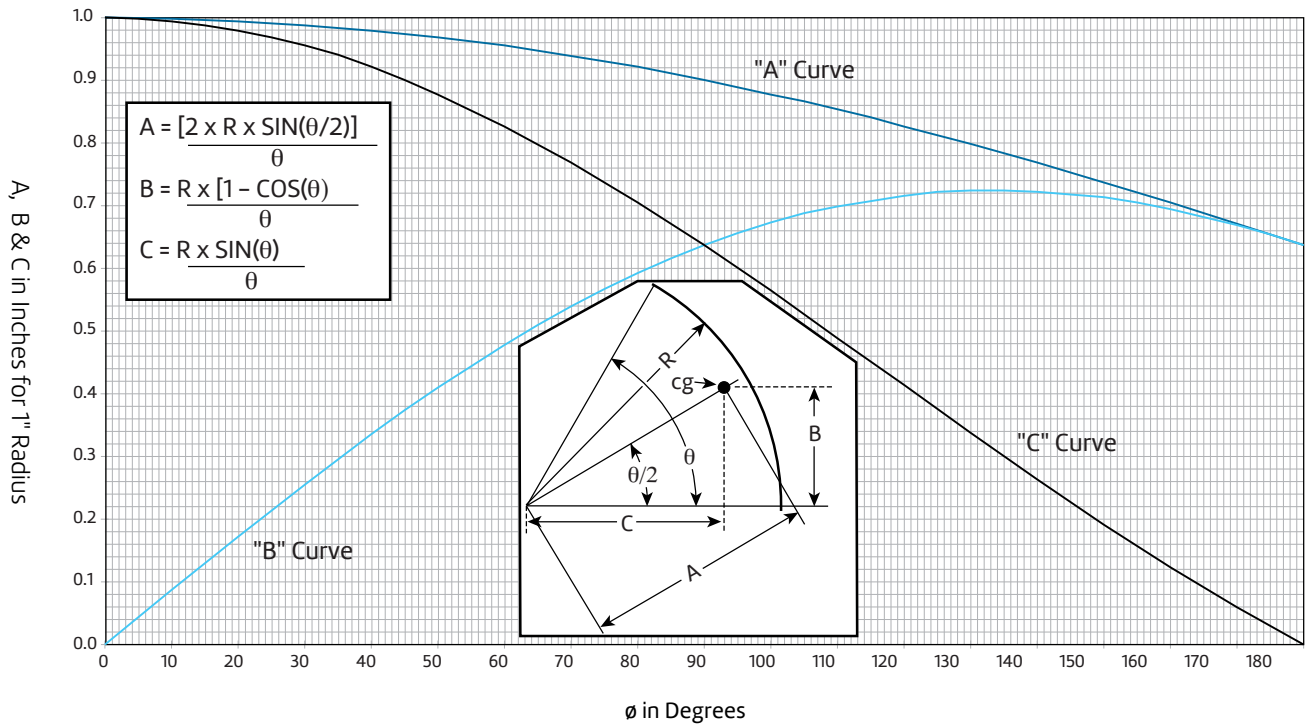
Summary – Support Forces

| Piping System | Weight (Lbs) | Support Forces Plus Terminal Point Loads, lb |
|-------------------------------------------|---------------|----------------------------------------------|
| 109.5 ft. of 12" Pipe @ 180.7 lb./ft. | 19,787 | A = 192 |
| (3) 12" 5 Dia. Bends @ 1418 lb. | 4,254 | H-1 = 5,363 |
| (2) 12" 90° L.R. Ells @ 436 lb. | 872 | H-2 = 1,870 |
| 30.45 ft. of 6" Pipe @ 56.8 lb./ft. | 1,730 | H-3 = 8,521 |
| (2) 6" 90° L.R. Ells @ 70 lb.. | 140 | H-4 = 5,905 |
| (1) 6" 45° Ell @ 33 lb. | 33 | H-5 = 3545 |
| (1) 12" 1,500 lb. Check Valve @ 3,533 lb. | 3,533 | H-6 = 5,671 |
| (1) 12" 1,500 lb. Gate Valve @ 4,813 lb. | 4,813 | H-7 = 3,515 |
| (1) 12" 1,500 lb. WN Flange @ 874 lb. | 874 | H-8 = 872 |
| (1) 6" 1,500 lb. Gate Valve @ 1,676 lb. | 1,676 | H-9 = 2,258 |
| Total Weight of Piping System. | 37,712 | Total = 37,712 |

Calculated Arc Distances for Bends and Welding Elbows



Center of Gravity of an Arc



Thermal Movements

The next step in the design of pipe hangers involves the calculation of the thermal movements of the pipe at each hanger location. Based on the amount of vertical movement and the supporting force required, the engineer can most economically select the proper type hanger (i.e. Constant Support, Variable Spring, or Rigid Assembly).

The determination of piping movements to a high degree of accuracy necessitates a highly complicated study of the piping system. The simplified method shown here is one which gives satisfactory approximations of the piping movements.

Whenever differences occur between the approximations and actual movements, the approximation of the movement will always be the greater amount.

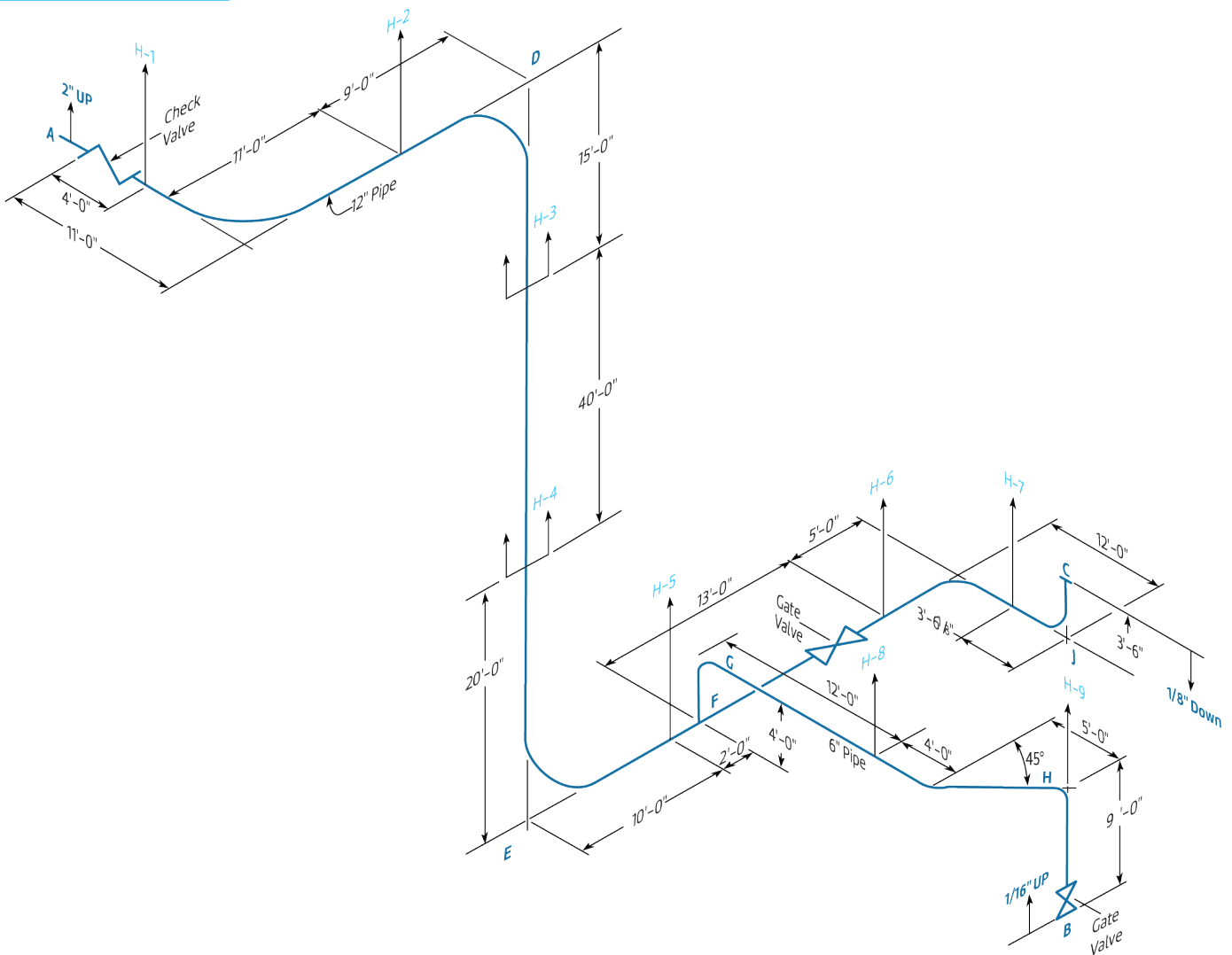
STEP – Chart Vertical Movements

Draw the piping system of Figure 1 and show all known vertical movements of the piping from its cold to hot, or operating, position (see Figure 11). These movements will include those supplied by the equipment manufacturers for the terminal point connections. For the illustrated problem, the following vertical movements are known:

- Point A -- 2 in. up, cold to hot
- Point B -- $\frac{1}{16}$ in. up, cold to hot
- Point C -- $\frac{1}{8}$ in. down, cold to hot
- H-4 - 0 in., cold to hot

The operating temperature of the system is given as 1,050°F.

FIGURE 11 – Vertical Movements



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Referring to the thermal expansion table (page 64), the coefficient of expansion for low-chrome steel at 1,050°F is .0946 in.

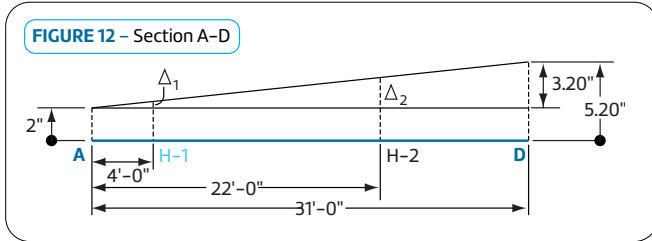
Calculate the movements at points **D** and **E** by multiplying the coefficient of the expansion by the vertical distance of each point from the position of zero movement on the riser **D-E**:

$$55 \text{ ft.} \times .0946 \text{ in./ft.} = 5.2 \text{ in. up at D}$$

$$20 \text{ ft.} \times .0946 \text{ in./ft.} = 1.89 \text{ in. down at E}$$

STEP 2 – Section – A-D

Make a simple drawing of the piping between two adjacent points of known movement, extending the piping into a single plane as shown for the portion between **A** and **D**.



The vertical movement at any hanger location will be proportional to its distance from the end points:

$$\Delta_1 = \frac{4}{31} \times 3.20 = .41 \text{ in.}$$

The vertical movement at **H-1** = .41 in. + 2 in.

$$\Delta_{H-1} = 2.41 \text{ in. up}$$

$$\Delta_2 = \frac{22}{31} \times 3.20 = 2.27 \text{ in.}$$

The vertical movement at **H-2** = 2.27 in. + 2 in.

$$\Delta_{H-2} = 4.27 \text{ in. up}$$

STEP 3 – Movement at H-3

To calculate the vertical movement at **H-3**, multiply its distance from **H-4** by the coefficient of expansion.

$$\Delta_{H-3} = 40 \text{ ft.} \times .0946 \text{ in./ft.} = 3.78 \text{ in. up}$$

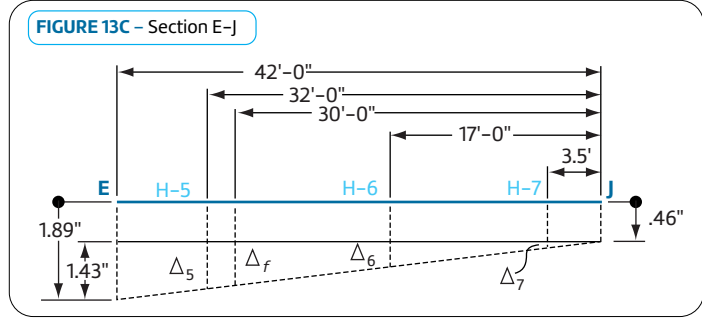
$$\Delta_{H-3} = 3.78 \text{ in. up}$$

STEP 4 – Section – E-J

The next section with two points of known movement is the length **E-J**. Movement at **E** was calculated as 1.89 in. down.

Movement at **J** is equal to the movement at the terminal point **C** ($\frac{1}{8}$ in. down) plus the amount of expansion of the leg **C-J**:

$$\Delta_J = .125 \text{ in.} + (3.5 \text{ ft.} \times .0946 \text{ in./ft.}) = .46 \text{ in. down}$$



$$\Delta_7 = \frac{3.5}{42} \times 1.43 = 0.12 \text{ in.}$$

$$\Delta_{H-7} = 0.12 \text{ in.} + 0.46 \text{ in.} = 0.58 \text{ in. down}$$

$$\Delta_6 = \frac{17}{42} \times 1.43 = 0.58 \text{ in.}$$

$$\Delta_{H-6} = 0.58 \text{ in.} + 0.46 \text{ in.} = 1.04 \text{ in. down}$$

$$\Delta_F = \frac{30}{42} \times 1.43 = 1.02 \text{ in.}$$

$$\Delta_F = 1.02 \text{ in.} + 0.46 \text{ in.} = 1.48 \text{ in. down}$$

$$\Delta_5 = \frac{32}{42} \times 1.43 = 1.09 \text{ in.}$$

$$\Delta_{H-5} = 1.09 \text{ in.} + 0.46 \text{ in.} = 1.55 \text{ in. down}$$

STEP 5

Draw the section **G-H**. The movement at **G** is equal to the movement at **F** minus the expansion of the leg **G-F**:

$$\Delta_G = 1.48 \text{ in. down} - (4 \text{ ft.} \times .0946 \text{ in./ft.})$$

$$\Delta_G = 1.10 \text{ in. down}$$

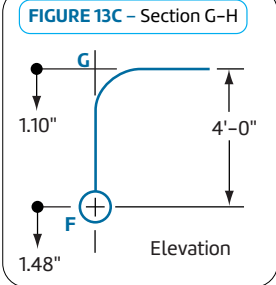
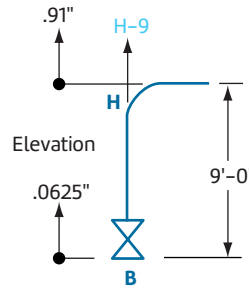


FIGURE 15A – Section B-H



The movement at **H** is equal to the movement of the terminal point **B** ($\frac{1}{16}$ in. up) plus the expansion of the leg **B-H**:

$$\Delta_H = .0625 \text{ in. up} + (9 \text{ ft.} \times .0946 \text{ in./ft.})$$

$$\Delta_H = 0.91 \text{ in. up}$$

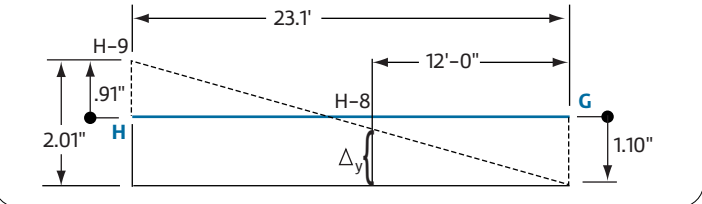
Since **H-9** is located at point **H**,

$$H-9 = \Delta_H = 0.91 \text{ in. up}$$

$$\Delta_Y = \frac{12}{23.1} \times 2.01 \text{ in.} = 1.04 \text{ in.}$$

$$\Delta_{H-8} = 1.10 \text{ in.} - 1.04 \text{ in.} = .06 \text{ in. down}$$

FIGURE 15B – Section G-H



After calculating the movement at each hanger location it is often helpful, for easy reference when selecting the appropriate type hanger, to make a simple table of hanger movements like the one shown at the right.

Hanger No. Movement

| | |
|-----|------------|
| H-1 | 2.41" up |
| H-2 | 4.27" up |
| H-3 | 3.78" up |
| H-4 | 0" |
| H-5 | 1.55" down |
| H-6 | 1.04" down |
| H-7 | 0.58" down |
| H-8 | 0.06" down |
| H-9 | 0.91" up |

Selection of the Proper Hanger

Selection of the appropriate type hanger for any given application is governed by the individual piping configuration and job requirements. Job specifications covering hanger types, however, are of necessity written in broad terms, and some emphasis is placed on the good judgement of the hanger engineer to ensure a satisfactory, yet economical, system.

The type of hanger assemblies are generally classified as follows:

- 1 Flexible hangers, which include hangers of the constant support and variable spring types.
- 2 Rigid hangers, such as rod hangers and stanchions.
- 3 Rollers

The location of anchors and restraints is not usually considered a responsibility of the hanger designer. Since it is necessary to determine the location of anchors and restraints before accurate and final stress analysis is possible, they are considered a part of piping design.

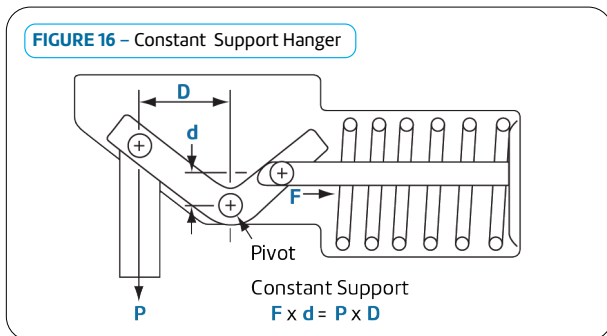
Flexible Hangers

When a pipe line expands vertically as a result of thermal expansion it is necessary to provide flexible pipe supports which apply supporting force throughout the expansion and contraction cycle of the system.

There are two types of Flexible hangers:

- Variable Spring
- Constant Support

Constant Support hangers provide constant supporting force for piping throughout its full range of vertical expansion and contraction. This is accomplished through the use of a helical coil spring working in conjunction with a bell crank lever in such a way that the spring force times its distance to the lever pivot is always equal to the pipe load times its distance to the lever pivot.



Because of its constancy in supporting effect the Constant Support hanger is used where it is desirable to prevent pipe weight load transfer to connected equipment or adjacent hangers. Consequently, they are used generally for the support of critical piping systems.

Variable Spring hangers are used to support piping subject to vertical movement where Constant Supports are not required.

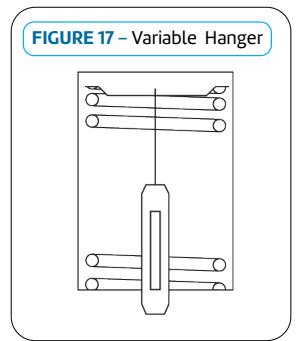
The inherent characteristic of a Variable Spring is such that its supporting force varies with spring deflection and spring scale. Therefore, vertical expansion of the piping causes a corresponding extension or compression of the spring and will cause a change in the actual supporting effect of the hanger.



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The variation in supporting force is equal to the product of the amount of vertical expansion and the spring scale of the hanger. Since the pipe weight is the same during any condition, cold or operating, the variation in supporting force results in pipe weight transfer to equipment and adjacent hangers and consequently additional stresses in the piping system. When Variable Spring hangers are used, the effect of this variation must be considered.



Variable Spring hangers are recommended for general use on non-critical piping systems and where vertical movement is of small magnitude on critical systems. Accepted practice is to limit the amount of supporting force variation to 25% for critical system applications on horizontal piping.

To illustrate the difference in the effect of using a Variable Spring as compared with a Constant Support hanger, refer to the sample problem shown in Figure 1, page 6.

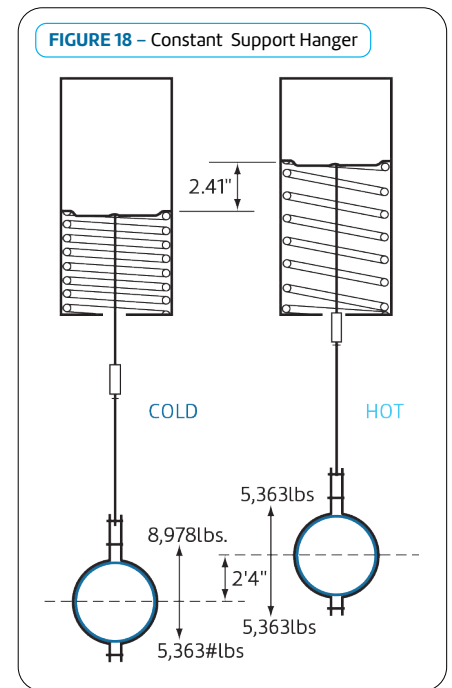
The load for Hanger H-1 was calculated as 5,363 lb. The vertical movement at H-1 was calculated as 2.41 in. up, from the cold to the hot position of the pipe.

If a Variable Spring hanger were used at H-1, the effect of the variation in supporting force would have to be considered. The amount of variation can be determined by multiplying the spring scale in lbs./in. by the amount of vertical expansion in inches.

For example, if the Anvil Figure B-268 Variable Spring Hanger were considered, the proper spring size would be number 16 which has a spring scale of 1,500 lbs./in. (For convenience, we have neglected the weight of the pipe clamp, rod and hex nuts. In designing hangers for an actual problem, the weight of components should be added to the calculated load.)

The amount of variation is 1,500 lb/in. x 2.41 in. = 3,615 lb. Standard practice is to calibrate the hanger in such a way that when the piping is at its hot position the supporting force of the hanger is equal to the calculated load of the pipe. This means that the maximum variation in supporting force occurs when the piping is at its cold position, when stresses added to the piping as a result of variations in supporting forces are less critical. The hot load for the variable spring, then is 5,363 lb.

As the direction of movement from cold to hot is upward, the cold load is 5,363 lb. + 3,615 lb., or 8,978 lb. Figure 18 shows the pipe and spring in both the cold and hot condition.



The purpose of the considerations given to the variation in supporting effect is apparent when you recall that the pipe weight does not change throughout its cold to hot cycle, while the supporting force varies. In **Figure 18** (hot condition), the supporting force is equal to the pipe weight. However, in the cold condition, the supporting force is 8,978 lb. while the pipe weight is 5,363 lb. The hanger would exert an unbalanced force on the pipe equal to the amount of variation, or 3,615 lb. Most of this force would be imposed directly on connection A, where limits are established for the force which may be applied.

Further, safe piping design must be based on total pipe stress which includes bending, torsional, shear, longitudinal, and circumferential stresses. The addition of large forces resulting from spring variations can cause stresses which will greatly reduce the factor of safety of the entire spring system.

It is possible to reduce the amount of variability by using a variable spring which has a smaller spring scale, as an **Anvil Figure 98 (Variable Spring Hanger)**.

The **#16 Figure 98** has a spring scale of 750 lb/in., one-half that of the B268. The amount of variability would be reduced by one-half, or $2.41 \times 750 = 1,808$ lb. However, it should be obvious that even this change in supporting force is too great for the critical location at **H-1**.

The appropriate hanger type for **H-1** is a constant support hanger. This hanger would be calibrated to the calculated pipe weight. It would apply a constant supporting force, ensuring complete support of the pipe throughout the piping expansion.

That is, its supporting force would be 5,363 lb. when the pipe was at its cold position, and 5,363 lb. also when the pipe was at its hot position.

Hanger **H-2** has a calculated load of 1,870 lb. The vertical movement at this location is 4.27in. up, cold to hot. Although the load may be considered slight, the magnitude of the vertical movement is great, and a considerable amount of supporting force change would occur if a variable spring were used.

For example, the appropriate size variable spring is a **#12 Figure 98** (the 4.27 in. travel is beyond the travel capacity of the **Figure B-268**), which has a spring scale of 225 lb. in. The amount of variation equals $4.21 \text{ in.} \times 225 \text{ lb. in.},$ or 947 lb.

This variation, expressed as a percentage, is $947 \text{ lb.}/1,870 \text{ lb.} \times 100,$ or greater than 50%.

Unless the hanger engineer were willing to perform some rather elaborate stress calculations to determine the effect of this variation, it would be safer to apply the accepted rule which limits variability to 25% for critical systems, and rule out the selection of a variable spring in favor of the constant support type hanger.

The vertical movement of the pipe at **H-3** was calculated as 3.78 in. up, and the load as 8,521 lb.

In selecting the spring type for the hanger assembly, it should be recognized that any variation in supporting force will not produce bending stresses in the piping system. As the supporting forces at **H-3** and **H-4** are concurrent, no bending is produced as a result of spring variation at **H-3**. Rather, any supporting force variation will merely result in a corresponding load change at the rigid hanger **H-4**.

The hanger type for **H-3** may be variable spring type. It is only necessary that the variable spring have a travel capacity which is greater than the calculated pipe movement of 3.78 in.

Such a variable spring hanger is the **Figure 98**, which has a working travel range of 5 inches.

As this assembly is a riser "trapeze" type, two spring units will be used, each supporting one-half the total load of 8,521 lb, or 4,261 lb. The appropriate size hanger is a **#15 Figure 98** with a spring scale of 540 lb. inch. The amount of variation per spring is $3.78 \text{ in.} \times 540 \text{ lb./in.},$ or 2,041 lb. The hot load setting for each hanger is equal to $\frac{1}{2}$ the calculated load, or 4,261 lb. As the direction of movement, cold to hot, is upward, the cold load setting will be $4,261 \text{ lb.} + 2,041 \text{ lb.} = 6,302 \text{ lb.}$

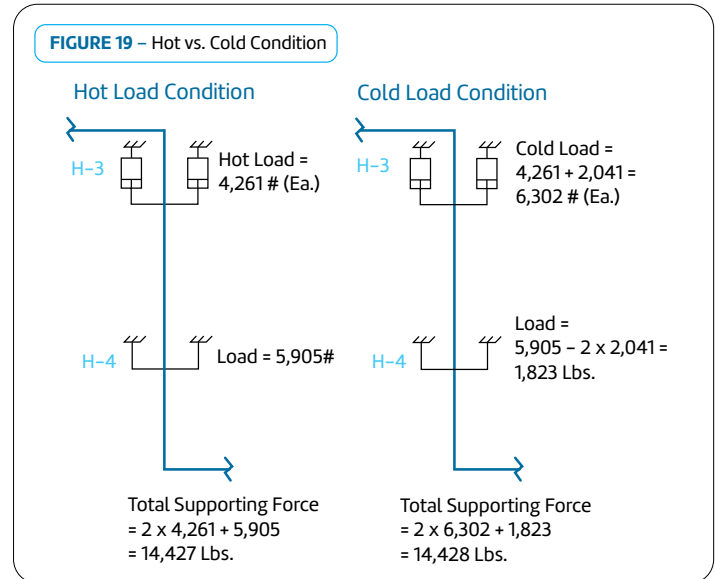


Figure 19 shows the supporting forces at **H-3** and **H-4** when the pipe is at its cold and its hot position. The weight of riser clamps, rods, etc., are not included, for convenience.

The design load for **H-3** should allow for a calculated cold load of $6,302 \text{ lb.} \times 2 = 12,604 \text{ lb.}$

The load at rigid hanger **H-4** is 1,823 lb. cold, 5,905 lb. hot. All hanger components should be designed for the larger load.

Variation in supporting forces at hangers **H-5**, **H-6**, **H-7** and **H-9** will produce reactions at connections B and C. As one of the requirements of the problem under study is that weight loads at B and C shall be zero, these hangers must be of the constant support type.

Although it holds true that at **H-8** any hanger force variation will cause weight loads at B and C, the load and movement at this hanger location are so slight that the spring variation effect can be considered negligible. The load was calculated as 872 lb, the movement as .06 in. down. The variability of a **#8 Figure B-268** is $.06 \text{ in.} \times 150 \text{ lb./in.},$ or 9 lb. For practical purposes, a 9 lb. change in supporting force could be neglected and a variable spring selected for Hanger **H-8**.

The selection of hanger types for supports **H-1** through **H-9** in the sample problem illustrates the many considerations which should be given in selecting the appropriate flexible hanger at each support location for any major piping system.



In selecting flexible hanger types the engineer should consider that:

- Wherever constant support hangers are used, the supporting force equals the pipe weight throughout its entire expansion cycle, and no pipe weight reactions are imposed at equipment connections and anchors.
- Wherever variable spring hangers are used, the engineer must check to assure that the total variation in supporting effect does not result in harmful stresses and forces within the piping system.
- Where piping stresses and reactions are known to be close to allowable, the simplest and, in the long run, most economical type of flexible support is obviously the constant support hanger.
- Where piping stresses and end reactions are known to be low, variable spring hangers can be used satisfactorily for most non-critical piping support, and for the support of critical systems where vertical movements are of small magnitude.

Rigid Hangers

Rigid hangers are normally used at locations where no vertical movement of the piping occurs.

The design considerations for a rigid hanger are pipe temperature, for selection of appropriate pipe clamp material, and load, for selection of components suitable for the pipe weights involved.

Pipe clamp material is usually carbon steel for temperatures up to 750°F, and alloy steel for temperatures above 750°F. Malleable iron pipe clamps may be used at temperatures up to 450°F.

For piping systems of low operating temperature, where vertical expansion is usually not a factor, the rigid hanger assembly components are selected and designed on the basis of calculated or approximated loads.

In some instances, however, the rigid hanger is used in a manner where it does more than merely support the pipe weight, but acts as against vertical piping movements. It is in these cases that the engineer should exercise care in the location of the rigid hanger and the design load he uses in the selection of components.

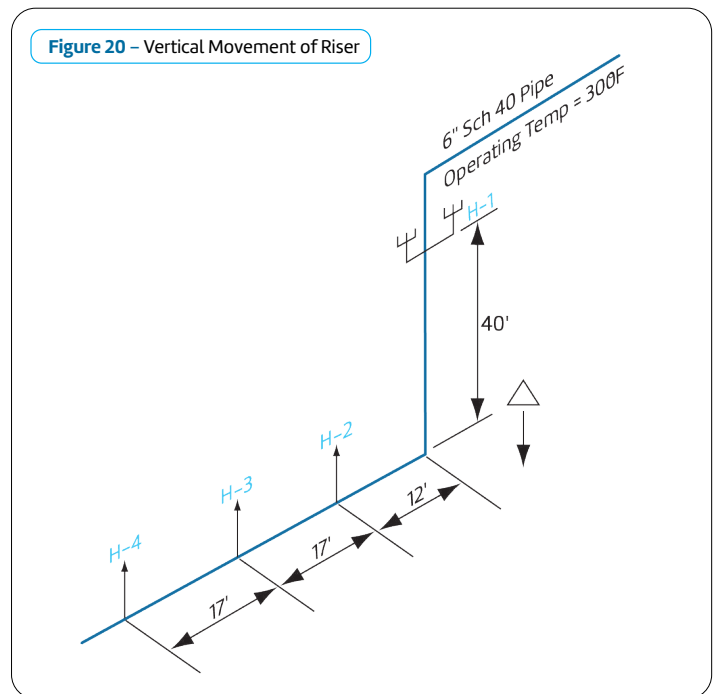
The location and effect of any restraint, guide or anchor on a high temperature and high pressure system is of necessity a function of the stress analyst. The indiscriminate placing of a restraining device on a piping system could alter the piping stresses and end reactions to a serious degree, changing a conservatively designed system into one which exceeds the limits of good design practices.

The hanger engineer, though not as well acquainted with the total stress picture of a piping system as is the stress analyst, must usually decide if the problem is of this "critical" nature, or whether the system under study is such that the effect of adding a restraint for convenience will be negligible. The decision is based on the factors of operating temperature, operating pressure, and the configuration of the system. Recognizing that pipe design is based on total pipe stress, one must determine whether the stresses produced by the addition of a rigid hanger, or vertical restraint, are critical.

This article is not intended to present a short-cut method for the stress analysis of a piping system. In any instance where it is not obvious to an engineer that he is dealing with a noncritical case, the problem should either be reviewed formally from a total stress view-point, or the decision to use a rigid hanger should be changed and a flexible support be utilized.

This article is intended to provide the engineer with a simple and quick method of deciding how he can most economically treat vertical thermal movement on a long, horizontal section of a non-critical piping system. Often, the problem can be expressed in the simple terms of whether he will be able to use a rigid hanger rather than a flexible hanger without producing obviously harmful stresses in the system.

Consider a simple example, shown in Figure 20, where the hanger engineer is confronted with the problem of how to best treat vertical movement resulting from thermal expansion of the riser. The horizontal sections at both the top and the bottom of the riser are of any hangers H-2, H-3, H-4, etc., should be spring hangers and which will be rigid hangers (vertical restraints in this instance). The solution must satisfy a condition that the bending stress produced by the restraining action of the hanger is no greater than some acceptable amount, say, in this instance, 10,000 psi.



For an operating temperature of 300°F, the expansion for carbon steel pipe is .0182in. per foot.

$$\Delta = 40\text{ft.} \times .0182\text{in./ft.} = .728\text{in. down.}$$

(See "Thermal Movement Calculations", page 12.)

From the Chart on Page 68 using values of 6 in. pipe and a deflection of $\frac{3}{4}$ in., read 17.5 ft. This is the minimum distance from the riser where the first rigid hanger may be placed for this problem.

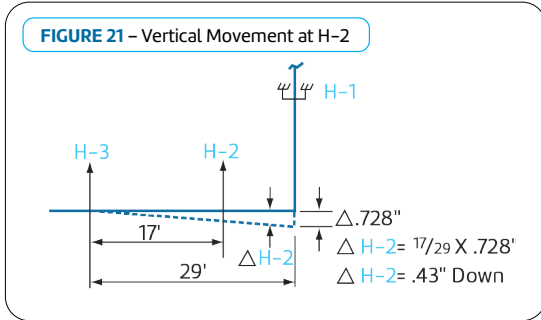
If the locations of the hangers are fixed, as they are for this case, then H-2 must be a spring hanger assembly because it is located only 12 ft. from the riser. Therefore, the nearest rigid hanger will be hanger H-3, located 29 ft. from the riser.



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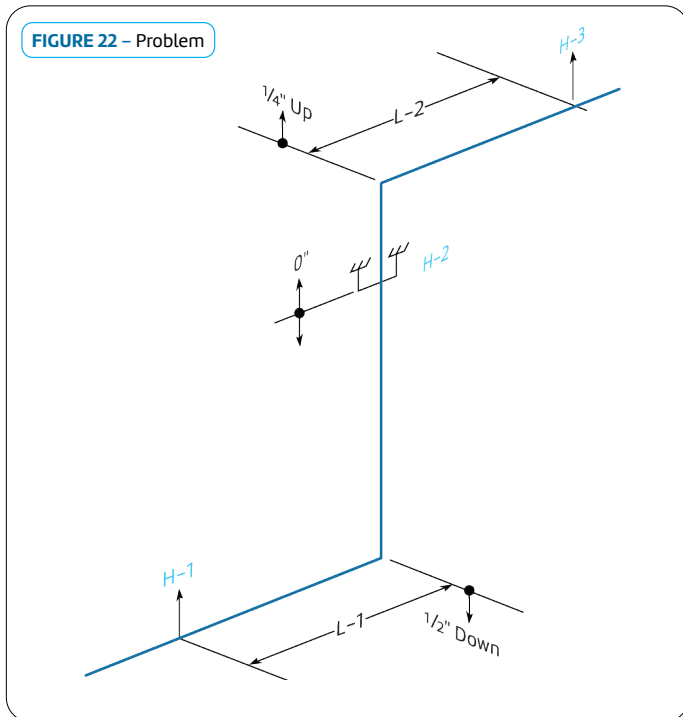
The amount of vertical movement at hanger **H-2** will be proportional to its distance between **H-3** and the riser, and can be approximated as shown in Figure 21:



Thus, **H-2** would be selected as a variable spring hanger for .43 in. of downward vertical movement, and **H-3** would be designed as a rigid hanger.

In the above problem the hanger locations were fixed. If this were not the case, and the hangers could be placed at any convenient location subject to usual hanger span limits, then **H-2** would be placed at any distance 17.5 ft. or more from the riser. This would satisfy the condition that a maximum bending stress of 10,000 psi would result from the restraining effect of the hanger. If the allowable effect was given as a higher stress, then the hanger could be placed closer to the riser; if lower, the nearest rigid hanger would be placed a greater distance from the riser.

If the hanger were located closer to the riser, a greater restraining force would be applied to the pipe by the hanger. As the location is changed to a greater distance from the riser, a lesser force is required. As illustrated in the following sample problem, this force can be an important factor in the design load of the hanger.



Problems

Given 10 in. Sch. 40 pipe, and allowable bending stress of 10,000 psi produced by the restraining effect of the hangers,

Find:

- 1 L-1 and L-2 the distances to the nearest rigid hangers **H-1** and **H-3**, see Figure 22.
- 2 The forces which the hangers must apply to the pipe to allow the 1/4 in. and 1/2 in. deflections resulting from the thermal expansion of the vertical pipe.

Solution:

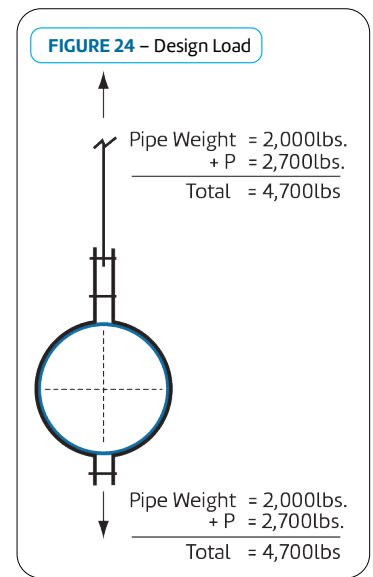
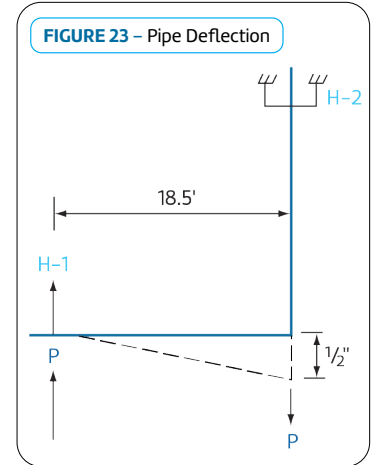
From the Chart on page 68 using values of 1/2 in. deflection and 10 in. pipe, read L-1, as 18.5 ft., the distance from the riser to the rigid hanger **H-1**. Thus, at a distance of 18.5 ft., the hanger will exert sufficient force to deflect the pipe 1/2 in., producing 10,000 psi bending stress. (See Figure 23).

Use the Chart on page 70 to find the value of force P. For a pipe size of 10 in. and a span of 18.5 ft., read P as approximately 2,700 lb.

This force is applied by the pipe hanger **H-1**, and, therefore, must be included in the design load for **H-1**. In this instance, where the piping movement is in the downward direction, the force P is added to the pipe weight to be supported by Hanger **H-1**. If the pipe weight for **H-1** were calculated as 2,000 lb., then the design load for the hanger components is 2,000 lb.+2,700 lb., or 4,700 lb., as shown in Figure 24.

To solve for L-2 refer to the Chart on page 68 and, using values of 1/4 in. deflection and 10 in. pipe, read L-2 as 13 ft., the distance to the proposed rigid hanger **H-3**. As discussed for **H1** of this problem, hanger **H-3** must apply sufficient force to restrain the pipe vertically against the force resulting from the thermal expansion of the vertical piping above **H-2**.

The force P which is required at **H-3** can be determined from the Chart on page 70. Using values for 10 in. pipe and a 13 ft. span, P is approximately 3,800 lb. Since this force restrains the upward movement of the pipe, it should be checked against the pipe weight load to assure that the hanger assembly can exert a force equal to the difference of the force P and the pipe weight load.



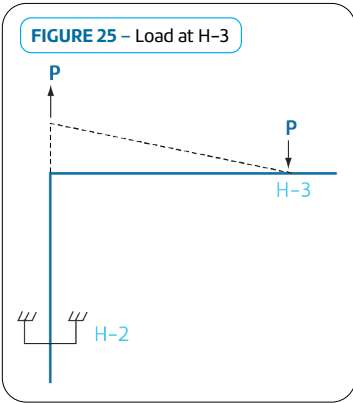


FIGURE 25 – Load at H-3

To illustrate, assume that the pipe load at H-3 was calculated as 5,000 lb. The difference between the pipe weight and the force P would equal 5,000 lb. - 3,800 lb. = 1,200 lb., as shown in Figure 26.

The design load used for hanger H-3 should equal 5,000 lb, or pipe weight only in this instance. Where the vertical movement is in the upward direction, and the force P approaches the pipe weight load, the rigid hanger will tend to unload.

This is, as the pipe expands upward the net force applied to the pipe by the hanger becomes less. If the force P becomes greater than the pipe weight at the hanger, the net force on the hanger becomes compressive rather than tensile. When the system has expanded its full amount, the pipe will tend to lift from the hanger, and the supporting effect of the hanger will be zero.

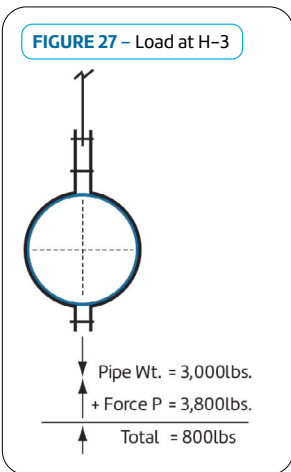


FIGURE 27 – Load at H-3

If the pipe weight for the sample problem had been calculated as 3,000 lb., then the net force is 3,000 lb. - 3,800 lb., or 800 lb. upward, as shown in Figure 27.

The hanger, in this case, would not be considered as a support for the pipe, but a vertical restraint against upward movement. Therefore, either a greater span should be used in order to reduce the force P, or a spring hanger should be used if L-2 is maintained as 13 ft., in order to provide support and allow the piping to move upward at this hanger location. Using the values of L-1 and L-2, as determined in the original problem, the forces P at each hanger are as shown in Figure 28.

The forces at H-1 and H-3 have been discussed in some detail, but it should also be noted that the design load for H-1 should include these forces as well. For this example, the design load for H-2 equals the pipe weight plus 3,800 lb., minus 2,700 lb, or design load = pipe weight load + 1,100 lb.

In the preceding problems, the allowable bending stress due to the restraining effect of the hanger was given as 10,000 psi.

This allowable stress will, of course, vary with the individual case. Where the stress is other than 10,000 psi, use the Chart on page 68 to read the minimum span, and multiply the span in feet by the factor indicated in the

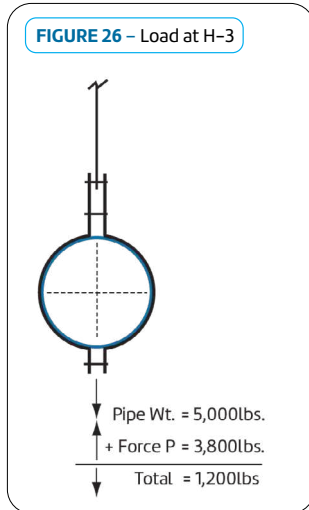


FIGURE 26 – Load at H-3

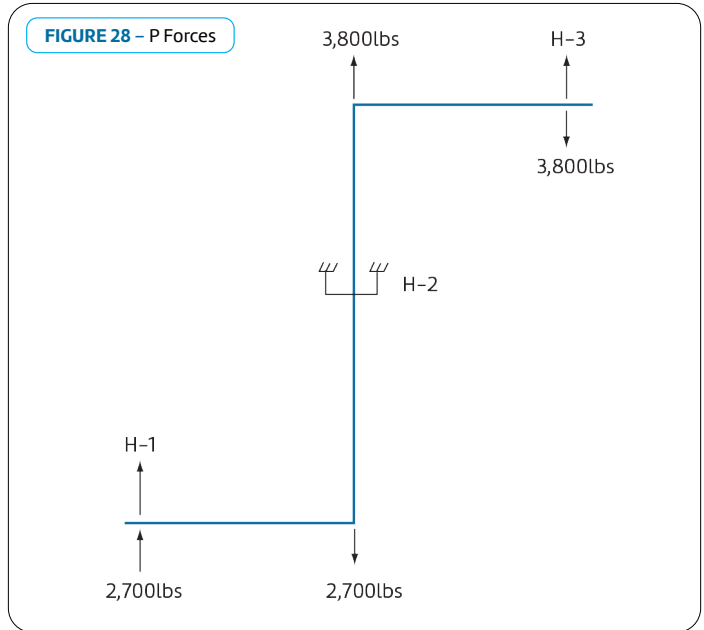


FIGURE 28 – P Forces

Correction Factor for Stresses Other Than 10,000 PSI

| For Bending Stress (PSI) Of: | Multiply Length By: |
|------------------------------|---------------------|
| 2,000 | 2.24 |
| 3,000 | 1.83 |
| 4,000 | 1.58 |
| 5,000 | 1.41 |
| 6,000 | 1.29 |
| 8,000 | 1.12 |
| 10,000 | 1.00 |
| 12,000 | .91 |
| 15,000 | .82 |
| 20,000 | .71 |

Illustrative Example

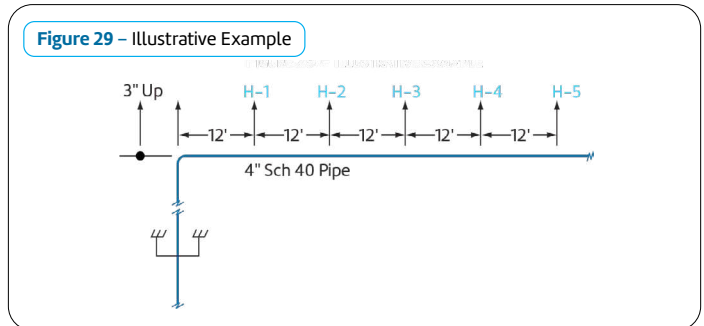


Figure 29 – Illustrative Example

Chart above for the specific stress.

Given:

4in. Sch. 40 pipe, $\Delta = 3$ in., and 3,000 psi maximum bending stress through the restraining effect of the first rigid hanger.

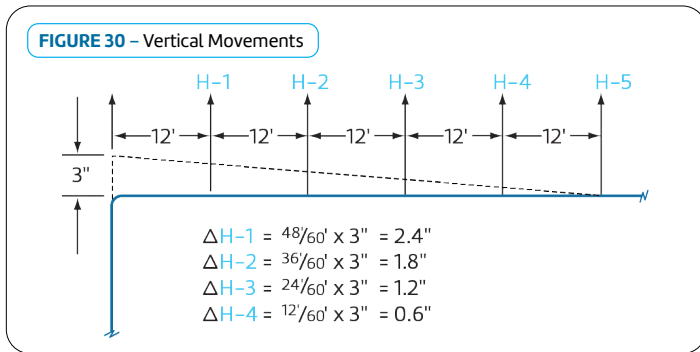
Find:

L, the distance from the riser to the first rigid support.

From the Chart on page 68 using values of 4 in. pipe and 3 in. deflection, read a span of 29 ft. This span is based on a stress of 10,000 psi, and, to correct for 3,000 psi, refer to the correction factor chart on the previous page. For a stress of 3,000 psi, the correction factor for spans is 1.83. Multiplying 2 ft. by 1.83, the span for 4 in. pipe with 3 in. deflection at 3,000 psi is 29 x 1.83, or 53 ft. Thus, L, the minimum distance to the first rigid hanger, is 53 ft.

The first rigid hanger in the above problem will be H-5, located 60 ft. from the riser. The force P required to restrain the piping vertically can be determined from the Chart on page 69 as about 83 lb., using values of 4 in. pipe and a span of 60 ft. The effect of this force will be considered negligible for this problem. The vertical movements at hanger locations between H-5 and the riser are as shown in Figure 30.

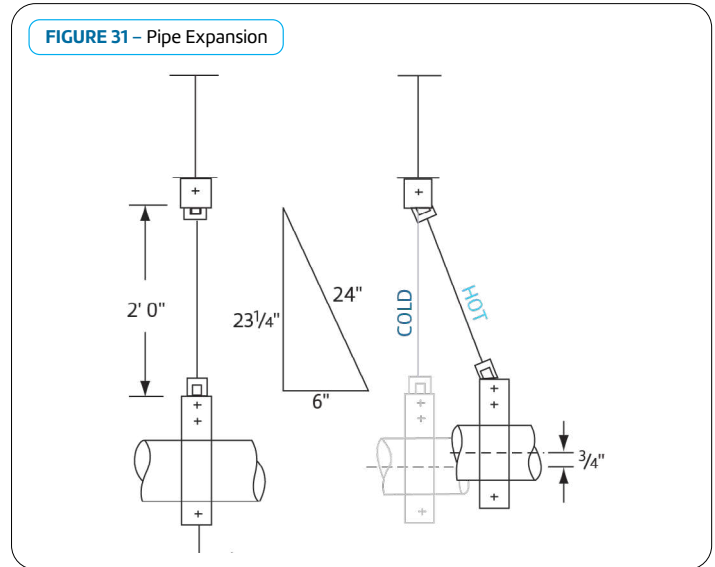
The above results are based on an approximate but conservative analysis. Whenever the appropriate charts are used, the values listed should assist the engineer in arriving at an economical, safe design for any rigid hanger assembly. The examples described represent situations not frequently encountered in pipe support design, but do point out that the rigid hanger in some instances is more than a simple pipe support, and that good design must allow for all applicable conditions.



Rollers

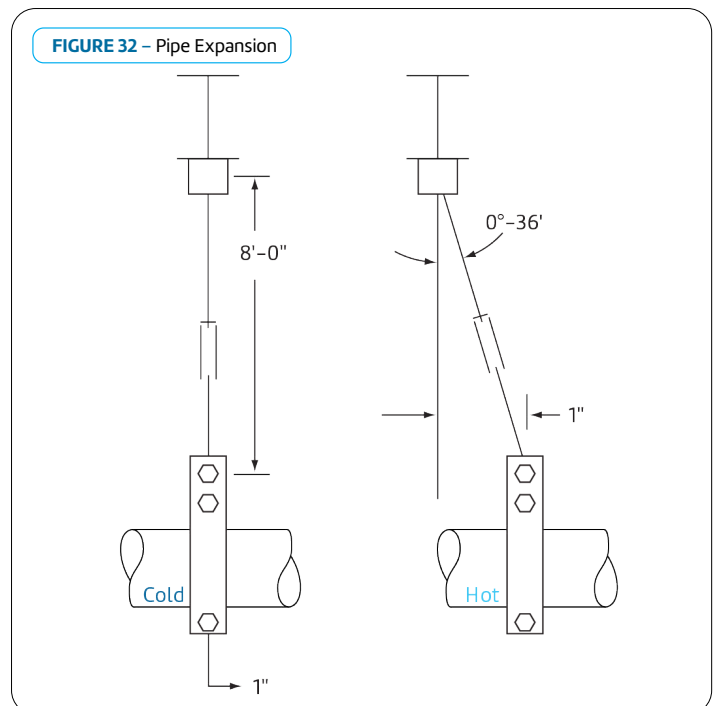
The pipe attachment and structural attachment of a hanger assembly should be such that they will permit the hanger rod to swing to allow for lateral movement of the piping where horizontal pipe expansion is anticipated.

In some instances, where piping expansion is slight and hanger rods are long, the swing permitted by the pivoting of the rod at the upper and lower connections is sufficient, as shown in Figure 31.

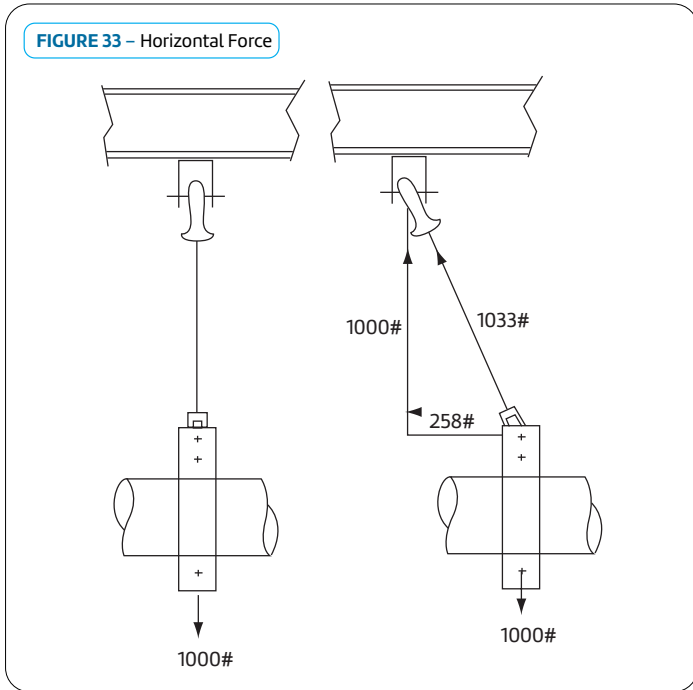


In other instances the angularity caused by the horizontal piping movements can appreciably effect the position of the piping system, and can cause harmful horizontal forces within the piping system.

In Figure 32, note that, because of the large axial piping movement and short hanger rod, the pipe is pulled 3/4 in. off elevation when it expands 6 in. horizontally.

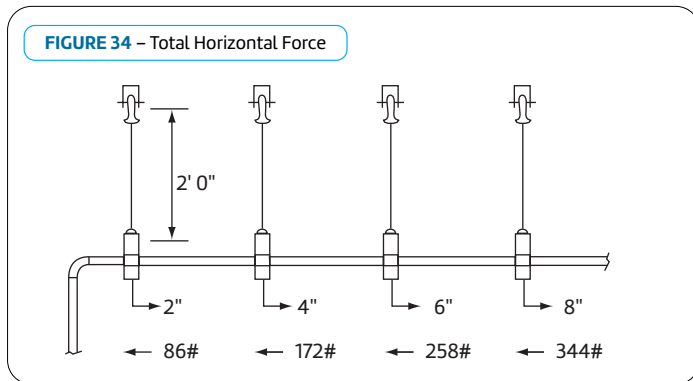


The condition shown in Figure 32 also places a horizontal force component into the piping system. For example, assume a pipe weight of 1000 lb. for the above hanger, as in Figure 33.



The 258 lb. horizontal force by itself may not be of great consequence, but where there is a series of hangers located on the same long section of pipe, the effect of the total horizontal force can be serious. (See Figure 34)

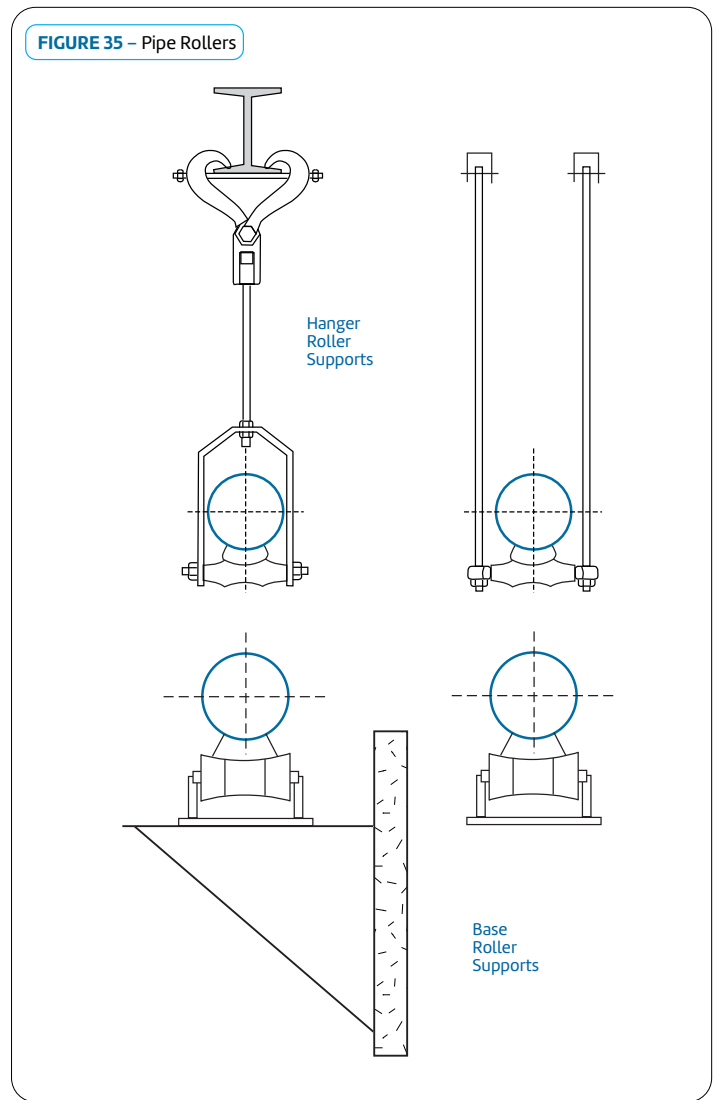
$$\text{Total horizontal force} = 86 + 172 + 258 + 344 = 860 \text{ lb}$$



Certainly, for any system subject to horizontal expansion, the rod angularity from the vertical will result in a horizontal force component. The point where this angularity becomes critical cannot be defined for every case, but accepted practice is to limit the swing from the vertical to 4°.

Where this angle is greater than 4°, a pipe roller should be considered.

Pipe roller supports are of two basic types: those which attach to overhead structure, and those which are placed beneath the pipe as



base supports (see Figure 35).

It should be noted that where rollers are required, the pipe operating temperatures usually are sufficiently high that pipe insulation is used to reduce heat loss and for personnel protection. In these cases a pipe covering protection saddle should be used in conjunction with the rollers to keep the insulation from crushing.

Where the piping is not insulated, the pipe will rest directly on the roller. This is common practice for the support of long transmission lines where the gas or fluid transported is not of elevated operating temperatures, but where the pipe run is subject to some change in ambient temperature, as from summer to winter variances.

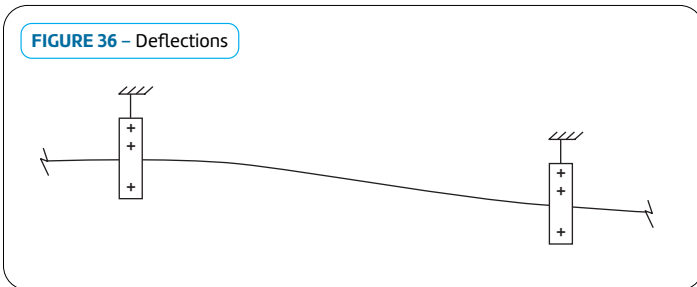
For example, a pipe line 300 ft. long subject to ambient changes from 70° F to 110° F expands only .00306 in./ft. from the low to high temperature. Multiplied by 300 ft., however, the total axial expansion is 300 ft. x .00306 in./ft., or .918 in.

In instances of this nature, rollers will be used, but the pipe covering protection saddles will not be required.

For economy in the support of low pressure, low temperature systems, and long outdoor transmission lines, hanger spans may be based on the allowable total stresses of the pipe and the amount of allowable deflection between supports.

In steam lines with long spans the deflection caused by the weight of the pipe may be large enough to cause an accumulation of condensate at the low points of the line. Water lines, unless properly drained, can be damaged by freezing. These conditions can be avoided by erecting the line with a downward pitch in such a manner that succeeding supports are lower than the points of maximum deflection in preceding spans as shown in Figure 36.

The stresses indicated in the Chart on page 66 and the Chart on page 67 are bending stresses resulting from the weight of the pipe between supports. It should be realized that this stress must be considered with other stresses in the piping, such as those due to the pressure of the fluid within the pipe, the bending and torsional stresses resulting from thermal expansion, etc., in order to design the system for total allowable stress.



The stresses and deflections indicated in the Charts on pages 66, 67 and 68 are based on a single span of pipe with free ends, and make no allowances for concentrated loads of valves, flanges, etc., between hangers.

The stress and deflection values shown in the Charts on pages 66, 67 and 68 are based on a free end beam formula and reflect a conservative analysis of the piping. Actually, the pipe line is a continuous structure partially restrained by the pipe supports, and the true stress and deflection values lie between those calculated for the free end beam and a fully restrained structure.

The deflections and bending stress values indicated represent safe values for any schedule pipe from Sch. 10 to XS pipe.

For fluids other than water, the bending stress can be found by first finding the added stress caused by water from the Charts on pages 68 and 69 and multiplying by the specific gravity of the fluid. Add this to the stress value of the pipe empty.

For lines which are thickly insulated, find the deflection or bending stress resulting from the weight of pipe bare and multiply by a ratio of the weight of pipe per foot plus insulation to the weight of bare pipe per foot. To illustrate the use of the deflection and stress charts, consider the following examples:

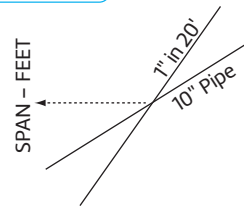
Problem:

Find: The maximum economical hanger spacing for a 10 in. non-insulated steam transmission line, 1,200 ft. long, which will provide sufficient drainage with minimum deflection within an allowable bending stress limit of 10,000 psi. The maximum difference in elevations of the ends of the line is 5ft.

Solution:

$$\text{Maximum Slope} = \frac{(5 \text{ ft.} \times 12 \text{ in./ft.})}{1,200 \text{ ft.}} = 1 \text{ in./20 ft.}$$

FIGURE 37 – Determination of Span



From the Chart on page 68 find the intersection of the Curve 1 in. in 20 ft., and 10 in. nominal pipe size. Read left to find the allowable pipe span of 40 ft. From the Chart on page 69, the bending stress for 10 in. pipe with a support span of 40 ft. is 3,250 psi, which is below the allowable 10,000 psi.

Answer:

Span = 40 ft .

Problem:

Find: The maximum economical spacing to provide sufficient drainage for an 8 in. water filled line 600 ft. long. The allowable bending stress is 6,000 psi, and the difference in elevations between the ends of the pipe line is 5 ft.

Solution:

$$\text{Maximum Slope} = \frac{(5 \text{ ft.} \times 12 \text{ in./ft.})}{600 \text{ ft.}} = 1 \text{ in./10}$$

From the Chart on page 68, find the intersection of the curve 1 in. in 10 ft. and 8 in. pipe, and read left to a span of 43 ft. From the Chart on page 69, for an 8 in. water filled line with a support span of 43 ft., the bending stress is 8,300 psi, which is greater than the allowable 6,000 psi. Therefore, the maximum span should be based on the allowable bending stress of 6,000 psi. Referring to the Chart on page 66, the maximum span for 8 in. pipe and an allowable bending stress of 6000 psi is 37 ft.

Answer:

Span = 37 ft

Problem:

Find: The maximum spacing and slope for a 6 in. water filled line where the allowable bending stress is 10,000 psi. The difference in the elevations of the ends of the system is not limited.

From the Chart on page 68, the maximum span for a 6 in. water filled line with an allowable bending stress of 10,000 psi is 42 ft.

On the Chart on page 69 read from the 42 foot span value to the 6in. pipe curve. Interpolating between the slope curves 1 in. in 10 ft. and 1 in. in 5 ft., read the slope 1 in. in 6 ft.

Answer:

Span = 42 ft

Pipe is sloped at 1 in. in 6 ft. (A difference in elevation of 7 in. between supports.)

1 Scope

This specification shall apply for the design and fabrication of all hangers, supports, anchors, and guides. Where piping design is such that exceptions to this specification are necessary, the particular system will be identified, and the exceptions clearly listed through an addendum which will be made a part of the specification.

2 Design

- a All supports and parts shall conform to the latest requirements of the ASME Code for Pressure Piping B31.1.0, and MSS Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.
- b Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible.
- c Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.
- d Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being introduced into the or connected equipment.
- e Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- f For critical high-temperature piping, at hanger locations where the vertical movement of the piping is $\frac{1}{2}$ in. or more, or where it is necessary to avoid the transfer of load to adjacent hangers or connected equipment, pipe hangers shall be an approved constant support design, as Anvil Figure 80-V and Figure 81-H where transfer of load to adjacent hangers or equipment is not critical, and where the vertical movement of the piping is less than $\frac{1}{2}$ in., variable spring hangers may be used, provided the variation in supporting effect does not exceed 25% of the calculated piping load through its total vertical travel.
- g The total travel for constant support hangers will be equal to actual travel plus 20%. In no case will the difference between actual and total travel be less than 1 in. The constant support hanger will have travel scales on both sides of the support frame to accommodate inspections.
- h Each constant support hanger should be individually calibrated before shipment to support the exact loads specified. The calibration record of each constant support shall be maintained for a period of 20 years to assist the customer in any redesign of the piping system. Witness marks shall be stamped on the Load Adjustment Scale to establish factory calibration reference point.
- i In addition to the requirements of ASTM A-125 all alloy springs shall be shot peened and examined by magnetic particle. The spring rate tolerance shall be $\pm 5\%$. All three critical parameters (free height, spring rate and loaded height) of spring coils must be purchased with a C.M.T.R. and be of domestic manufacturer.
- j Constant supports should have a wide range of load adjustability. No less than 10% of this adjustability should be provided either side of the calibrated load for plus or minus field adjustment. Load adjustment scale shall be provided to aid the field in accurate adjustment of loads. Additionally, the constant support should be designed so that the load adjustments can be made without use of special tools and not have an impact on the travel capabilities of the supports.
- k Constant supports shall be furnished with travel stops which shall prevent upward and downward movement of the hanger. The travel stops will be factory installed so that the hanger level is at the "cold" position. The travel stops will be of such design as to permit future re-engagement, even in the event the lever is at a position other than "cold", without having to make hanger adjustments.
- l For non-critical, low temperature systems, where vertical movements up to 2 in. are anticipated, an approved pre-compressed variable spring design similar to Anvil Figure B268 may be used. Where the vertical movement is greater than 2 in., a variable spring hanger similar to Anvil Figure 98 may be used. Where movements are of a small magnitude, spring hangers similar to Anvil Figure 82 may be used.
- m Each variable spring shall be individually calibrated at the factory and furnished with travel stops. Spring coils must be square to within 1° to insure proper alignment. Each spring coil must be purchased with a C.M.T.R. and be of domestic manufacture.
- n All rigid rod hangers shall provide a means of vertical adjustment after erection.
- o Where the piping system is subject to shock loads, such as seismic disturbances or thrusts imposed by the actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices of approved design, such as Anvil Figure 200 shock and sway suppressor.
- p Selection of vibration control devices shall not be part of the standard hanger contract. If vibration is encountered after the piping system is in operation, appropriate vibration control equipment shall be installed.
- q Hanger rods shall be subject to tensile loading only (see Table III, Page 38). At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- r Where horizontal piping movements are greater than $\frac{1}{2}$ in. and where as the hanger rod angularity from the vertical is less than or equal to 4° from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such manner that the rod is vertical in the hot position. When the hanger rod angularity is greater than 4° from vertical, then structural attachment will be offset so that at no point will the rod angularity exceed 4° from vertical.
- s Hangers shall be spaced in accordance with Tables I and II (Shown to the right).
- t Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp lugs. Welded attachments shall be of material comparable to that of the pipe, and designed in accordance with governing codes.



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- U** Supports, guides, and anchors shall be so designed that excessive heat will not be transmitted to the building steel. The temperature of supporting parts shall be based on a temperature gradient of 100°F per 1 in. distance from the outside surface of the pipe.
- V** Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.
- W** **Hydraulic Snubbers** — The hydraulic units shall have a temperature stable control valve. The valve shall provide a locking and bleed rate velocity that provides for tamper proof settings. The fluid system shall utilize a silicone fluid with proven compatible seals made of approved compounds. The reservoir shall provide a fluid level indicator for exact reading of reservoir fluid level in any snubber orientation.

The valve device shall offer a minimum amount of resistance to thermal movement. Any shock force shall cause the suppressor valve to close. With the suppressor valve closed the fluid flow shall essentially stop, thereby causing the unit to resist and absorb the disturbing forces. After the disturbing forces subside the suppressor valve shall open again to allow free thermal movement of the piping. The suppressor shall have a means of regulating the amount of movement under shock conditions up to the design load for faulted conditions without release of fluid. The suppressor design shall include a fluid bleed system to assure continued free thermal movement after the shock force subsides. The suppressor shall have a hard surfaced, corrosion resistant piston rod supported by a bronze rod bushing. The assembly shall have self-aligning lubricated bushings and shall be designed so that it is capable of exerting the required force in tension and compression, utilizing the distance.

- Y** **Paint** — Variable spring and constant support units will be furnished prime painted. All other material will receive one shop coat of a red chromate primer meeting the requirements of Federal Specification TTP-636. For corrosive conditions, hangers will be galvanized or painted with Garbo-Zinc #11.

1 Hanger Design Service

Hangers for piping 2½ in. and larger, and all spring support assemblies, shall be completely engineered.

- a** Engineered hanger assemblies shall be detailed on 8½ in. x 11 in. sheets. Each sketch will include a location plan showing the location of the hanger in relation to columns of equipment. Each sketch will include an exact bill of material for the component parts making up each assembly.
- b** Each engineered hanger assembly will be individually bundled and tagged as far as practical, ready for installation. Hanger material for piping 2 in. and smaller shall be shipped as loose material, identified by piping system only. A piping drawing marked with approximate hanger locations and types, and hanger sketches showing typical support arrangements will be furnished.
- c** Hanger inspections shall be performed in accordance with MSS-SP89 (Section 7.7) and ASME B31.1 (Appendix V)

Table I Maximum Horizontal Spacing Between Pipe Supports for Standard Weight Steel Pipe

| Nom. Pipe Size (In.) | ½ | ¾ | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
|---------------------------------|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Max Span, Water Serv. (ft.) --> | 7 | 7 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 19 | 22 | 23 | 24 | 27 | 28 | 30 | 32 |
| Max Span, Vapor Serv. (ft.) --> | 8 | 9 | 9 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 21 | 24 | 26 | 30 | 32 | 35 | 37 | 39 | 42 |

Table II Maximum Horizontal Spacing Between Copper Tubing Supports

| Nom. Pipe Size (In.) | ½ | ¾ | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
|---------------------------------|---|---|---|----|----|----|----|----|----|
| Max Span, Water Serv. (ft.) --> | 7 | 7 | 7 | 9 | 10 | 11 | 12 | 13 | 14 |
| Max Span, Vapor Serv. (ft.) --> | 8 | 9 | 9 | 12 | 13 | 14 | 15 | 16 | 17 |



Field Engineering Walkdowns

Critical piping systems shall be observed visually, as frequently as deemed necessary, and any unusual conditions shall be brought to the attention of the operating company. Only qualified and trained personnel shall be utilized for these observations. Observations shall include determination of interferences with or from other piping or equipment, vibrations, and general condition of the supports, hangers, guides, anchors, supplementary steel, and attachments, etc.

Hanger position scale readings of variable and constant support hangers shall be determined periodically. It is recommended that readings be obtained while the piping is in its fully hot position, and if practical, when the system is reasonably cool or cold sometime during the year as permitted by plant operation. Pipe temperature at time of reading hangers shall be recorded.

Variable and constant support hangers, vibration control devices, shock suppressors, dampeners, slide supports and rigid rod hangers shall be maintained in accordance with the limits specified by the manufacturers and designers. Maintenance of these items shall include, but not necessarily be limited to, cleaning, lubrication and corrosion protection.

Pipe location readings and travel scale readings of variable and constant support hangers shall be recorded on permanent log sheets in such a manner that will be simple to interpret. Records of settings of all hangers shall be made before the original commercial operation of the plant and again after startup.

After visually observing piping, hangers, and supports, repairs and/or modifications are to be carried out by qualified maintenance personnel for all of the following items:

- a Excessively corroded hangers and other support components
- b Broken springs or any hardware item which is part of the complete hanger or support assembly
- c Excessive piping vibration; valve operator shaking or movements
- d Piping interferences
- e Excessive piping deflection which may require the installation of spring units having a greater travel range
- f Pipe sagging which may require hanger adjustment or the reanalysis and redesign of the support system
- g Hanger unit riding at either the top or the bottom of the available travel
- h Need for adjustment of hanger load carrying capacity
- i Need for adjustments of hanger rods or turnbuckle for compensation of elevation changes
- j Loose or broken anchors
- k Inadequate clearances at guides
- l Inadequate safety valve vent clearances at outlet of safety valves

- m Any failed or deformed hanger, guide, U-bolt, anchor, snubber, or shock absorber, slide support, dampener, or supporting steel
- n Leaks at flanges, valve bonnets and valve stems
- o Excessively corroded valves
- p Defective traps, separators, strainers, silencers, flexible hose, flexible fittings, and water level gage glasses
- q Unacceptable movements in expansion joints

The use of photographs can be an important tool in recording piping systems, hangers and supports. These can be stored with the other records and are beneficial for future reference and will establish a system history for future reference. Each plant should maintain and file the following documentation that exists for each unit:

- a Current piping drawings
- b Construction isometrics
- c Pipeline specifications covering material, outside diameter, and wall thickness
- d Flow diagrams
- e Support drawings
- f Support setting charts
- g Records of any piping system modifications



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Nuclear Pipe Supports

Nuclear pipe support design has evolved from a relatively simple design-by-rule approach to a complex design-by-analysis approach. Pipe support design has presented some major challenges for the nuclear power industry. The ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NF, "Component Supports", contains very detailed requirements for nuclear pipe supports. The NF Code contains requirements for material design, fabrication and installation, examination, nameplates, stamping, and reports. The principal differences between nuclear and non-nuclear pipe supports lie in the more sophisticated and demanding design, analysis, additional non-destructive examination (NDE), quality assurance, and Code inspection and stamping. However, the type of pipe supports and materials used for nuclear pipe supports are essentially the same as those used for nonnuclear.

The design of nuclear pipe supports is dependent upon a piping analysis which provides the appropriate support loading and displacements. The pipe support designer/analyst must be aware of specific assumptions that the piping analyst used in performing the piping analysis. Typical assumptions are:

- 1 No excessive support mass on pipe;
- 2 Support is provided in directions shown with type support shown;
- 3 Support is sufficiently rigid to permit decoupling of the analysis of the support from the pipe;
- 4 Support allows for essentially unrestricted movement in the unsupported direction.

Seismic Supports

The following is for reference only. Refer to MSS-SP127 for detailed requirements). Seismology and its effect on building structures, components and attachments affect almost every building code and standard. Increasingly, codes and standards are requiring seismic restraints in critical areas. There are several codes and standards across the country that contain entire sections devoted to seismic restraints and bracing. Some of the more common codes are the Uniform Building Code 1991 and the 1991 California Building Standard Code (CAC Title 24, Part II).

The progressive CAC Title 24 states in Section 2330 (a):

"Every building or structure and every portion thereof, including the nonstructural components, shall be designed and constructed to resist stresses and limit deflections calculated on the basis of dynamic analysis or equivalent static lateral forces analysis ..."

It continues in Section 2336 (a)

"Parts and portions of structure and their attachments, permanent nonstructural components and their attachments, and the attachments for permanent equipment supported by a structure shall be designed to resist the total design lateral seismic force, F_p , given by the following formula:

$F_p = Z \times I \times C_p \times W_p$, Where:

F_p = Total Design Lateral Seismic Force.

Z = Seismic Zone Factor, Numerical Coefficient as shown in Table 23-1 and derived from Seismic Zones Map on Page 27.

I = Importance Factor, as shown on Table No. 23-L and derived from Occupancy Categories shown on Table No. 23-K.

C_p = Horizontal Force Factor ("... conduit, ductwork and piping ..." has a C_p of 0.75 per the CAC Title 24 and a C_p of 0.45 per the 1991 Uniform Building Code).

Nuclear pipe supports are designed to the same loadings that fossil power plants experience, i.e., thermal, deadweight, thermal equipment displacement loadings, and operating loadings, including turbine trip, rapid valve closure, etc. In addition to these normal loadings, nuclear power plants require detailed analysis for seismic loadings on the piping system. This detailed seismic requirement results in the significant difference between the design of nuclear pipe support versus a conventional power plant.

The seismic requirement resulted in piping systems which were considerably stiffer when compared to similar systems without seismic requirements. This was the direct result of providing additional lateral and vertical restraints to resist the seismic loadings on the piping system. The additional restraints reduced seismic stresses, but resulted in increased thermal stresses. To minimize this impact, pipe snubbers were utilized in piping systems. Snubbers are devices which are essentially only active during an earthquake or other dynamic event and offer little resistance to the slow pipe movement resulting from thermal growth. Although snubbers have seen limited use in conventional plants, their primary use was in nuclear facilities. Since the use of snubbers requires a significant amount of functional testing and inspection, their use has been considerably reduced. In addition, most nuclear plants have initiated programs to eliminate as many snubbers as possible. Although the use of snubbers should generally be avoided, they may, in certain circumstances, present the most simple and cost effective solution.

W_p = Weight of Element or Component (Weight of pipe, ductwork and conduit)

The following conduit, ductwork and piping do NOT require bracing per CAC Title 24, Part II: Table No. 23-P, note 12.

- a Gas piping less than 1 in. diameter.
- b Piping in boiler and mechanical equipment rooms less than 1.25 in. inside diameter.
- c All piping less than 2.5 in. inside diameter.
- d All piping suspended by individual hangers 12 in. or less in length from the top of pipe to the bottom of the support for the hanger.
- e All electrical conduit less than 2.5 in. inside diameter.
- f All rectangular air-handling ducts less than 6 sq. ft. in cross-sectional area.
- g All round air handling ducts less than 28 in. diameter.
- h All ducts suspended by hangers 12 in. or less in length from the top of the duct to the bottom of the support for the hanger.



Table 23K Occupancy Categories

(I) Essential Facilities (Essential facilities are those structures which are necessary for the emergency operations subsequent to a natural disaster.)

- Hospitals and other medical facilities having surgery and emergency treatment areas.
- Fire, Sheriff and Police Stations
- Municipal, county and state government disaster operation and communication centers deemed vital in emergencies.
- Tanks of other structures containing, housing or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities, or special occupancy structures.
- Emergency vehicle shelters and garages.
- Standby power-generating equipment for essential facilities.

(II) Hazardous Facilities

- Structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of general public if released.

(III) Special Occupancy Structure

- Covered structures whose primary occupancy is public assembly - capacity \geq 300 persons.
- Buildings for schools through secondary or day-care centers - capacity \geq 250 students.
- Buildings for colleges or adult education schools - capacity \geq 500 students.
- Medical facilities with 50 or more resident incapacitated patients, not included above.
- Jails and detention facilities.
- All structures with occupancy \geq 5,000 persons.
- Structures and equipment in power-generating stations and other public utility facilities not included above, and required for continued operation.

(IV) Standard Occupancy Structure

- All structures having occupancies or functions not listed above.

**Table 23-L Earthquake Importance Factor (I),
Based on Occupancy Category**

| Occupancy Category | 1991 Uniform Building Code | CAC Title 24 |
|-----------------------------------|----------------------------|--------------|
| I. Essential Facility | 1.25 | 1.50 |
| II. Hazardous Facilities | 1.25 | 1.50 |
| III. Special Occupancy Structures | 1.00 | 1.15 |
| IV. Standard Occupancy Structures | 1.00 | 1.00 |

Table 23-I Seismic Zone Factor "Z"

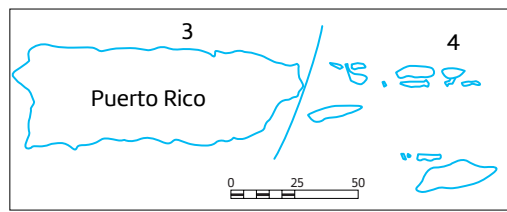
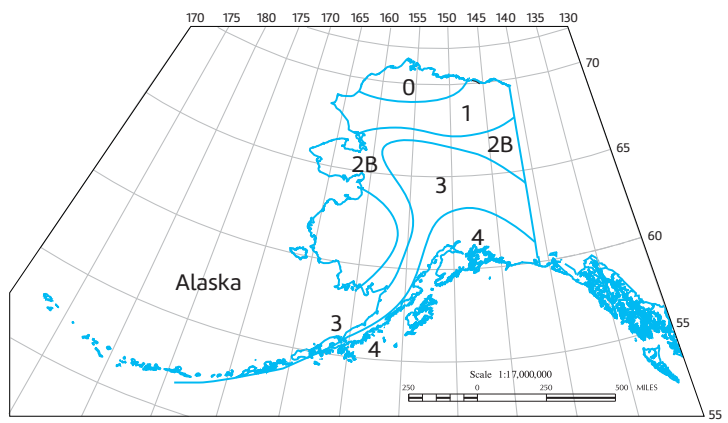
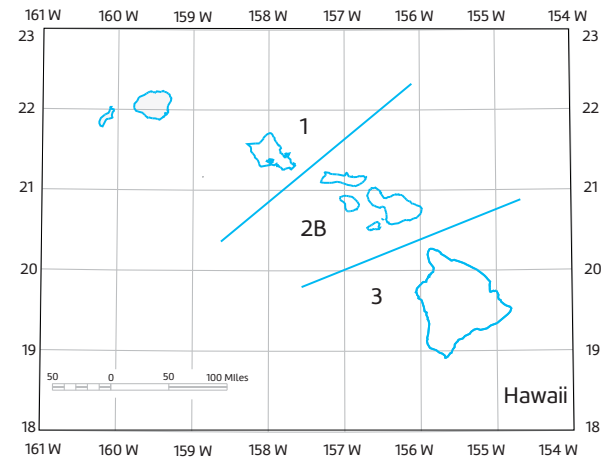
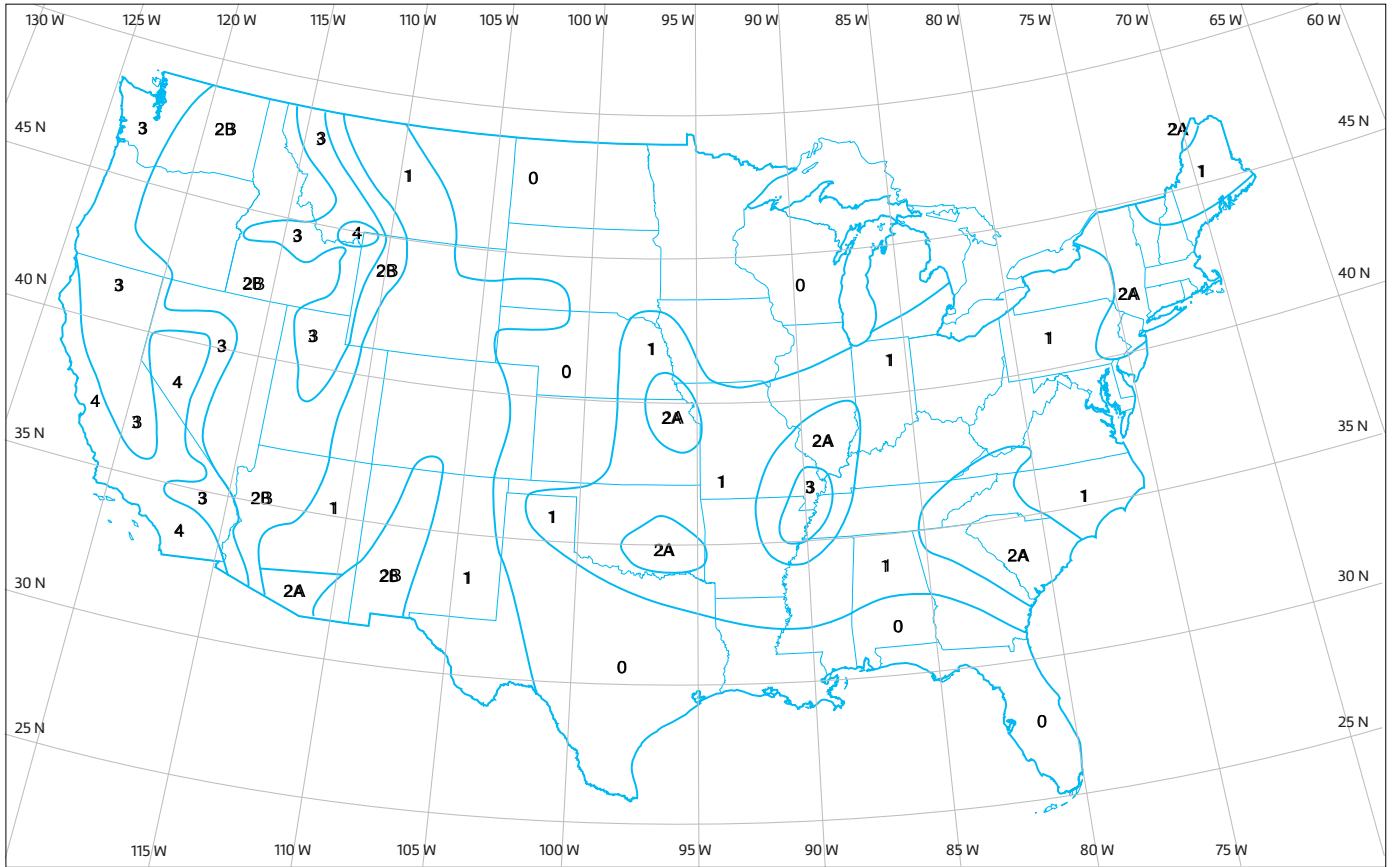
| Zone ----> | 1 | 2A | 2B | 3 | 4 |
|-------------------|-------|------|------|------|------|
| Zone Factor ----> | 0.075 | 0.15 | 0.20 | 0.30 | 0.40 |

Refer to zone map on the following page for general information purposes, or visit <http://www.eqhazmaps.usgs.gov> for current seismic zone information.



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The maps shown above are for general information purposes, please visit <http://www.earthquake.usgs.gov/hazmaps/> for current seismic zone information.

1994 Uniform Building Code zone map. Zones are identified by the numbers from 0 to 4.

Seismic zone factors are assigned to each zone; Zone 0 = 0, Zone 1 = 0.075, Zone 2A = 0.15, Zone 2B = 0.20, Zone 3 = 0.3, and Zone 4 = 0.4.

Each zone also has specific structural detailing requirements.



Pipe Supports – Grooved Piping

When designing the hangers, supports and anchors for a grooved end pipe system, the piping designer must consider certain unique characteristics of the grooved type coupling in addition to many universal pipe hanger and support design factors. As with any pipe system, the hanger or support system must provide for

- 1 The weight of the pipe, couplings, fluid and pipe system components;
- 2 Reduce stresses at pipe joints; and
- 3 Permit required pipe system movement to relieve stress.
The following special factors should be considered when designing hangers and supports for a grooved end pipe system.

Pipe Hanger Spacing

The following charts show the maximum span between pipe hangers for straight runs of standard weight steel pipe filled with water or other similar fluids.

Do not use these values where critical span calculations are made or where there are concentrated loads between supports.

Pipe Hanger Spacing for Straight Runs without Concentrated Loads and Where Full Linear Movement IS NOT Required

| Nominal Pipe Size Range | Max. Span Between Hangers |
|-------------------------|---------------------------|
| ¾"-1" | 7' |
| 1¼"-2" | 10' |
| 2½"-4" | 12' |
| 5"-8" | 14' |
| 10"-12" | 16' |
| 14"-16" | 18' |
| 18"-24" | 20' |

Pipe Hanger Spacing for Straight Runs without Concentrated Loads and Where Full Linear Movement IS Required

| Nominal Pipe Size Range | Pipe Length in Feet | | | | | | | | | |
|-------------------------|--------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | *Average Hangers per Pipe Length (Evenly Spaced) | | | | | | | | | |
| | 7' | 10' | 12' | 15' | 20' | 22' | 25' | 30' | 35' | 40' |
| ¾"-1" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 1¼"-2" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 2½"-4" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 5"-8" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 10"-12" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 14"-16" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 18"-24" | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |

* No pipe length should be left unsupported between any two couplings.

Coupling Flexibility

The grooved coupling's capability to allow angular and rotational movement within the coupling joint must be considered when deciding hanger and support locations. Spring hangers and supports providing for movement in more than one plane are often used to allow the pipe system to move without introducing additional stress into the pipe system.

FIGURE 38 – Sag Due to Flexibility

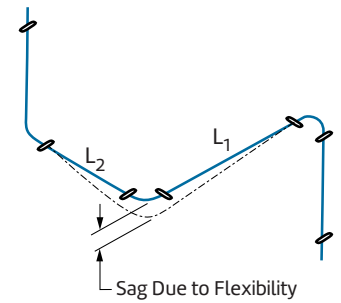
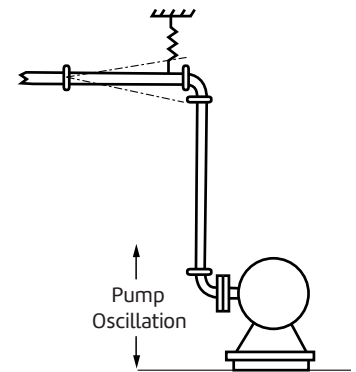


Figure 38 demonstrates the need for each pipe length in a grooved system to be supported. The sag due to the flexibility of the Gruvlok joint could be eliminated with the proper positioning of hangers on both "L1" and "L2".

Figure 39 illustrates the effect of pump oscillation on a piping system.

A spring hanger should be used to support the pipe section and also respond to the induced vibrations. The couplings in the horizontal run above the riser, should accommodate the deflection without transmitting bending stresses through the pipe system.

FIGURE 39 – Pump Oscillation



Pressure Thrusts

Gruvlok couplings react to the application of system pressure and restrain the pipe ends from separation due to the pressure force. However, the coupling joint may not be in the self-restraining configuration prior to the application of system pressure. The Gruvlok coupling does not restrain adjacent pipe sections from separation due to pressure forces until the coupling key sections engage the groove walls.

Random coupling joint installation will produce installed coupling conditions ranging from pipe ends fully butted to fully separated to the maximum available gap. Thus, only after system pressurization will the self-restraining function of the coupling be in effect.

The designer must account for the movement to be encountered when the system is pressurized and the joints are fully separated. Anchor and guide positions must be defined to direct the pipe joint movement such that it is not detrimental to the pipe system.

The effect of pressure thrust are shown in the following examples.



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FIGURE 40 – Pressure Thrust

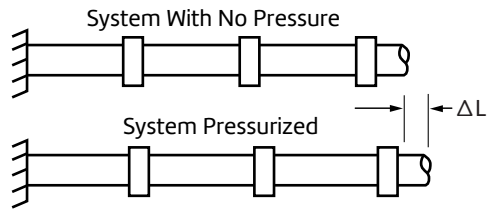


Figure 40 – The coupling joints have been installed butted or partially open. When pressurized the pipe ends in the coupling joints will separate to the maximum amount permitted by the coupling design.

The coupling key sections will make contact with the groove walls and restrain the pipe from further separation.

The movement at each coupling joint will add with all other joints and produce ΔL .

Figure 41 – In the system shown here, the pipe will move and deflect at the elbow joint due to pressure thrust. The pipe designer must assure himself that the system has the capability of deflecting sufficiently to absorb this movement without introducing additional stresses into the pipe system. In the deflected condition shown, temperature increases would produce further expansion of the pipe system thus increasing the deflection.

FIGURE 41 – Pressure Thrust

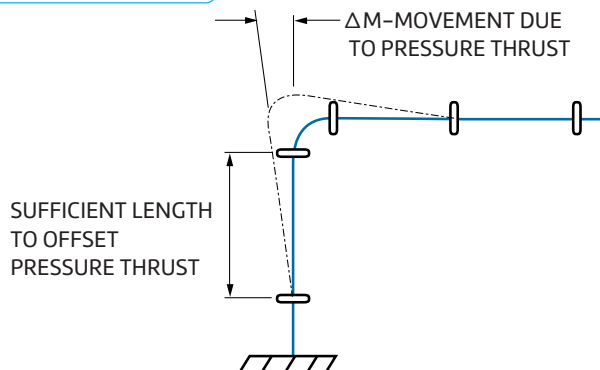


FIGURE 42 – Pressure Thrust

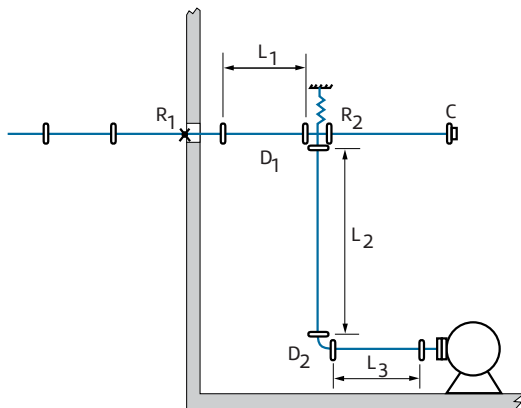


Figure 42 – To restrain this system provide a pressure thrust anchor at "R1" to resist the pressure thrust acting through the tee "D1" at the cap "C". Provide a hanger at Point "R2", or a base support at Point "D2" to support the vertical column. If the offsets L1, L2, and L3 are of adequate length to handle expected pipe movements, no additional anchoring is required. Thermal movement of the pipe system should also be considered, and intermediate anchors located as required, to direct the pipe movement so as to prevent introducing bending stresses into the system.

FIGURE 43 – Lateral Restraint

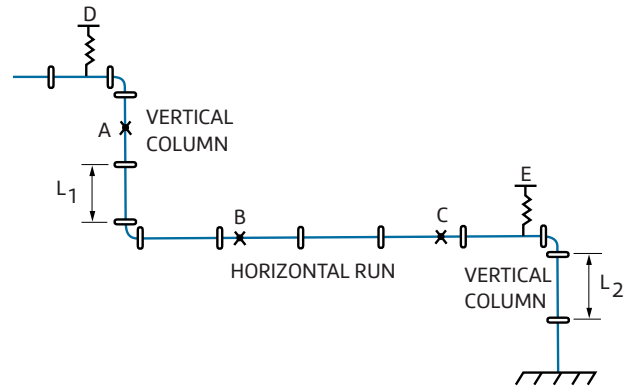


Figure 43 – Anchor at "A" to support weight of vertical water column. Use spring hanger at "D" and "E" to allow movement of vertical piping.

Anchors at "B" and "C" if offsets at L1 and L2 are insufficiently long to handle expected pipe movements.

FIGURE 44 – Lateral Restraint

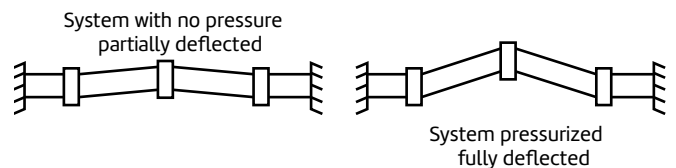


Figure 44 [Lateral Restraint] – A grooved coupling joint installed in a partially deflected condition between anchor locations will deflect to its fully deflected condition when pressurized. Hangers and supports must be selected with consideration of the hanger's capability to provide lateral restraint.

Light duty hangers, while acceptable in many installations, may deflect against the application of lateral forces and result in "snaking" conditions of the pipe system.



Riser Design

Risers assembled with Gruvlok couplings are generally installed in either of two ways. In the most common method, the pipe ends are butted together within the coupling joint. Note that when installing risers, the gasket is first placed onto the lower pipe and rolled back away from the pipe end prior to positioning the upper pipe. Anchoring of the riser may be done prior to pressurization with the pipe ends butted or while pressurized, when, due to pressure thrust, the pipe ends will be fully separated. An alternative method of riser installation is to place a metal spacer of a predetermined thickness, between the pipe ends when an additional length of pipe is added to the riser stack. The upper pipe length is anchored, the spacer removed and the coupling is then installed. This method creates a predetermined gap at each pipe joint which can be utilized in pipe systems where thermal movement is anticipated and in systems with rigid (threaded, welded, flanged) branch connections where shear forces due to pressure thrust could damage the rigid connections.

The following examples illustrate methods of installing commonly encountered riser designs.

Risers without Branch Connections

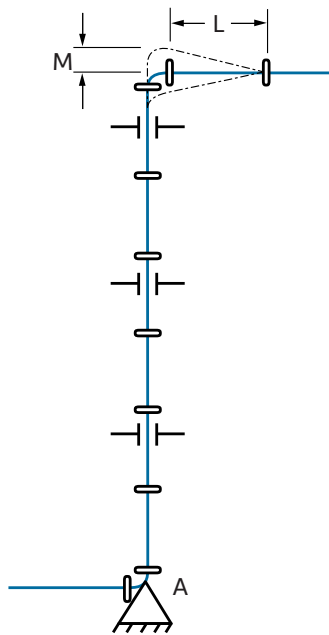
Install the riser with the pipe ends butted.

Locate an anchor at the base of the riser (A) to support the total weight of the pipe, couplings and fluid. Provide pipe guides on every other pipe length, as a minimum, to prevent possible deflection of the pipe line at the coupling joints as the riser expands due to pressure thrust or thermal growth. Note that no intermediate anchors are required.

When the system is pressurized the pipe stack will "grow" due to pressure thrust which causes maximum separation of pipe ends within the couplings. The maximum amount of stack growth can be predetermined (see Linear Movement).

In this example the pipe length "L" at the top of the riser must be long enough to permit sufficient deflection (see Angular Movement) to accommodate the total movement "M" from both pressure thrust and thermal gradients.

FIGURE 45 – Riser without Branch Connections



Risers with Branch Connections

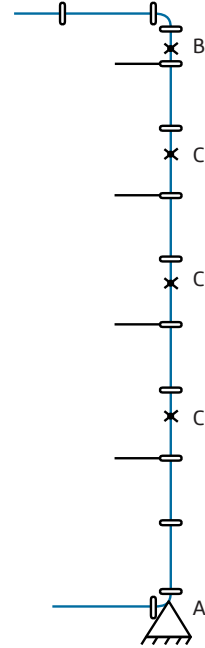
Install the riser with the predetermined gap method.

Anchor the pipe at or near the base with a pressure thrust anchor "A" capable of supporting the full pressure thrust, weight of pipe and the fluid column. Anchor at "B" with an anchor capable of withstanding full pressure thrust at the top of the riser plus weight of pipe column.

Place intermediate anchors "C" as shown, between anchors "A" and "B". Also place intermediate clamps at every other pipe length as a minimum.

When this system is pressurized, the pipe movement due to pressure thrust will be restrained and there will be no shear forces acting at the branch connections.

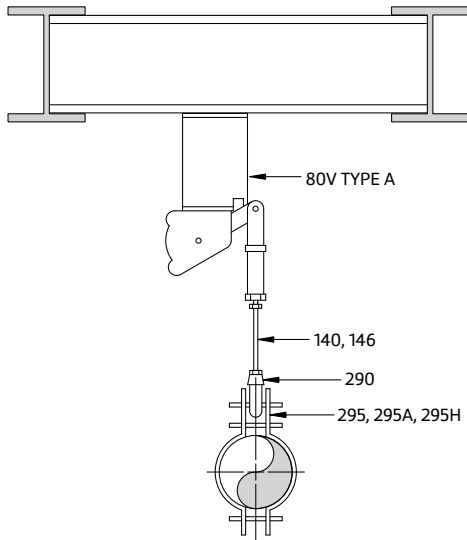
FIGURE 46 – Riser with Branch Connections



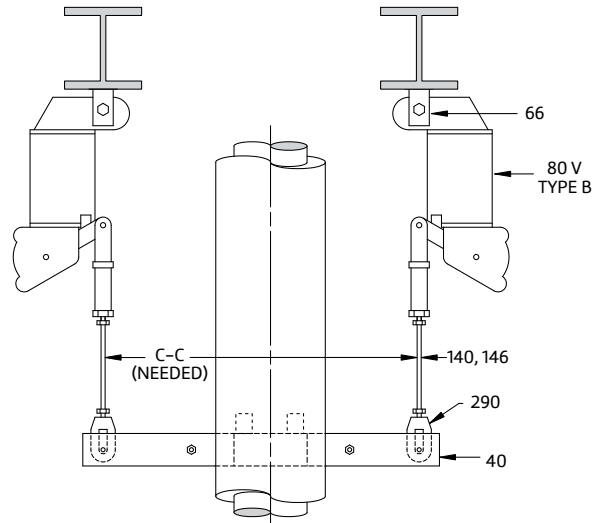
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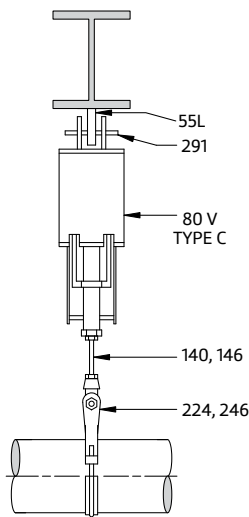
Constant Hanger Assemblies



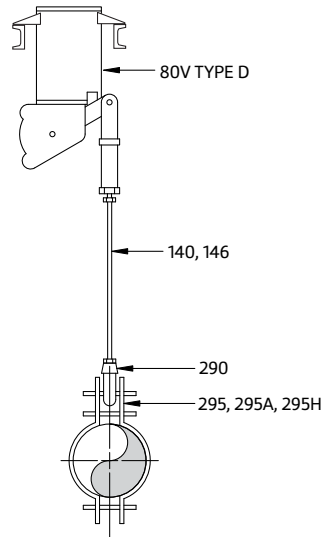
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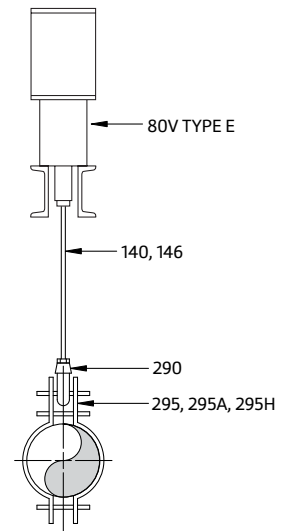
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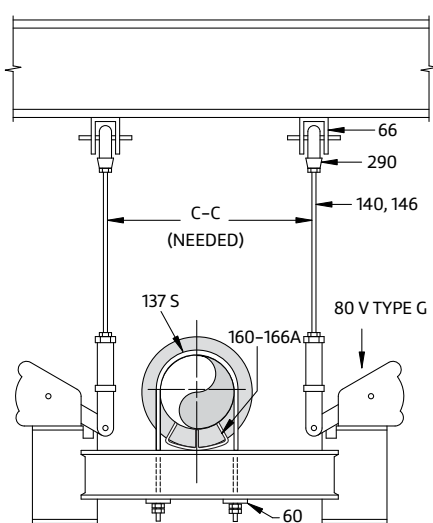
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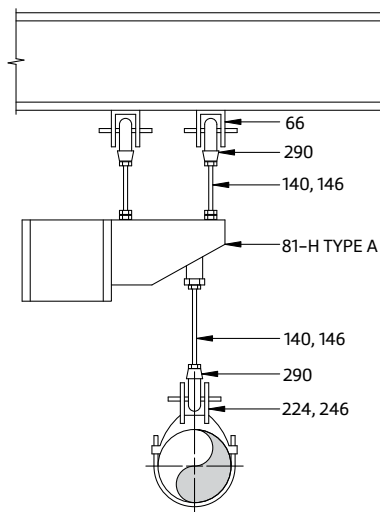
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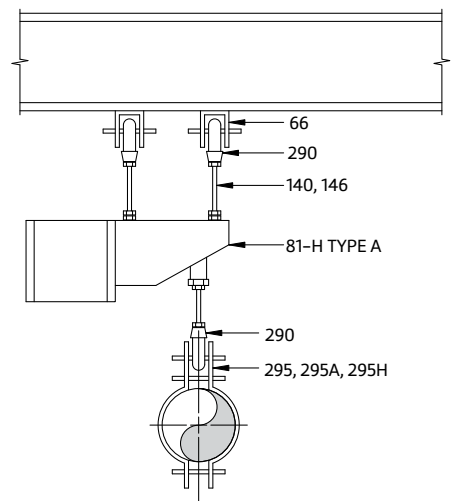
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Fig_80V_Type_G.DWG, .DXF, or .EPS



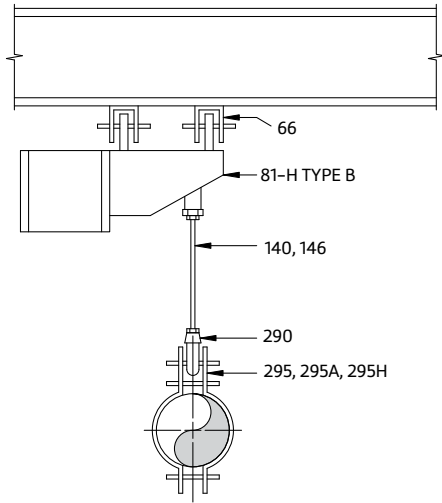
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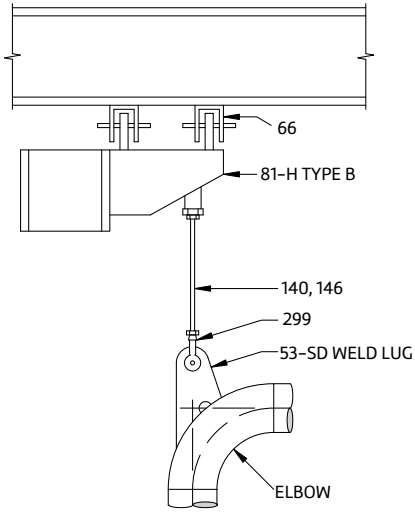
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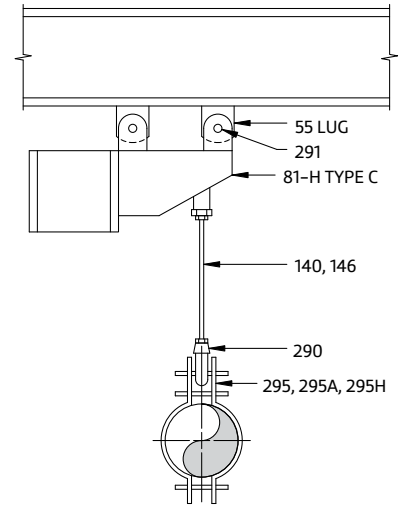
Constant Hanger Assemblies (Cont.)



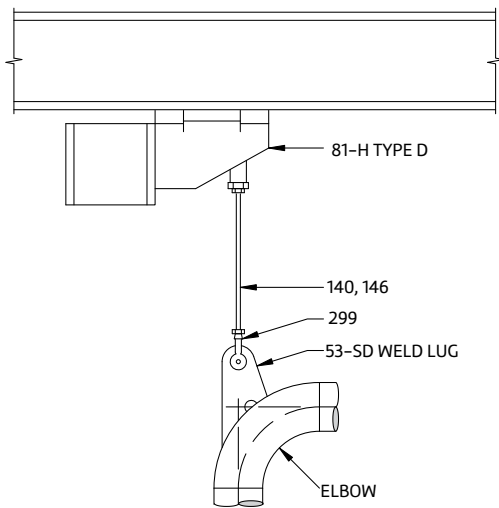
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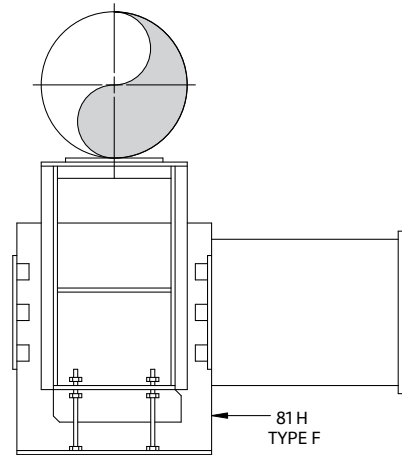
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Fig_81H_Type_F .DWG, .DXF, or .EPS

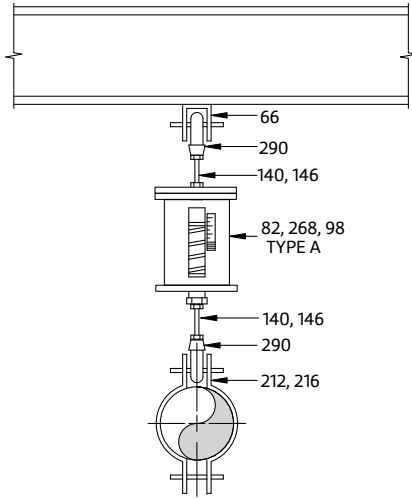
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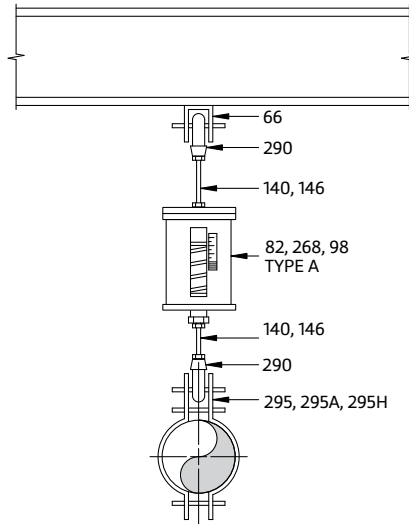
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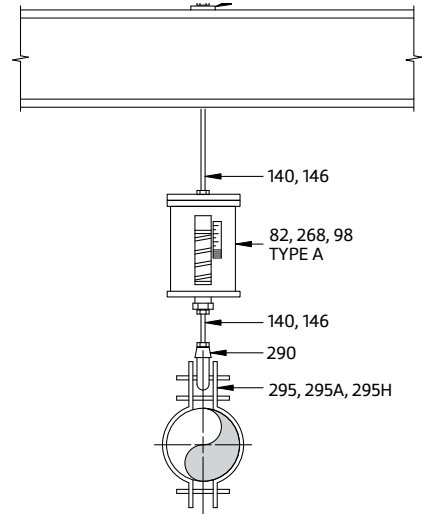
Spring Hanger Assemblies



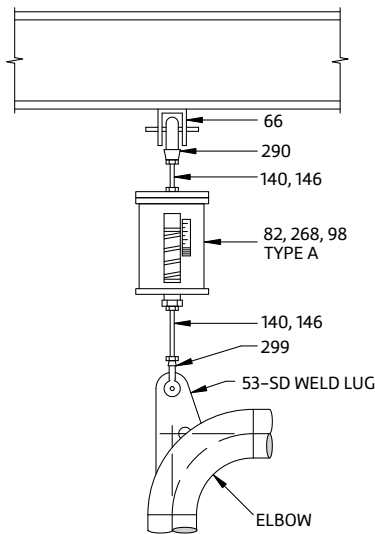
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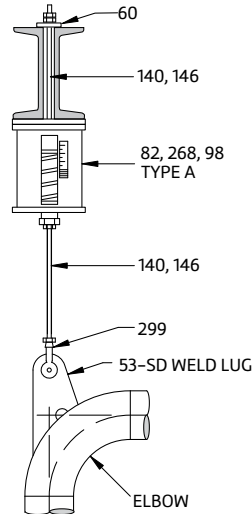
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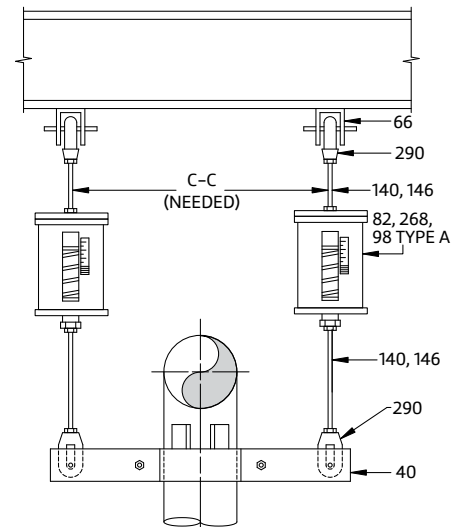
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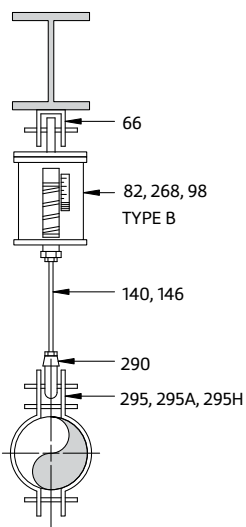
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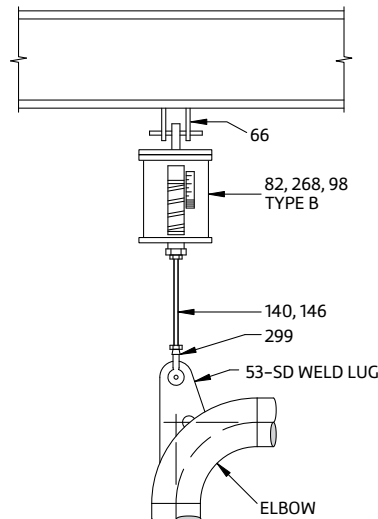
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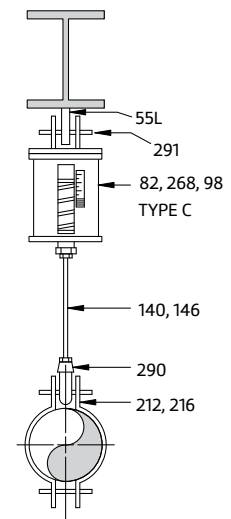
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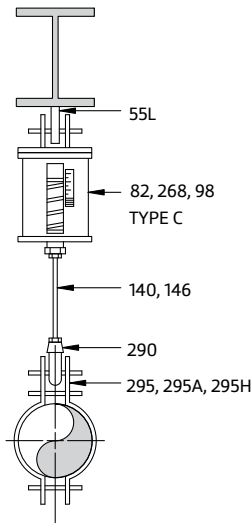
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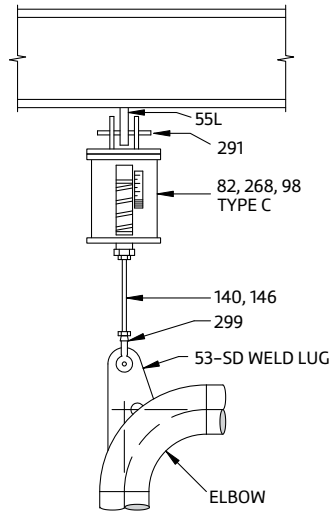
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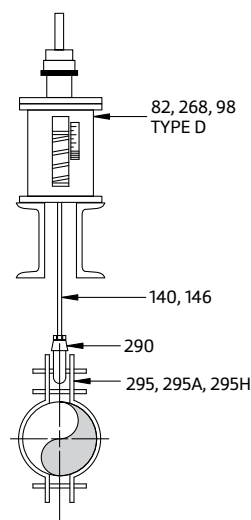
Spring Hanger Assemblies (Cont.)



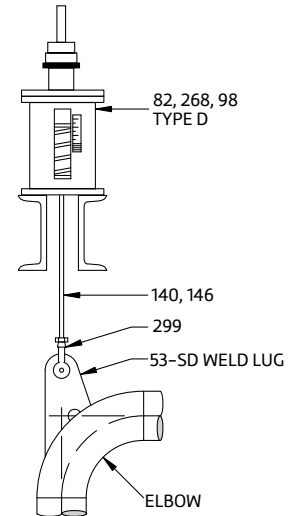
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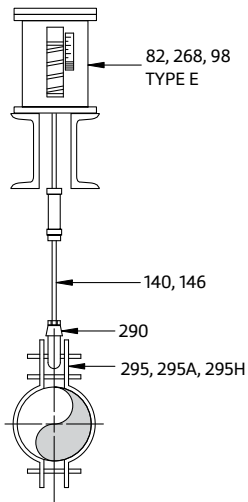
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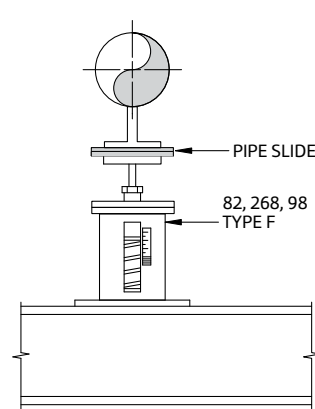
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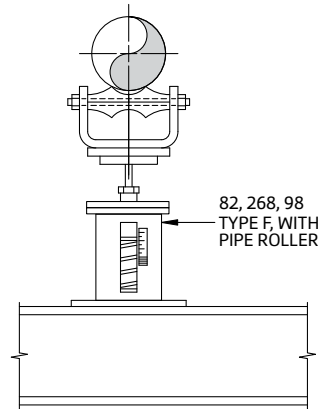
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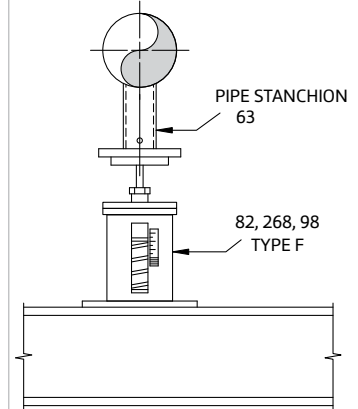
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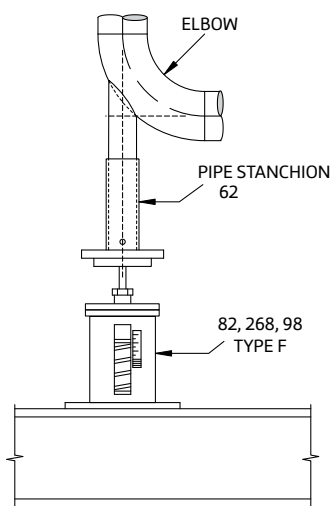
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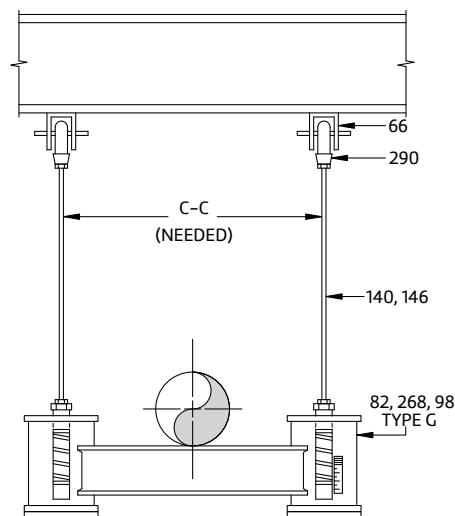
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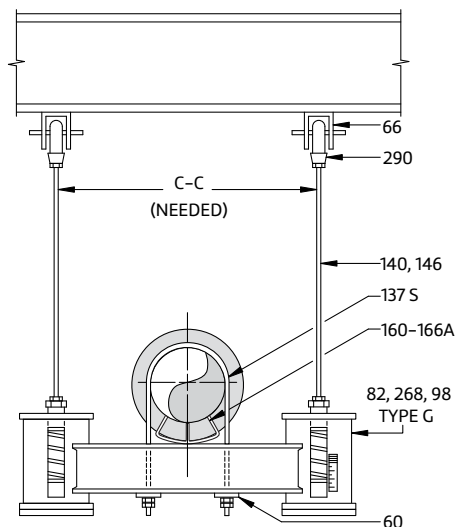
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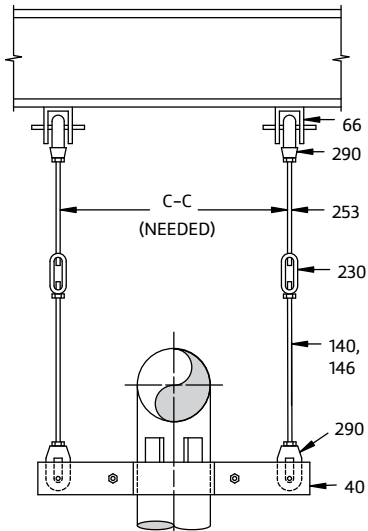
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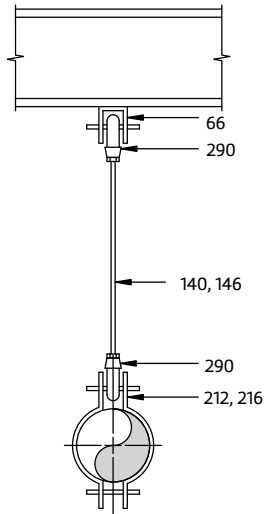
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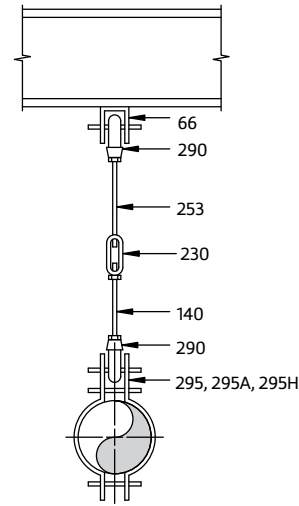
Rigid Hanger Assemblies



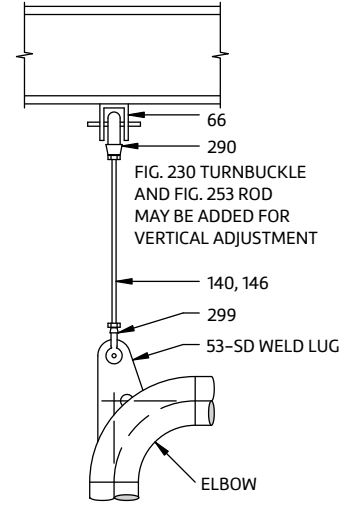
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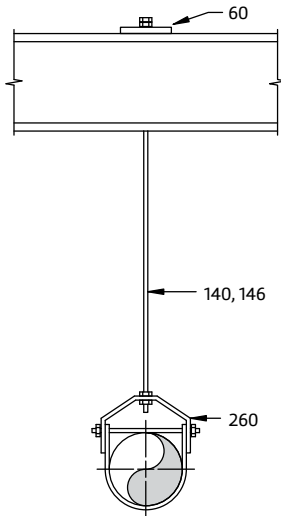
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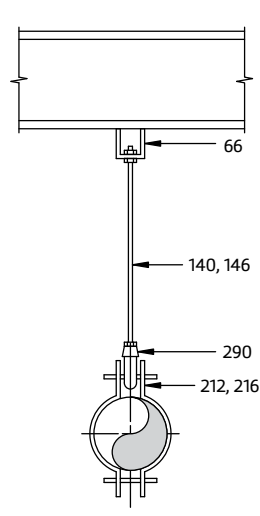
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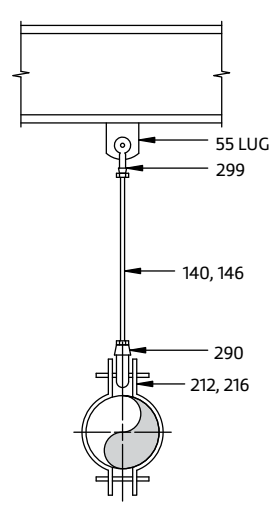
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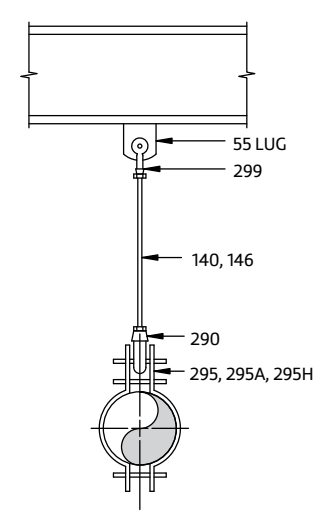
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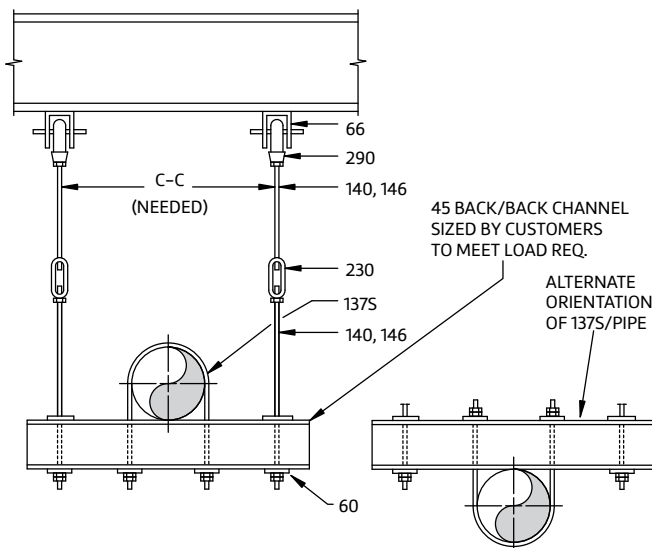
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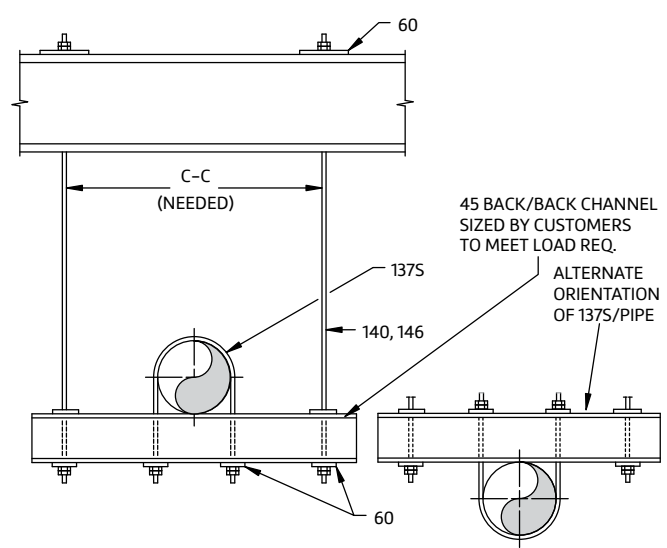
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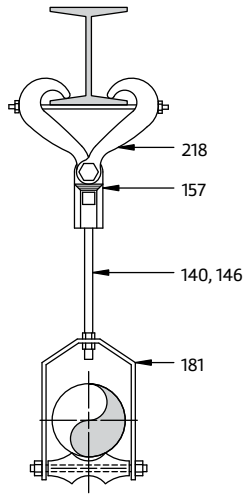
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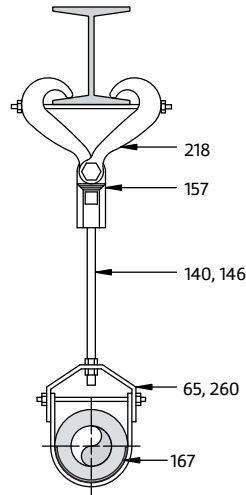
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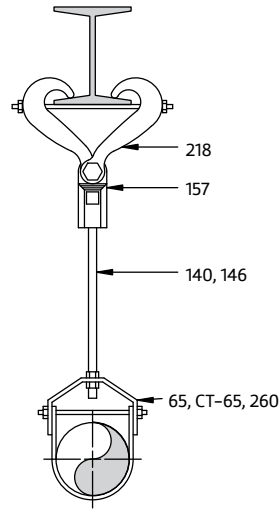
Rigid Hanger Assemblies (Cont.)



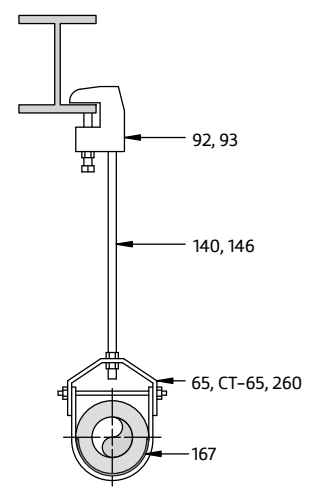
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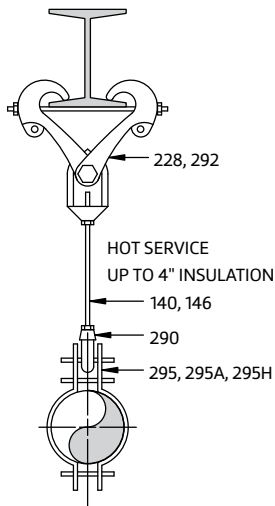
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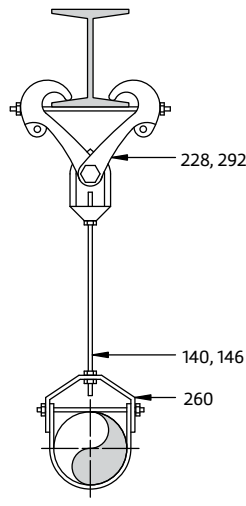
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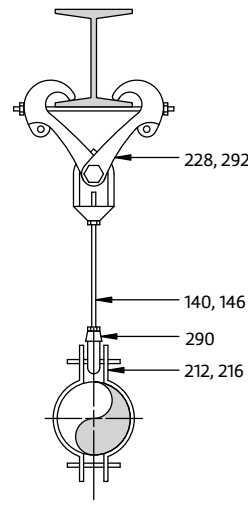
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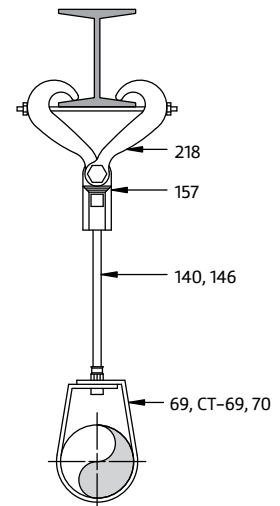
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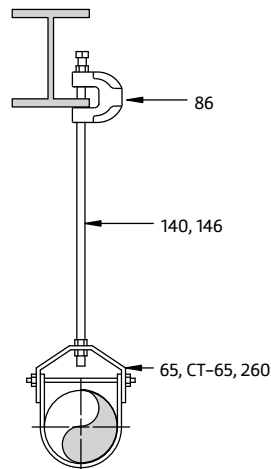
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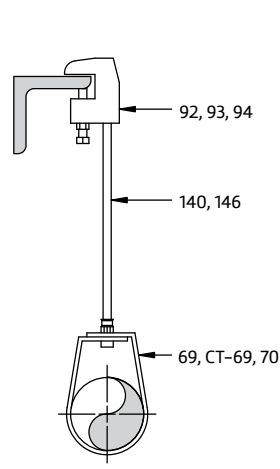
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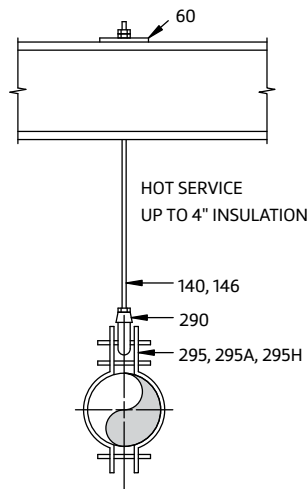
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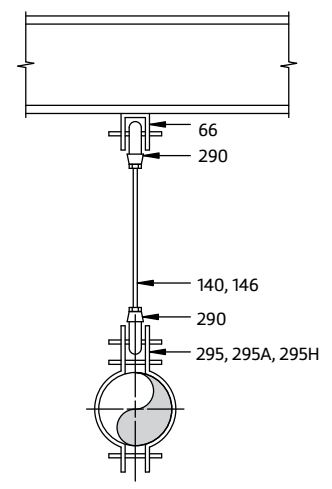
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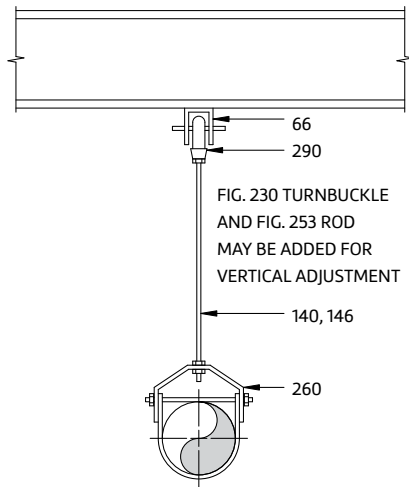
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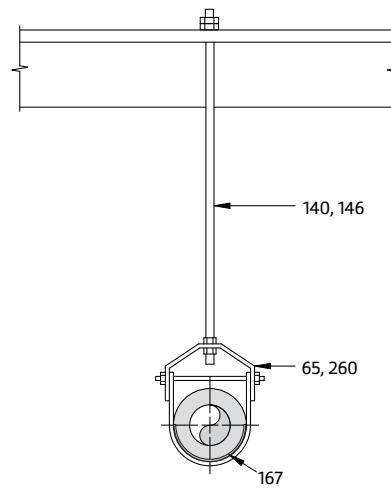
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Each of these drawings are available on the ASC website in CAD format. The file name at the bottom of each box refers to that CAD file.

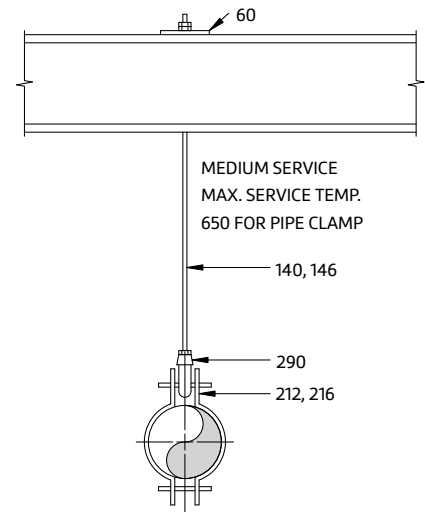
Rigid Hanger Assemblies (Cont.)



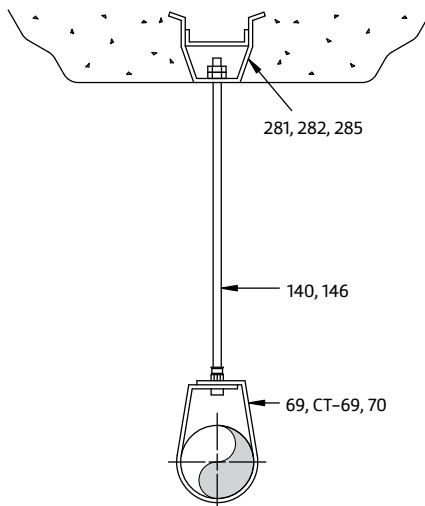
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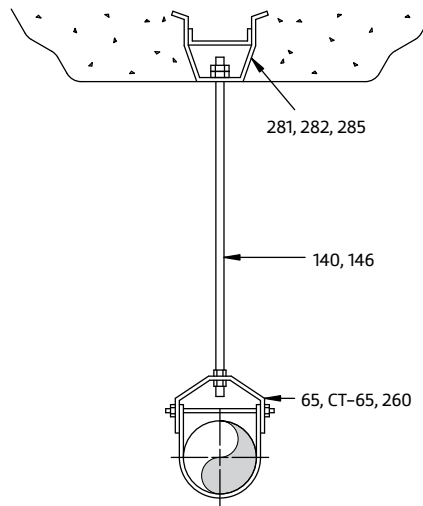
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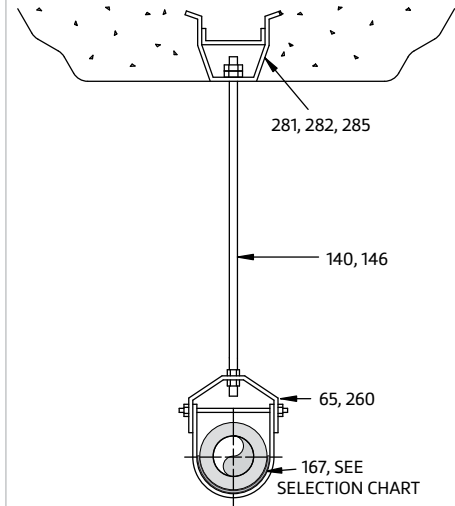
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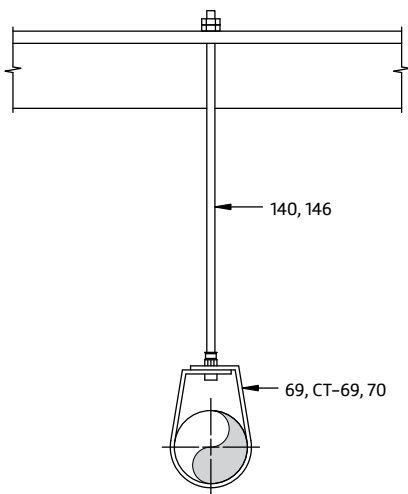
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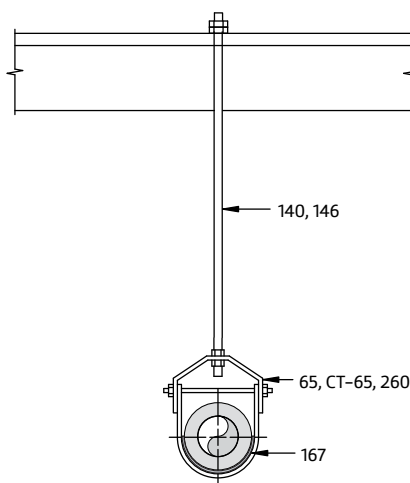
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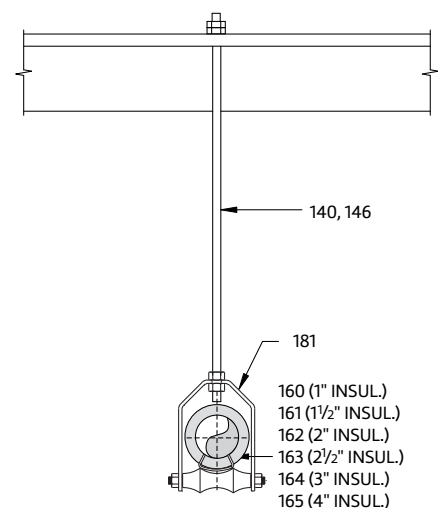
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RH_69_60.DWG, .DXF, or .EPS



RH_160_181_60.DWG, .DXF, or .EPS



RH_167_260_60.DWG, .DXF, or .EPS

Each of these drawings are available on the ASC website in CAD format. The file name at the bottom of each box refers to that CAD file.

Weights of Piping Materials – Introduction

The tabulation of weights of standard piping materials presented on the following pages has been arranged for convenience of selection of data that formerly consumed considerable time to develop. For special materials, the three formulae listed below for weights of tubes, weights of contents of tubes, and weights of piping insulation will be helpful.

$$\text{Weight of Tube} = F \times 10.68 \times T \times (D - T) \text{ lb/ft}$$

T = Wall thickness in inches
D = Outside diameter in inches
F = Relative weight factor

The weight of tube furnished in this piping data is based on low carbon steel weighing 0.2833 lb/in³.

Relative Weight Factor F

| | |
|----------------------------|------|
| Aluminum | 0.35 |
| Brass | 1.12 |
| Cast Iron | 0.91 |
| Copper | 1.14 |
| Ferritic stainless steel | 0.95 |
| Austenitic stainless steel | 1.02 |
| Steel | 1.00 |
| Wrought iron | 0.98 |

Weight of Contents of Tube

$$\text{Weight of Tube Contents} = G \times .3405 \times (D - 2T)^2 \text{ lb/ft}$$

G = Specific gravity of contents
T = Tube wall thickness in inches
D = Tube outside diameter in inches

Weight Tolerances

The weight per foot of steel pipe is subject to the following tolerances:

| Specification | Tolerance |
|------------------------------------|-------------|
| ASTM A-120 & ASTM A-53 | |
| STD WT | +5% -5% |
| XS WT | +5% -5% |
| XXS WT | +10% -10% |
| ASTM A-106 | |
| SCH 10-120 | +6.5% -3.5% |
| SCH 140-160 | +10% -3.5% |
| ASTM A-335 | |
| 12" and under | +6.5% -3.5% |
| over 12" | +10% -5% |
| ASTM A-312 & ASTM A-376 | |
| 12" and under | +6.5% -3.5% |
| API 5L All sizes | +6.5% -3.5% |

The weight of welding tees and laterals are for full size fittings. The weights of reducing fittings are approximately the same as for full size fittings.

The weights of welding reducers are for one size reduction, and are approximately correct for other reductions. Weights of valves of the same type may vary because of individual manufacturer's designs. Listed valve weights are approximate only. Specific valve weights should be used when available. Where specific insulation thicknesses and densities differ from those shown, refer to "Weight of Piping Insulation" formula below.

Weight of Piping Insulation

$$\text{Pipe Insulation Weight} = I \times .0218 \times T \times (D+T) \text{ lb/ft}$$

I = Insulation density in pounds per cubic foot
T = Insulation thickness in inches
D = Outside diameter of pipe in inches

Table III – Load Capacity of Threaded Hanger Rods in Accordance with MSS-SP58

| Nominal Rod Diam. Inch | Root Area of Course Thread sq. in. | Max. Recommended Load at Rod Temp 650° Lbs |
|------------------------|------------------------------------|--------------------------------------------|
| 3/8 | 0.068 | 730 |
| 1/2 | 0.126 | 1,350 |
| 5/8 | 0.202 | 2,160 |
| 3/4 | 0.302 | 3,230 |
| 7/8 | 0.419 | 4,480 |
| 1 | 0.551 | 5,900 |
| 1 1/4 | 0.890 | 9,500 |
| 1 1/2 | 1.29 | 13,800 |
| 1 3/4 | 1.74 | 18,600 |
| 2 | 2.30 | 24,600 |
| 2 1/4 | 3.02 | 32,300 |
| 2 1/2 | 3.72 | 39,800 |
| 2 3/4 | 4.62 | 49,400 |
| 3 | 5.62 | 60,100 |
| 3 1/4 | 6.72 | 71,900 |
| 3 1/2 | 7.92 | 84,700 |
| 3 3/4 | 9.21 | 98,500 |
| 4 | 10.6 | 114,000 |
| 4 1/4 | 12.1 | 129,000 |
| 4 1/2 | 13.7 | 146,000 |
| 4 3/4 | 15.4 | 165,000 |
| 5 | 17.2 | 184,000 |



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



Building connections that last™

Weight of Piping Materials – 1" PIPE (1.313" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 160 | XXS |
|---------------------------|-------|-------|---------|-------|------|-------|
| Thickness -- In. | 0.065 | 0.109 | 0.133 | 0.179 | 0.25 | 0.358 |
| Pipe -- Lbs/Ft. | 0.868 | 1.404 | 1.68 | 2.17 | 2.84 | 3.66 |
| Water -- Lbs/Ft | 0.478 | 0.409 | 0.37 | 0.31 | 0.23 | 0.12 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | |
|-----------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|
|  L.R. 90° Elbow | 0.2 0.3 | 0.4 0.3 | 0.4 0.3 | 0.4 0.3 | 0.6 0.3 | 1.00 0.3 |
|  S.R. 90° Elbow | | | 0.3 0.2 | | | |
|  L.R. 45° Elbow | 0.1 0.2 | 0.3 0.2 | 0.3 0.2 | 0.3 0.2 | 0.4 0.2 | 0.5 0.2 |
|  Tee | 0.4 0.4 | 0.6 0.4 | 0.8 0.4 | 0.9 0.4 | 1.1 0.4 | 1.3 0.4 |
|  Lateral | 0.7 1.1 | 1.2 1.1 | 1.7 1.1 | 2.5 1.1 | | |
|  Reducer | 0.2 0.2 | 0.4 0.2 | 0.3 0.2 | 0.4 0.2 | 0.5 0.2 | 0.5 0.2 |
|  Cap | 0.1 0.3 | 0.1 0.3 | 0.3 0.3 | 0.3 0.3 | 0.4 0.3 | 0.5 0.3 |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|-------------------|-----------------|-----------------|-----------------|------------------|------------------|------------------|--|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 2.3 1.5 | 4 1.5 | 2.5 1.5 | 4 1.5 | 5 1.5 | 5 1.5 | 12 1.5 | 12 1.5 | 15 1.5 | |
|  Welding Neck | | | 3 1.5 | 5 1.5 | 7 1.5 | 7 1.5 | 12 1.5 | 12 1.5 | 16 1.5 | |
|  Lap Joint | | | 2.5 1.5 | 4 1.5 | 5 1.5 | 5 1.5 | 12 1.5 | 12 1.5 | 15 1.5 | |
|  Blind | 2.5 1.5 | 5 1.5 | 2.5 1.5 | 5 1.5 | 5 1.5 | 5 1.5 | 12 1.5 | 12 1.5 | 15 1.5 | |
|  S.R. 90° Elbow | | | | | | | 15 3.7 | 28 3.8 | | |
|  L.R. 90° Elbow | | | | | | | | | | |
|  45° Elbow | | | | | | | 14 3.4 | 26 3.7 | | |
|  Tee | | | | | | | 20 5.6 | 39 5.7 | | |
|  Flanged Bonnet Gate | | | | | | | 20 1.2 | 25 1.5 | 80 4.3 | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | 84 3.5 | |
|  Flanged Bonnet - Check | | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | 31 1.7 | 31 1.7 | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|-------------------------------|-------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------|-----------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. 1 0.72 | Nom. Thick., In. 1 0.72 | Nom. Thick., In. 1½ 1.23 | Nom. Thick., In. 2 1.94 | Nom. Thick., In. 2 1.94 | | | | | | |
| Combination | | | | | | 2½ 3.3 | 2½ 3.3 | 2½ 3.3 | 3 4.7 | 3 4.7 | 3 4.7 |

Weight of Piping Materials – 1¼" PIPE (1.660" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 160 | XXS |
|---------------------------|-------|-------|---------|-------|------|-------|
| Thickness -- In. | 0.065 | 0.109 | 0.00 | 0.191 | 0.00 | 0.382 |
| Pipe -- Lbs/Ft. | 1.11 | 1.81 | 2.27 | 3.00 | 3.77 | 5.22 |
| Water -- Lbs/Ft | 0.8 | 0.71 | 0.65 | 0.56 | 0.46 | 0.27 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | |
|-----------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|  L.R. 90° Elbow | 0.3 0.3 | 0.5 0.3 | 0.6 0.3 | 0.8 0.3 | 1.0 0.3 | 1.3 0.3 |
|  S.R. 90° Elbow | | | 0.4 0.2 | | | |
|  L.R. 45° Elbow | 0.2 0.2 | 0.3 0.2 | 0.3 0.2 | 0.5 0.2 | 0.6 0.2 | 0.7 0.2 |
|  Tee | 0.7 0.5 | 1.1 0.5 | 1.6 0.5 | 1.6 0.5 | 1.9 0.5 | 2.4 0.5 |
|  Lateral | 1.1 1.2 | 1.9 1.2 | 2.4 1.2 | 3.8 1.2 | | |
|  Reducer | 0.3 0.2 | 0.4 0.2 | 0.5 0.2 | 0.6 0.2 | 0.7 0.2 | 0.8 0.2 |
|  Cap | 0.1 0.3 | 0.1 0.3 | 0.4 0.3 | 0.4 0.3 | 0.6 0.3 | 0.6 0.3 |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|-------------------|------------------|-----------------|------------------|------------------|------------------|------------------|
| | Cast Iron | | | Steel | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | 2.5 1.5 | 4.8 1.5 | 3.5 1.5 | 5 1.5 | 7 1.5 | 7 1.5 | 13 1.5 | 13 1.5 | 23 1.5 |
|  Welding Neck | | | 3 1.5 | 7 1.5 | 8 1.5 | 8 1.5 | 13 1.5 | 13 1.5 | 25 1.5 |
|  Lap Joint | | | 3.5 1.5 | 5 1.5 | 7 1.5 | 7 1.5 | 13 1.5 | 13 1.5 | 22 1.5 |
|  Blind | 2.8 1.5 | 5.5 1.5 | 3.5 1.5 | 4 1.5 | 7 1.5 | 7 1.5 | 13 1.5 | 13 1.5 | 23 1.5 |
|  S.R. 90° Elbow | | | | 17 3.7 | | 18 3.8 | | 33 3.9 | |
|  L.R. 90° Elbow | | | | 18 3.9 | | | | | |
|  45° Elbow | | | | 15 3.4 | | 16 3.5 | | 31 3.7 | |
|  Tee | | | | 23 5.6 | | 20 5.6 | | 49 5.9 | |
|  Flanged Bonnet Gate | | | | 40 4.0 | | 60 4.2 | | 97 4.6 | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | |
|  Flanged Bonnet - Check | | | | 21 4.0 | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | 38 1.1 | 38 1.1 | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|-----------|------------|-----------|-----------|------------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 0.65 | 1 0.65 | 1½ 1.47 | 2 1.83 | 2 1.83 | 2½ 2.65 | 2½ 2.65 | 2½ 2.65 | 3 3.58 | 3 3.58 | 3 3.58 |
| Combination | | | | | | 2½ 3.17 | 2½ 3.17 | 2½ 3.17 | 3 5.76 | 3 5.76 | 3 5.76 |

Weight of Piping Materials – 1½" PIPE (1.900" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 160 | XXS | | |
|---------------------------|-------|-------|---------|-------|-------|------|-------|------|
| Thickness -- In. | 0.065 | 0.109 | 0.145 | 0.2 | 0.281 | 0.4 | 0.525 | 0.65 |
| Pipe -- Lbs/Ft. | 1.27 | 2.09 | 2.72 | 3.63 | 4.86 | 6.41 | 7.71 | 8.68 |
| Water -- Lbs/Ft | 1.07 | 0.96 | 0.88 | 0.77 | 0.61 | 0.41 | 0.25 | 0.12 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | |
|--------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--|--|
|  L.R. 90° Elbow | 0.4 0.4 | 0.8 0.4 | 0.9 0.4 | 1.2 0.4 | 1.5 0.4 | 2.0 0.4 | | |
|  S.R. 90° Elbow | | | 0.6 0.3 | 0.8 0.3 | | | | |
|  L.R. 45° Elbow | 0.3 0.2 | 0.5 0.2 | 0.5 0.2 | 0.7 0.2 | 0.8 0.2 | 1.0 0.2 | | |
|  Tee | 0.9 0.6 | 1.5 0.6 | 2.0 0.6 | 2.4 0.6 | 3 0.6 | 3.7 0.6 | | |
|  Lateral | 1.3 1.3 | 2.1 1.3 | 3.3 1.3 | 5.5 1.3 | | | | |
|  Reducer | 0.3 0.2 | 0.6 0.2 | 0.6 0.2 | 0.8 0.2 | 1.0 0.2 | 1.2 0.2 | | |
|  Cap | 0.1 0.3 | 0.2 0.3 | 0.4 0.3 | 0.5 0.3 | 0.7 0.3 | 0.8 0.3 | | |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

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- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
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- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
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- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|-------------------|------------------|------------------|------------------|------------------|-------------------|------------------|
| | Cast Iron | | | Steel | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | 3 1.5 | 6 1.5 | 3.5 1.5 | 6 1.5 | 9 1.5 | 9 1.5 | 19 1.5 | 19 1.5 | 31 1.5 |
|  Welding Neck | | | 4.5 1.5 | 8 1.5 | 12 1.5 | 12 1.5 | 19 1.5 | 19 1.5 | 34 1.5 |
|  Lap Joint | | | 3.5 1.5 | 6 1.5 | 9 1.5 | 9 1.5 | 19 1.5 | 19 1.5 | 30 1.5 |
|  Blind | 4 1.5 | 6 1.5 | 3.5 1.5 | 8 1.5 | 10 1.5 | 10 1.5 | 19 1.5 | 19 1.5 | 31 1.5 |
|  S.R. 90° Elbow | 9 3.7 | | 12 3.7 | 23 3.8 | | 26 3.9 | | 46 4.0 | |
|  L.R. 90° Elbow | 12 4.0 | | 13 4.0 | 24 4.0 | | | | | |
|  45° Elbow | 8 3.4 | | 11 3.4 | 21 3.5 | | 23 3.5 | | 39 3.7 | |
|  Tee | 15 5.6 | | 20 5.6 | 30 5.7 | | 37 5.8 | | 70 6.0 | |
|  Flanged Bonnet Gate | 27 6.8 | | | 55 4.2 | | 70 4.5 | | 125 5.0 | |
|  Flanged Bonnet - Globe or Angle | | | | 40 4.2 | | 40 4.2 | | 170 5.0 | |
|  Flanged Bonnet - Check | | | | 30 4.1 | 35 4.1 | 40 4.2 | | 110 4.5 | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | 42 1.9 | 42 1.2 |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 - 199 | 200 - 299 | 300 - 399 | 400 - 499 | 500 - 599 | 600 - 699 | 700 - 799 | 800 - 899 | 900 - 999 | 1,000 - 1,099 | 1,100 - 1,200 |
|-------------------------------|--------------------------------------|-----------|------------|-----------|-----------|------------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 0.84 | 1 0.84 | 1½ 1.35 | 2 2.52 | 2 2.52 | 2½ 3.47 | 2½ 3.47 | 2½ 3.47 | 3 4.52 | 3 4.52 | 3 4.52 |
| Combination | | | | | | 2½ 4.2 | 2½ 4.2 | 2½ 4.2 | 3 5.62 | 3 5.62 | 3 5.62 |

Weight of Piping Materials – 2" PIPE (2.375" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 160 | XXS | | |
|---------------------------|-------|-------|---------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.065 | 0.109 | 0.154 | 0.218 | 0.343 | 0.436 | 0.562 | 0.687 |
| Pipe -- Lbs/Ft. | 1.60 | 2.64 | 3.65 | 5.02 | 7.44 | 9.03 | 10.88 | 12.39 |
| Water -- Lbs/Ft | 1.72 | 1.58 | 1.46 | 1.28 | 0.97 | 0.77 | 0.53 | 0.34 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | |
|--------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--|--|
|  L.R. 90° Elbow | 0.6 0.5 | 1.1 0.5 | 1.5 0.5 | 2.1 0.5 | 3.0 0.5 | 4.0 0.5 | | |
|  S.R. 90° Elbow | | | 1.0 0.3 | 1.4 0.3 | | | | |
|  L.R. 45° Elbow | 0.4 0.2 | 0.6 0.2 | 0.9 0.2 | 1.1 0.2 | 1.6 0.2 | 2.0 0.2 | | |
|  Tee | 1.1 0.6 | 1.8 0.6 | 2.9 0.6 | 3.7 0.6 | 4.9 0.6 | 5.7 0.6 | | |
|  Lateral | 1.9 1.4 | 3.2 1.4 | 5.0 1.4 | 7.7 1.4 | | | | |
|  Reducer | 0.4 0.3 | 0.9 0.3 | 0.9 0.3 | 1.2 0.3 | 1.6 0.3 | 1.9 0.3 | | |
|  Cap | 0.2 0.4 | 0.3 0.4 | 0.6 0.4 | 0.7 0.4 | 1.1 0.4 | 1.2 0.4 | | |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|------------------|--|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 5 1.5 | 7 1.5 | 6 1.5 | 9 1.5 | 11 1.5 | 11 1.5 | 32 1.5 | 32 1.5 | 49 1.5 | |
|  Welding Neck | | | 7 1.5 | 11 1.5 | 14 1.5 | 14 1.5 | 32 1.5 | 32 1.5 | 53 1.5 | |
|  Lap Joint | | | 6 1.5 | 9 1.5 | 11 1.5 | 11 1.5 | 32 1.5 | 32 1.5 | 48 1.5 | |
|  Blind | 5 1.5 | 8 1.5 | 5 1.5 | 10 1.5 | 12 1.5 | 12 1.5 | 32 1.5 | 32 1.5 | 50 1.5 | |
|  S.R. 90° Elbow | 14 3.8 | 20 3.8 | 19 3.8 | 29 3.8 | | 35 4.0 | | 83 4.2 | | |
|  L.R. 90° Elbow | 16 4.1 | 27 4.1 | 22 4.1 | 31 4.1 | | | | | | |
|  45° Elbow | 12 3.4 | 18 3.5 | 16 3.4 | 24 3.5 | | 33 3.7 | | 73 3.9 | | |
|  Tee | 21 5.7 | 32 5.7 | 27 5.7 | 41 5.7 | | 52 6.0 | | 129 6.3 | | |
|  Flanged Bonnet Gate | 37 6.9 | 52 7.1 | 40 4.0 | 65 4.2 | | 80 4.5 | | 190 5.0 | | |
|  Flanged Bonnet - Globe or Angle | 30 7.0 | 64 7.3 | 30 3.8 | 45 4.0 | | 85 4.5 | | 235 5.5 | | |
|  Flanged Bonnet - Check | 26 7.0 | 51 7.3 | 35 3.8 | 40 4.0 | | 60 4.2 | | 300 5.8 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | 150 2.5 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | 165 3.0 | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|-----------|------------|-----------|-----------|------------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 1.01 | 1 1.01 | 1½ 1.71 | 2 2.53 | 2 2.53 | 2½ 3.48 | 2½ 3.48 | 3 4.42 | 3 4.42 | 3 4.42 | 3½ 5.59 |
| Combination | | | | | | 2½ 4.28 | 2½ 4.28 | 3 5.93 | 3 5.93 | 3 5.93 | 3½ 7.80 |

Weight of Piping Materials – 2½" PIPE (2.875" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 160 | XXS | | |
|---------------------------|-------|-------|---------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.083 | 0.120 | 0.203 | 0.276 | 0.375 | 0.552 | 0.675 | 0.800 |
| Pipe -- Lbs/Ft. | 2.48 | 3.53 | 5.79 | 7.66 | 10.01 | 13.7 | 15.86 | 17.73 |
| Water -- Lbs/Ft | 2.50 | 2.36 | 2.08 | 1.84 | 1.54 | 1.07 | 0.79 | 0.55 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | |
|-----------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|  L.R. 90° Elbow | 1.2 0.6 | 1.8 0.6 | 3.0 0.6 | 3.8 0.6 | 5.0 0.6 | 7.0 0.6 |
|  S.R. 90° Elbow | | | 2.2 0.4 | 2.5 0.4 | | |
|  L.R. 45° Elbow | 0.7 0.3 | 0.6 0.2 | 0.9 0.2 | 1.1 0.2 | 1.6 0.2 | 2.0 0.2 |
|  Tee | 1.1 0.6 | 1.8 0.6 | 2.9 0.6 | 3.7 0.6 | 4.9 0.6 | 5.7 0.6 |
|  Lateral | 1.9 1.4 | 3.2 1.4 | 5.0 1.4 | 7.7 1.4 | | |
|  Reducer | 0.4 0.3 | 0.9 0.3 | 0.9 0.3 | 1.2 0.3 | 1.6 0.3 | 1.9 0.3 |
|  Cap | 0.3 0.4 | 0.4 0.4 | 0.9 4.0 | 1.0 0.4 | 1.9 0.4 | 2.0 0.4 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|------------------|-------------------|------------------|-------------------|------------------|-------------------|-------------------|-------------------|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 7 1.5 | 12.5 1.5 | 8 1.5 | 14 1.5 | 17 1.5 | 17 1.5 | 46 1.5 | 46 1.5 | 69 1.5 | |
|  Welding Neck | | | 11 1.5 | 16 1.5 | 22 1.5 | 22 1.5 | 46 1.5 | 46 1.5 | 66 1.5 | |
|  Lap Joint | | | 8 1.5 | 14 1.5 | 16 1.5 | 16 1.5 | 45 1.5 | 45 1.5 | 67 1.5 | |
|  Blind | 7.8 1.5 | 10 1.5 | 8 1.5 | 16 1.5 | 19 1.5 | 19 1.5 | 45 1.5 | 45 1.5 | 70 1.5 | |
|  S.R. 90° Elbow | 20 3.8 | 33 3.9 | 27 3.8 | 42 3.9 | | 50 4.1 | | 114 4.4 | | |
|  L.R. 90° Elbow | 24 4.2 | | 30 4.2 | 47 4.2 | | | | | | |
|  45° Elbow | 18 3.5 | 31 3.6 | 22 3.5 | 35 3.6 | | 46 3.8 | | 99 3.9 | | |
|  Tee | 31 5.7 | 49 5.8 | 42 5.7 | 61 5.9 | | 77 6.2 | | 169 6.6 | | |
|  Flanged Bonnet Gate | 50 7 | 82 7.1 | 60 4 | 100 4.2 | | 105 4.6 | | 275 5.2 | | |
|  Flanged Bonnet - Globe or Angle | 43 7.1 | 87 7.4 | 50 4 | 70 4.1 | | 120 4.6 | | 325 5.5 | | |
|  Flanged Bonnet - Check | 36 7.1 | 71 7.4 | 40 4.0 | 50 4.0 | | 105 4.6 | | 320 5.5 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | 215 2.5 | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | 230 2.8 |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|-----------|------------|-----------|-----------|------------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 1.14 | 1 1.14 | 1½ 2.29 | 2 3.23 | 2 3.23 | 2½ 4.28 | 2½ 4.28 | 3 5.46 | 3 5.46 | 3½ 6.86 | 3½ 6.86 |
| Combination | | | | | | 2½ 5.2 | 2½ 5.2 | 3 7.36 | 3 7.36 | 3½ 9.58 | 3½ 9.58 |

Weight of Piping Materials – 3" PIPE (3.500" O.D.)

Pipe

| Sch./Wall Designation ---> | 5S | 10S | 40/Std. | 80/XS | 160 | XXS | | |
|----------------------------|-------|-------|---------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.083 | 0.120 | 0.216 | 0.300 | 0.438 | 0.600 | 0.725 | 0.850 |
| Pipe -- Lbs/Ft. | 3.03 | 4.33 | 7.58 | 10.25 | 14.32 | 18.58 | 21.49 | 24.06 |
| Water -- Lbs/Ft | 3.78 | 3.61 | 3.20 | 2.86 | 2.35 | 1.80 | 1.43 | 1.10 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | |
|--------------------------------------------------------------------------------------------------|-------------------|-------------------|--------------------|-------------------|--------------------|--------------------|
|  L.R. 90° Elbow | 1.7 0.8 | 2.5 0.8 | 4.7 0.8 | 6.0 0.8 | 8.5 0.8 | 11.0 0.8 |
|  S.R. 90° Elbow | | | 3.3 0.5 | 4.1 0.5 | | |
|  L.R. 45° Elbow | 0.9 0.3 | 1.3 0.3 | 2.5 0.3 | 3.3 0.3 | 4.5 0.3 | 5.5 0.3 |
|  Tee | 2.7 0.8 | 3.9 0.8 | 7.0 0.8 | 10 0.8 | 12.2 0.8 | 14.8 0.8 |
|  Lateral | 4.5 1.8 | 6.4 1.8 | 12.5 1.8 | 18 1.8 | | |
|  Reducer | 0.8 0.3 | 1.5 0.3 | 2.1 0.3 | 2.8 0.3 | 3.7 0.3 | 4.6 0.3 |
|  Cap | 0.5 0.5 | 0.7 0.5 | 1.4 0.5 | 1.8 0.5 | 3.5 0.5 | 3.6 0.5 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 8.6 1.5 | 15.8 1.5 | 9 1.5 | 17 1.5 | 20 1.5 | 20 1.5 | 37 1.5 | 61 1.5 | 102 1.5 | |
|  Welding Neck | | | | 12 1.5 | 19 1.5 | 27 1.5 | 27 1.5 | 38 1.5 | 61 1.5 | 113 1.5 |
|  Lap Joint | | | | 9 1.5 | 17 1.5 | 19 1.5 | 19 1.5 | 36 1.5 | 60 1.5 | 99 1.5 |
|  Blind | 9 1.5 | 17.5 1.5 | 10 1.5 | 20 1.5 | 24 1.5 | 24 1.5 | 38 1.5 | 61 1.5 | 105 1.5 | |
|  S.R. 90° Elbow | 25 3.9 | 44 4.0 | 32 3.9 | 53 4.0 | | 67 4.1 | 98 4.3 | 150 4.6 | | |
|  L.R. 90° Elbow | | | 29 4.3 | 40 4.3 | 63 4.3 | | | | | |
|  45° Elbow | 21 3.5 | 39 3.6 | 28 3.5 | 46 3.6 | | 60 3.8 | 93 3.9 | 135 4.0 | | |
|  Tee | 38 5.9 | 62 6.0 | 52 5.9 | 81 6.0 | | 102 6.2 | 151 6.5 | 238 6.9 | | |
|  Flanged Bonnet Gate | 66 7.0 | 112 7.4 | 70 4.0 | 125 4.4 | | 155 4.8 | 260 5.0 | 410 5.5 | | |
|  Flanged Bonnet - Globe or Angle | 56 7.2 | 87 7.6 | 60 4.3 | 95 4.5 | | 155 4.8 | 225 5.0 | 495 5.5 | | |
|  Flanged Bonnet - Check | 46 7.2 | 100 7.6 | 60 4.3 | 70 4.4 | | 120 4.8 | 150 4.9 | 440 5.8 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | 208 3.0 | 235 3.2 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | 135 2.5 | 180 3.0 | |

Pipe Insulation








| Temp. Range ---> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|-----------|------------|-----------|-----------|------------|-----------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 1.25 | 1 1.25 | 1½ 2.08 | 2 3.01 | 2 3.01 | 2½ 4.07 | 3 5.24 | 3 5.24 | 3 5.24 | 3½ 6.65 | 3½ 6.65 |
| Combination | | | | | | 2½ 5.07 | 3 6.94 | 3 6.94 | 3 6.94 | 3½ 9.17 | 3½ 9.17 |

Weight of Piping Materials – 3½" PIPE (4.000" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 160 |
|---------------------------|-------|------|---------|-------|-------|
| Thickness -- In. | 0.083 | 0.12 | 0.226 | 0.318 | 0.636 |
| Pipe -- Lbs/Ft. | 3.47 | 4.97 | 9.11 | 12.51 | 22.85 |
| Water -- Lbs/Ft | 5.01 | 4.81 | 4.28 | 3.85 | 2.53 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | |
|--------------------------------------------------------------------------------------------------|-------------------|-------------------|--------------------|--------------------|--------------------|
|  L.R. 90° Elbow | 2.4 0.9 | 3.4 0.9 | 6.7 0.9 | 8.7 0.9 | 15.0 9.0 |
|  S.R. 90° Elbow | | | 4.2 0.6 | 5.7 0.6 | |
|  L.R. 45° Elbow | 1.2 4.0 | 1.7 0.4 | 3.3 0.4 | 4.4 0.4 | 8.0 0.4 |
|  Tee | 3.4 0.9 | 4.9 0.0 | 10.3 0.9 | 13.8 0.9 | 20.2 0.9 |
|  Lateral | 6.2 1.8 | 8.9 1.8 | 17.2 1.8 | 25 1.8 | |
|  Reducer | 1.2 0.3 | 2.1 0.3 | 3.0 0.3 | 4.0 0.3 | 6.8 0.3 |
|  Cap | 0.6 0.6 | 0.8 0.6 | 2.1 0.6 | 2.8 0.6 | 5.5 0.6 |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|------------------|-------------------|------------------|-------------------|-------------------|-------------------|------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 11 1.5 | 20 1.5 | 13 1.5 | 21 1.5 | 27 1.5 | 27 1.5 | | | | |
|  Welding Neck | | | 14 1.5 | 22 1.5 | 32 1.5 | 32 1.5 | | | | |
|  Lap Joint | | | 13 1.5 | 21 1.5 | 26 1.5 | 26 1.5 | | | | |
|  Blind | 13 1.5 | 23 1.5 | 15 1.5 | 25 1.5 | 35 1.5 | 35 1.5 | | | | |
|  S.R. 90° Elbow | 33 4.0 | | 49 4.0 | | | 82 4.3 | | | | |
|  L.R. 90° Elbow | | | 54 4.4 | | | | | | | |
|  45° Elbow | 29 3.6 | | 39 3.6 | | | 75 3.6 | | | | |
|  Tee | 51 6.0 | 103 6.2 | 70 6.0 | | | 133 6.4 | | | | |
|  Flanged Bonnet Gate | 82 7.1 | 143 7.5 | 90 4.1 | 155 4.5 | | 180 4.8 | 360 5.0 | 510 5.5 | | |
|  Flanged Bonnet - Globe or Angle | 74 7.3 | 137 7.7 | | | | 160 4.7 | | | | |
|  Flanged Bonnet - Check | 71 7.3 | 125 7.7 | | | | 125 4.7 | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | 140 2.5 | 295 2.8 | 380 3.0 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|-----------|------------|-----------|------------|------------|-----------|------------|------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 1.83 | 1 1.83 | 1½ 2.77 | 2 3.71 | 2½ 4.88 | 2½ 4.88 | 3 6.39 | 3 6.39 | 3½ 7.8 | 3½ 7.8 | 3½ 7.8 |
| Combination | | | | | 2½ 6.49 | 3 8.71 | 3 8.71 | 3½ 10.8 | 3½ 10.8 | 3½ 10.8 | 3½ 10.8 |

Weight of Piping Materials – 4" PIPE (4.500" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 120 | 160 | XXS | | | | |
|---------------------------|-------|------|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.083 | 0.12 | 0.188 | 0.237 | 0.337 | 0.438 | 0.500 | 0.531 | 0.674 | 0.800 | 0.925 |
| Pipe -- Lbs/Ft. | 3.92 | 5.61 | 8.56 | 10.79 | 14.98 | 18.96 | 21.36 | 22.51 | 27.54 | 31.61 | 35.32 |
| Water -- Lbs/Ft | 6.40 | 6.17 | 5.80 | 5.51 | 4.98 | 4.48 | 4.16 | 4.02 | 3.38 | 2.86 | 2.39 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | | | |
|--------------------------------------------------------------------------------------------------|-------------------|--------------------|--------------------|--------------------|--|--------------------|--------------------|--|--|--|
|  L.R. 90° Elbow | 3.0 1.0 | 4.3 1.0 | 8.7 1.0 | 12 1.0 | | 18 1.0 | 20.5 1.0 | | | |
|  S.R. 90° Elbow | | | 6.7 0.7 | 8.3 0.7 | | | | | | |
|  L.R. 45° Elbow | 1.5 0.4 | 2.2 0.4 | 4.3 0.4 | 5.9 0.4 | | 8.5 0.4 | 10.0 4.0 | | | |
|  Tee | 3.9 1.0 | 5.7 1.0 | 13.5 1.0 | 16.4 1.0 | | 22.8 1.0 | 26.6 1.0 | | | |
|  Lateral | 6.6 2.1 | 10.0 2.1 | 20.5 2.1 | 32.0 2.1 | | | | | | |
|  Reducer | 1.2 0.3 | 2.4 0.3 | 3.6 0.3 | 4.8 0.3 | | 6.6 0.3 | 8.2 0.3 | | | |
|  Cap | 0.8 0.3 | 1.2 0.3 | 2.5 0.5 | 3.4 0.5 | | 6.5 6.5 | 6.6 6.6 | | | |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 14 1.5 | 24 1.5 | 15 1.5 | 26 1.5 | 32 1.5 | 43 1.5 | 66 1.5 | 90 1.5 | 158 1.5 | |
|  Welding Neck | | | 17 1.5 | 29 1.5 | 41 1.5 | 48 1.5 | 64 1.5 | 90 1.5 | 177 1.5 | |
|  Lap Joint | | | 15 1.5 | 26 1.5 | 31 1.5 | 42 1.5 | 64 1.5 | 92 1.5 | 153 1.5 | |
|  Blind | 16 1.5 | 27 1.5 | 19 1.5 | 31 1.5 | 39 1.5 | 47 1.5 | 67 1.5 | 90 1.5 | 164 1.5 | |
|  S.R. 90° Elbow | 43 4.1 | 69 4.2 | 59 4.1 | 85 4.2 | 99 4.3 | 128 4.4 | 185 4.5 | 254 4.8 | | |
|  L.R. 90° Elbow | 50 4.5 | | 72 4.5 | 98 4.5 | | | | | | |
|  45° Elbow | 38 3.7 | 62 3.8 | 51 3.7 | 78 3.8 | 82 3.9 | 119 4 | 170 4.1 | 214 4.2 | | |
|  Tee | 66 6.1 | 103 6.3 | 86 6.1 | 121 6.3 | 153 6.4 | 187 6.6 | 262 6.8 | 386 7.2 | | |
|  Flanged Bonnet Gate | 109 7.2 | 188 7.5 | 100 4.2 | 175 4.5 | 195 5.0 | 255 5.1 | 455 5.4 | 735 6.0 | | |
|  Flanged Bonnet - Globe or Angle | 97 7.4 | 177 7.8 | 95 4.3 | 145 4.8 | 215 5 | 230 5.1 | 415 5.5 | 800 6.0 | | |
|  Flanged Bonnet - Check | 80 7.4 | 146 7.8 | 80 4.3 | 105 4.5 | 160 4.8 | 195 5.0 | 320 5.6 | 780 6.0 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | 215 2.8 | 380 3.0 | 520 4.0 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | 240 2.7 | 290 3.0 | | |

Pipe Insulation








| Temp. Range --> | | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|-------------------------|-----------|-----------|------------|-----------|------------|------------|-----------|-----------|------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft | 1 1.62 | 1 1.62 | 1½ 2.55 | 2 3.61 | 2½ 4.66 | 2½ 4.66 | 3 6.07 | 3 6.07 | 3½ 7.48 | 3½ 7.48 | 4 9.1 |
| Combination | Nom. Thick., In. Lbs/Ft | | | | | | 2½ 6.07 | 3 8.3 | 3 8.3 | 3½ 10.6 | 3½ 10.6 | 3½ 10.6 |

Weight of Piping Materials – 5" PIPE (5.563" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 120 | 160 | XXS | | |
|---------------------------|-------|-------|---------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.109 | 0.134 | 0.258 | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.000 |
| Pipe -- Lbs/Ft. | 6.35 | 7.77 | 14.62 | 20.78 | 27.04 | 32.96 | 38.55 | 43.81 | 47.73 |
| Water -- Lbs/Ft | 9.73 | 9.53 | 8.66 | 7.89 | 7.09 | 6.33 | 5.62 | 4.95 | 4.23 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | | |
|--------------------------------------------------------------------------------------------------|--------------------|--------------------|--------------------|--------------------|--|--------------------|--------------------|--|--|
|  L.R. 90° Elbow | 6.0 1.3 | 7.4 1.3 | 16.0 1.3 | 21.4 1.3 | | 33.0 1.3 | 34.0 1.3 | | |
|  S.R. 90° Elbow | 4.2 0.8 | 5.2 0.8 | 10.4 0.8 | 14.5 0.8 | | | | | |
|  L.R. 45° Elbow | 3.1 0.5 | 3.8 0.5 | 8.3 0.5 | 10.5 0.5 | | 14.0 0.5 | 18.0 0.5 | | |
|  Tee | 9.8 1.2 | 12 1.2 | 19.8 1.2 | 26.9 1.2 | | 38.5 1.2 | 43.4 1.2 | | |
|  Lateral | 15.3 2.5 | 18.4 2.5 | 31.0 2.5 | 49 2.5 | | | | | |
|  Reducer | 2.5 0.4 | 4.3 0.4 | 5.9 0.4 | 8.3 0.4 | | 12.4 0.4 | 14.2 0.4 | | |
|  Cap | 1.3 0.7 | 1.6 0.7 | 4.2 0.7 | 5.7 0.7 | | 11.0 0.7 | 11.0 0.7 | | |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 17 1.5 | 28 1.5 | 18 1.5 | 32 1.5 | 37 1.5 | 73 1.5 | 100 1.5 | 162 1.5 | 259 1.5 | |
|  Welding Neck | | | 22 1.5 | 36 1.5 | 49 1.5 | 78 1.5 | 103 1.5 | 162 1.5 | 293 1.5 | |
|  Lap Joint | | | 18 1.5 | 32 1.5 | 35 1.5 | 71 1.5 | 98 1.5 | 168 1.5 | 253 1.5 | |
|  Blind | 21 1.5 | 35 1.5 | 23 1.5 | 39 1.5 | 50 1.5 | 78 1.5 | 104 1.5 | 172 1.5 | 272 1.5 | |
|  S.R. 90° Elbow | 55 4.3 | 91 4.3 | 80 4.3 | 113 4.3 | 123 4.5 | 205 4.7 | 268 4.8 | 435 5.2 | | |
|  L.R. 90° Elbow | 65 4.7 | | 91 4.7 | 128 4.7 | | | | | | |
|  45° Elbow | 48 3.8 | 80 3.8 | 66 3.8 | 98 3.8 | 123 4.0 | 180 4.2 | 239 4.3 | 350 4.5 | | |
|  Tee | 84 6.4 | 139 6.5 | 119 6.4 | 172 6.4 | 179 6.8 | 304 7.0 | 415 7.2 | 665 7.8 | | |
|  Flanged Bonnet Gate | 138 7.3 | 264 7.9 | 150 4.3 | 265 4.9 | 310 5.3 | 455 5.5 | 615 6.0 | 1340 7.0 | | |
|  Flanged Bonnet - Globe or Angle | 138 7.6 | 247 8 | 155 4.3 | 215 5.0 | 355 5.2 | 515 5.8 | 555 5.8 | 950 6.0 | | |
|  Flanged Bonnet - Check | 118 7.6 | 210 8.0 | 110 4.3 | 165 5.0 | 185 5.0 | 350 5.8 | 560 6.0 | 1150 7.0 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | 350 3.1 | 520 3.8 | 865 4.5 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | 280 4.0 | 450 4.5 | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|------------|------------|-----------|------------|------------|-----------|------------|------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 1.86 | 1½ 2.92 | 1½ 2.92 | 2 4.08 | 2½ 5.38 | 2½ 5.38 | 3 6.9 | 3½ 8.41 | 3½ 8.41 | 4 10.4 | 4 10.4 |
| Combination | | | | | | 2½ 7.01 | 3 9.3 | 3½ 11.8 | 3½ 11.8 | 4 14.9 | 4 14.9 |

Weight of Piping Materials – 6" PIPE (6.625" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 40/Std. | 80/XS | 120 | 160 | XXS | | | |
|---------------------------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.109 | 0.134 | 0.219 | 0.28 | 0.432 | 0.562 | 0.718 | 0.864 | 1.00 | 1.125 |
| Pipe -- Lbs/Ft. | 5.37 | 9.29 | 15.02 | 18.97 | 28.57 | 36.39 | 45.3 | 53.2 | 60.01 | 66.08 |
| Water -- Lbs/Ft | 13.98 | 13.74 | 13.1 | 12.51 | 11.29 | 10.3 | 9.2 | 8.2 | 7.28 | 6.52 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | | | |
|-------------------------------------------------------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--|--|--|
|  | 8.9 | 11.0 | 22.8 | 32.2 | 43.0 | 55.0 | 62.0 | | | |
| L.R. 90° Elbow | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.5 | | | |
|  | 6.1 | 7.5 | 16.6 | 22.9 | 30.0 | | | | | |
| S.R. 90° Elbow | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | | |
|  | 4.5 | 5.5 | 11.3 | 16.4 | 21 | 26.0 | 30 | | | |
| L.R. 45° Elbow | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | | |
|  | 13.8 | 17.0 | 31.3 | 39.5 | | 59.0 | 68.0 | | | |
| Tee | 1.4 | 1.4 | 1.4 | 1.4 | | 1.4 | 1.4 | | | |
|  | 16.7 | 20.5 | 42.0 | 78.0 | | | | | | |
| Lateral | 2.9 | 2.9 | 2.9 | 2.9 | | | | | | |
|  | 3.3 | 5.8 | 8.6 | 12.6 | | 18.8 | 21.4 | | | |
| Reducer | 0.5 | 0.5 | 0.6 | 0.5 | | 0.5 | 0.5 | | | |
|  | 1.6 | 1.9 | 6.4 | 9.2 | 13.3 | 17.5 | 17.5 | | | |
| Cap | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | | | |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|-------------------------------------------------------------------------------------|-----------------------|------------|------------|------------|------------|------------|------------|-------------|------------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  | 20 | 38 | 22 | 45 | 54 | 95 | 128 | 202 | 396 | |
| Screwed or Slip On | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | |
|  | | | 27 | 48 | 67 | 96 | 130 | 202 | 451 | |
| Welding Neck | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | |
|  | | | 22 | 45 | 52 | 93 | 125 | 208 | 387 | |
| Lap Joint | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | |
|  | 26 | 48 | 29 | 56 | 71 | 101 | 133 | 197 | 418 | |
| Blind | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | |
|  | 71 | 121 | 90 | 147 | 184 | 275 | 375 | 566 | | |
| S.R. 90° Elbow | 4.3 | 4.4 | 4.3 | 4.4 | 4.6 | 4.8 | 5.0 | 5.3 | | |
|  | 88 | | 126 | 182 | | | | | | |
| L.R. 90° Elbow | 4.9 | | 4.9 | 4.9 | | | | | | |
|  | 63 | 111 | 82 | 132 | 149 | 240 | 320 | 476 | | |
| 45° Elbow | 3.8 | 3.9 | 3.8 | 3.9 | 4.1 | 4.3 | 4.3 | 4.6 | | |
|  | 108 | 186 | 149 | 218 | 279 | 400 | 565 | 839 | | |
| Tee | 6.5 | 6.6 | 6.5 | 6.6 | 6.9 | 7.2 | 7.5 | 8.0 | | |
|  | 172 | 359 | 190 | 360 | 435 | 620 | 835 | 1595 | | |
| Flanged Bonnet Gate | 7.3 | 8.0 | 4.3 | 5.0 | 5.5 | 5.8 | 6.0 | 7.0 | | |
|  | 184 | 345 | 185 | 275 | 415 | 645 | 765 | 1800 | | |
| Flanged Bonnet – Globe or Angle | 7.8 | 8.2 | 4.4 | 5.0 | 5.3 | 5.8 | 6.0 | 7.0 | | |
|  | 154 | 286 | 150 | 200 | 360 | 445 | 800 | 1630 | | |
| Flanged Bonnet – Check | 7.8 | 8.2 | 4.8 | 5.0 | 5.4 | 6.0 | 6.4 | 7.0 | | |
|  | | | | | | 580 | 750 | 1215 | | |
| Pressure Seal – Bonnet, Gate | | | | | | 3.5 | 4.0 | 5.0 | | |
|  | | | | | | | 730 | 780 | | |
| Pressure Seal – Bonnet, Globe | | | | | | | 4.0 | 5.0 | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|------------|-----------|-----------|------------|-----------|-----------|------------|------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1 2.11 | 1½ 3.28 | 2 4.57 | 2 4.57 | 2½ 6.09 | 3 7.60 | 3 7.60 | 3½ 9.82 | 3½ 9.82 | 4 11.5 | 4 11.4 |
| Combination | Nom. Thick., In. Lbs/Ft | | | | | 3 10.3 | 3 10.3 | 3½ 13.4 | 3½ 13.4 | 4 16.6 | 4 16.6 |

Weight of Piping Materials – 8" PIPE (8.625" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 20 | 30 | 40/Std. | 60 | 80XS | 100 | 120 | 140 | 160 | |
|---------------------------|-------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.109 | 0.148 | 0.219 | 0.250 | 0.277 | 0.322 | 0.406 | 0.500 | 0.593 | 0.718 | 0.812 | 0.906 |
| Pipe -- Lbs/Ft. | 9.91 | 13.4 | 19.64 | 22.36 | 24.7 | 28.55 | 35.64 | 43.4 | 50.9 | 60.6 | 67.8 | 74.7 |
| Water -- Lbs/Ft | 24.07 | 23.59 | 22.9 | 22.48 | 22.18 | 21.69 | 20.79 | 19.8 | 188 | 176 | 16.7 | 15.8 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | | | | |
|--------------------------------------------------------------------------------------------------|--------------------|--------------------|--|--|--------------------|---------------------|--|--|--|--|---------------------|
|  L.R. 90° Elbow | 15.4 2.0 | 21.0 2.0 | | | 44.9 2.0 | 70.3 2.0 | | | | | 120.0 2.0 |
|  S.R. 90° Elbow | 6.6 1.3 | 14.3 1.3 | | | 34.5 1.3 | 50.2 1.3 | | | | | |
|  L.R. 45° Elbow | 8.1 0.8 | 11.0 0.8 | | | 22.8 0.8 | 32.8 0.8 | | | | | 56.0 0.8 |
|  Tee | 18.4 1.8 | 25.0 1.8 | | | 60.2 1.8 | 78.0 1.8 | | | | | 120.0 1.8 |
|  Lateral | 25.3 3.8 | 41.1 3.8 | | | 76.0 3.8 | 140.0 3.8 | | | | | |
|  Reducer | 4.5 0.5 | 7.8 0.5 | | | 13.9 0.5 | 20.4 0.5 | | | | | 32.1 0.5 |
|  Cap | 2.1 1.0 | 2.8 1.0 | | | 11.3 1.0 | 16.3 1.0 | | | | | 32.0 1.0 |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 29 1.5 | 60 1.5 | 33 1.5 | 67 1.5 | 82 1.5 | 135 1.5 | 207 1.5 | 319 1.5 | 601 1.5 | |
|  Welding Neck | | | 42 1.5 | 76 1.5 | 104 1.5 | 137 1.5 | 222 1.5 | 334 1.5 | 692 1.5 | |
|  Lap Joint | | | 33 1.5 | 67 1.5 | 79 1.5 | 132 1.5 | 223 1.5 | 347 1.5 | 587 1.5 | |
|  Blind | 43 1.5 | 79 1.5 | 48 1.5 | 90 1.5 | 115 1.5 | 159 1.5 | 232 1.5 | 363 1.5 | 649 1.5 | |
|  S.R. 90° Elbow | 113 4.5 | 194 4.7 | 157 4.5 | 238 4.7 | 310 5 | 435 5.2 | 639 5.4 | 995 5.7 | | |
|  L.R. 90° Elbow | 148 5.3 | | 202 5.3 | 283 5.3 | | | | | | |
|  45° Elbow | 97 3.9 | 164 4.0 | 127 3.9 | 203 4.0 | 215 4.1 | 360 4.4 | 507 4.5 | 870 4.8 | | |
|  Tee | 168 6.8 | 289 7.1 | 230 6.8 | 337 7.1 | 445 7.5 | 610 7.8 | 978 8.1 | 1465 8.6 | | |
|  Flanged Bonnet Gate | 251 7.5 | 583 8.1 | 305 4.5 | 505 5.1 | 730 6.0 | 960 6.3 | 1180 6.6 | 2740 7.0 | | |
|  Flanged Bonnet - Globe or Angle | 317 8.4 | 554 8.6 | 475 5.4 | 505 5.5 | 610 5.9 | 1130 6.3 | 1160 6.3 | 2865 7 | | |
|  Flanged Bonnet - Check | 302 8.4 | 454 8.6 | 235 5.2 | 310 5.3 | 475 5.6 | 725 6 | 1140 6.4 | 2075 7 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | 925 4.5 | 1185 4.7 | 2345 5.5 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | 1550 4.0 | 1680 5.0 | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|-----------|------------|-----------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 4.13 | 1½ 4.13 | 2 5.64 | 2 5.64 | 2½ 7.85 | 3 9.48 | 3½ 11.5 | 3½ 11.5 | 4 13.8 | 4 13.8 | 4½ 16.0 |
| Combination | | | | | | 3 12.9 | 3½ 16.2 | 3½ 16.2 | 4 20.4 | 4 20.4 | 4½ 23.8 |

Weight of Piping Materials – 10" PIPE (10.750" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 20 | 30 | 40/Std. | 60/XS | 80 | 100 | 120 | 140 | 160 | |
|---------------------------|-------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.134 | 0.165 | 0.219 | 0.250 | 0.307 | 0.365 | 0.500 | 0.593 | 0.718 | 0.843 | 1.000 | 1.125 |
| Pipe -- Lbs/Ft. | 15.15 | 18.7 | 24.63 | 28.04 | 34.24 | 40.5 | 54.7 | 64.3 | 76.9 | 89.2 | 104.1 | 115.7 |
| Water -- Lbs/Ft | 37.4 | 36.9 | 36.2 | 35.77 | 34.98 | 34.1 | 32.3 | 31.1 | 29.5 | 28.0 | 26.1 | 24.6 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | | | | |
|--------------------------------------------------------------------------------------------------|--------------------|--------------------|--|--|---------------------|---------------------|--|--|--|--|---------------------|
|  L.R. 90° Elbow | 29.2 2.5 | 36.0 2.5 | | | 84.0 2.5 | 112.0 2.5 | | | | | 230.0 2.5 |
|  S.R. 90° Elbow | 20.3 1.7 | 24.9 1.7 | | | 62.2 1.7 | 74 1.7 | | | | | |
|  L.R. 45° Elbow | 14.6 1.0 | 18.0 1.0 | | | 42.4 1.0 | 53.8 1.0 | | | | | 109.0 1.0 |
|  Tee | 30.0 2.1 | 37.0 2.1 | | | 104.0 2.1 | 132.0 2.1 | | | | | 222.0 2.1 |
|  Lateral | 47.5 4.4 | 70.0 4.4 | | | 124.0 4.4 | 200.0 4.4 | | | | | |
|  Reducer | 8.1 0.6 | 14.0 0.6 | | | 23.2 0.6 | 31.4 0.6 | | | | | 58.0 0.6 |
|  Cap | 3.8 1.3 | 4.7 1.3 | | | 20.0 1.3 | 26.3 1.3 | | | | | 59.0 1.3 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | Cast Iron | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | 45 1.5 | 93 1.5 | 50 1.5 | 100 1.5 | 117 1.5 | 213 1.5 | 293 1.5 | 528 1.5 | 1148 1.5 |
|  Welding Neck | | | 59 1.5 | 110 1.5 | 152 1.5 | 225 1.5 | 316 1.5 | 546 1.5 | 1291 1.5 |
|  Lap Joint | | | 50 1.5 | 110 1.5 | 138 1.5 | 231 1.5 | 325 1.5 | 577 1.5 | 1120 1.5 |
|  Blind | 66 1.5 | 120 1.5 | 77 1.5 | 146 1.5 | 181 1.5 | 267 1.5 | 338 1.5 | 599 1.5 | 1248 1.5 |
|  S.R. 90° Elbow | 182 4.8 | 306 4.9 | 240 4.8 | 343 4.9 | 462 5.2 | 747 5.6 | 995 5.8 | | |
|  L.R. 90° Elbow | | | 237 5.8 | 290 5.8 | 438 5.8 | | | | |
|  45° Elbow | 152 4.1 | 256 4.2 | 185 4.1 | 288 4.2 | 332 4.3 | 572 4.6 | 732 4.7 | | |
|  Tee | 277 7.2 | 446 7.4 | 353 7.2 | 527 7.4 | 578 7.8 | 1007 8.4 | 1417 8.7 | | |
|  Flanged Bonnet Gate | 471 7.7 | 899 8.3 | 455 4.5 | 750 5.0 | 1035 6 | 1575 6.9 | 2140 7.1 | 3690 8.0 | |
|  Flanged Bonnet - Globe or Angle | 541 9.1 | 943 9.1 | 485 4.5 | 855 5.5 | 1070 6.0 | 1500 6.3 | 2500 6.8 | 4160 8.0 | |
|  Flanged Bonnet - Check | 453 9.1 | 751 9.1 | 370 6.0 | 485 6.1 | 605 6.3 | 1030 6.8 | 1350 7.0 | 2280 7.5 | |
|  Pressure Seal - Bonnet, Gate | | | | | | 1450 4.9 | 1860 5.5 | 3150 6.0 | |
|  Pressure Seal - Bonnet, Globe | | | | | | | 1800 5.0 | 1910 6.0 | |

Pipe Insulation








| Temp. Range --> | 100 - 199 | 200 - 299 | 300 - 399 | 400 - 499 | 500 - 599 | 600 - 699 | 700 - 799 | 800 - 899 | 900 - 999 | 1,000 - 1,099 | 1,100 - 1,200 |
|-------------------------------|--------------------------------------|-----------|-----------|------------|------------|-----------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 5.2 | 1½ 5.2 | 2 7.07 | 2½ 8.93 | 2½ 8.93 | 3 11.0 | 3½ 13.2 | 3½ 13.2 | 4 15.5 | 4 15.5 | 4½ 18.1 |
| Combination | | | | | | 3 15.4 | 3½ 19.3 | 3½ 19.3 | 4 23.0 | 4 23.0 | 4½ 27.2 |

Weight of Piping Materials – 12" PIPE (12.750" O.D.)














Pipe

| Sch./Wall Designation --> | 5S | 10S | 20 | 30 | Std. | 40 | XS | 60 | 80 | 120 | 140 | 160 |
|---------------------------|-------|------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.156 | 0.18 | 0.250 | 0.33 | 0.375 | 0.406 | 0.500 | 0.562 | 0.687 | 1.000 | 1.125 | 1.312 |
| Pipe -- Lbs/Ft. | 20.99 | 24.2 | 33.38 | 43.8 | 49.6 | 53.5 | 65.4 | 73.2 | 88.5 | 125.5 | 139.7 | 160.3 |
| Water -- Lbs/Ft | 52.7 | 52.2 | 51.1 | 49.7 | 49.0 | 48.5 | 47.0 | 46.0 | 44.0 | 39.3 | 37.5 | 34.9 |

Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | | | | | | | | |
|--------------------------------------------------------------------------------------------------|--------------------|--------------------|--|---------------------|---------------------|--|--|--|--|--|--|---------------------|
|  L.R. 90° Elbow | 51.2 3.0 | 57.0 3.0 | | 122.0 3.0 | 156.0 3.0 | | | | | | | 375.0 3.0 |
|  S.R. 90° Elbow | 33.6 2.0 | 38.1 2.0 | | 82.0 2.0 | 104.0 2.0 | | | | | | | |
|  L.R. 45° Elbow | 25.5 1.3 | 29.0 1.3 | | 60.3 1.3 | 78.0 1.3 | | | | | | | 182.0 1.3 |
|  Tee | 46.7 2.5 | 54.0 2.5 | | 162.0 2.5 | 180.0 2.5 | | | | | | | 360 2.5 |
|  Lateral | 74.7 5.4 | 86.2 5.4 | | 180.0 5.4 | 273.0 5.4 | | | | | | | |
|  Reducer | 14.1 0.7 | 20.9 0.7 | | 33.4 0.7 | 43.6 0.7 | | | | | | | 94.0 0.7 |
|  Cap | 6.2 1.5 | 7.1 1.5 | | 29.5 1.5 | 38.1 1.5 | | | | | | | 95.0 1.5 |

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 58 1.5 | 123 1.5 | 71 1.5 | 140 1.5 | 164 1.5 | 261 1.5 | 388 1.5 | 820 1.5 | 1611 1.5 | |
|  Welding Neck | | | 87 1.5 | 163 1.5 | 212 1.5 | 272 1.5 | 434 1.5 | 843 1.5 | 1919 1.5 | |
|  Lap Joint | | | 71 1.5 | 164 1.5 | 187 1.5 | 286 1.5 | 433 1.5 | 902 1.5 | 1573 1.5 | |
|  Blind | 95 1.5 | 165 1.5 | 117 1.5 | 209 1.5 | 261 1.5 | 341 1.5 | 475 1.5 | 928 1.5 | 1775 1.5 | |
|  S.R. 90° Elbow | 257 5.0 | 430 5.2 | 345 5.0 | 509 5.2 | 669 5.5 | 815 5.8 | 1474 6.2 | | | |
|  L.R. 90° Elbow | 357 6.2 | 485 6.2 | 624 6.2 | | | | 1598 6.2 | | | |
|  45° Elbow | 227 4.3 | 360 4.3 | 282 4.3 | 414 4.3 | 469 4.5 | 705 4.7 | 1124 4.8 | | | |
|  Tee | 387 7.5 | 640 7.8 | 513 7.5 | 754 7.8 | 943 8.3 | 1361 8.7 | 1928 9.3 | | | |
|  Flanged Bonnet Gate | 687 7.8 | 1298 8.5 | 635 4.0 | 1015 5.0 | 1420 5.5 | 2155 7.0 | 2770 7.2 | 4650 8.0 | | |
|  Flanged Bonnet - Globe or Angle | 808 9.4 | 1200 9.5 | 710 5.0 | 1410 5.5 | | | | | | |
|  Flanged Bonnet - Check | 674 9.4 | 1160 9.5 | 560 6.0 | 720 6.5 | | 1410 7.2 | 2600 8.0 | 3370 8.0 | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | 1975 5.5 | 2560 6.0 | 4515 7.0 | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|-----------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 6.04 | 1½ 6.04 | 2 8.13 | 2½ 10.5 | 3 12.7 | 3 12.7 | 3½ 15.1 | 4 17.9 | 4 17.9 | 4½ 20.4 | 4½ 20.4 |
| Combination | Nom. Thick., In. Lbs/Ft | | | | | 3 17.7 | 3½ 21.9 | 4 26.7 | 4 26.7 | 4½ 31.1 | 4½ 31.1 |

Weight of Piping Materials – 14" PIPE (14" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 10 | 20 | 30/Std. | 40 | XS | 60XS | 80 | 120 | 140 | 160 |
|---------------------------|-------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.156 | 0.188 | 0.250 | 0.312 | 0.375 | 0.438 | 0.500 | 0.593 | 0.75 | 1.093 | 1.25 | 1.406 |
| Pipe -- Lbs/Ft. | 23.0 | 27.7 | 36.71 | 45.7 | 54.6 | 63.4 | 72.1 | 84.9 | 106.1 | 150.7 | 170.2 | 189.1 |
| Water -- Lbs/Ft | 63.7 | 63.1 | 62.06 | 60.92 | 59.7 | 58.7 | 57.5 | 55.9 | 53.2 | 47.5 | 45.0 | 42.6 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | |
|--------------------------------------------------------------------------------------------------|--------------------|---------------------|--|---------------------|---------------------|
|  L.R. 90° Elbow | 65.6 3.5 | 78.0 3.5 | | 157.0 3.5 | 200.0 3.5 |
|  S.R. 90° Elbow | 43.1 2.3 | 51.7 2.3 | | 108.0 2.3 | 135.0 2.3 |
|  L.R. 45° Elbow | 32.5 1.5 | 39.4 1.5 | | 80.0 1.5 | 98.0 1.5 |
|  Tee | 49.4 2.8 | 59.6 2.8 | | 196.0 2.8 | 220.0 2.8 |
|  Lateral | 94.4 5.8 | 113.0 5.8 | | 218.0 5.8 | 340.0 5.8 |
|  Reducer | 25.0 1.1 | 31.2 1.1 | | 63.0 1.1 | 83.0 1.1 |
|  Cap | 7.6 1.7 | 9.2 1.7 | | 35.3 1.7 | 45.9 1.7 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 90 1.5 | 184 1.5 | 95 1.5 | 195 1.5 | 235 1.5 | 318 1.5 | 460 1.5 | 1060 1.5 | | |
|  Welding Neck | | | 130 1.5 | 217 1.5 | 277 1.5 | 406 1.5 | 642 1.5 | 1241 1.5 | | |
|  Lap Joint | | | 119 1.5 | 220 1.5 | 254 1.5 | 349 1.5 | 477 1.5 | 1076 1.5 | | |
|  Blind | 125 1.5 | 239 1.5 | 141 1.5 | 267 1.5 | 354 1.5 | 437 1.5 | 574 1.5 | | | |
|  S.R. 90° Elbow | 360 5.3 | 617 5.5 | 497 5.3 | 632 5.5 | 664 5.7 | 918 5.9 | 1549 6.4 | | | |
|  L.R. 90° Elbow | 480 6.6 | 767 6.6 | 622 6.6 | 772 6.6 | | | | | | |
|  45° Elbow | 280 4.3 | 497 4.4 | 377 4.3 | 587 4.4 | 638 4.6 | 883 4.8 | 1246 4.9 | | | |
|  Tee | 540 8.0 | 956 8.4 | 683 8.0 | 968 8.3 | 1131 8.6 | 1652 8.9 | 2318 9.6 | | | |
|  Flanged Bonnet Gate | 921 7.9 | 1762 8.8 | 905 4.9 | 1525 6.0 | 1920 6.3 | 2960 7.0 | 4170 8.0 | 6425 8.8 | | |
|  Flanged Bonnet – Globe or Angle | 1171 9.9 | | | | | | | | | |
|  Flanged Bonnet – Check | 885 9.9 | | 1010 5.0 | 1155 5.2 | | | | | | |
|  Pressure Seal – Bonnet, Gate | | | | | | | 2620 6.0 | 3475 6.5 | 6380 7.5 | |
|  Pressure Seal – Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|-----------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 6.16 | 1½ 6.16 | 2 8.38 | 2½ 10.7 | 3 13.1 | 3 13.1 | 3½ 15.8 | 4 18.5 | 4 18.5 | 4½ 21.3 | 4½ 21.3 |
| Combination | | | | | | 3 18.2 | 3½ 22.8 | 4 27.5 | 4 27.5 | 4½ 32.4 | 4½ 32.4 |

Weight of Piping Materials – 16" PIPE (16" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 10 | 20 | 30/Std. | 40XS | 60 | 80 | 100 | 120 | 140 | 160 |
|---------------------------|-------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.165 | 0.188 | 0.250 | 0.312 | 0.375 | 0.500 | 0.656 | 0.843 | 1.031 | 1.218 | 1.438 | 1.593 |
| Pipe -- Lbs/Ft. | 28.0 | 32.0 | 42.1 | 52.4 | 62.6 | 82.8 | 107.5 | 136.5 | 164.8 | 192.3 | 223.6 | 245.1 |
| Water -- Lbs/Ft | 83.5 | 83.0 | 81.8 | 80.5 | 79.1 | 76.5 | 73.4 | 69.7 | 66.1 | 62.6 | 58.6 | 55.9 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | | |
|----------------------------------------------------------------------------------------------------|---------------------|---------------------|--|---------------------|---------------------|
|  L.R. 90° Elbow | 89.8 4.0 | 102.0 4.0 | | 208.0 4.0 | 270.0 4.0 |
|  S.R. 90° Elbow | 59.7 2.5 | 67.7 2.5 | | 135.0 2.5 | 177.0 2.5 |
|  L.R. 45° Elbow | 44.9 1.7 | 51.0 1.7 | | 104.0 1.7 | 136.0 1.7 |
|  Tee | 66.8 3.2 | 75.9 3.2 | | 250.0 3.2 | 278.0 3.2 |
|  Lateral | 127.0 6.7 | 144.0 6.7 | | 275.0 6.7 | 431.0 6.7 |
|  Reducer | 31.3 1.2 | 35.7 1.2 | | 77.0 1.2 | 102.0 1.2 |
|  Cap | 10.1 1.8 | 11.5 1.8 | | 44.3 1.8 | 57.0 1.8 |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 114 1.5 | 233 1.5 | 107 1.5 | 262 1.5 | 310 1.5 | 442 1.5 | 559 1.5 | 1297 1.5 | | |
|  Welding Neck | | | 141 1.5 | 288 1.5 | 351 1.5 | 577 1.5 | 785 1.5 | 1597 1.5 | | |
|  Lap Joint | | | 142 1.5 | 282 1.5 | 337 1.5 | 476 1.5 | 588 1.5 | 1372 1.5 | | |
|  Blind | 174 1.5 | 308 1.5 | 184 1.5 | 349 1.5 | 455 1.5 | 603 1.5 | 719 1.5 | | | |
|  S.R. 90° Elbow | 484 5.5 | 826 5.8 | 656 5.5 | 958 5.8 | 1014 6.0 | 1402 6.3 | 1886 6.7 | | | |
|  L.R. 90° Elbow | 684 7.0 | 1036 7.0 | 781 7.0 | 1058 7.0 | | | | | | |
|  45° Elbow | 374 4.3 | 696 4.6 | 481 4.3 | 708 4.6 | 839 4.7 | 1212 5.0 | 1586 5.0 | | | |
|  Tee | 714 8.3 | 1263 8.7 | 961 8.3 | 1404 8.6 | 1671 9.0 | 2128 9.4 | 3054 10.0 | | | |
|  Flanged Bonnet Gate | 1254 8.0 | 2321 9.0 | 1190 5.0 | 2015 7.0 | 2300 7.2 | 3675 7.9 | 4950 8.2 | 7875 9.0 | | |
|  Flanged Bonnet – Globe or Angle | | | | | | | | | | |
|  Flanged Bonnet – Check | 1166 10.5 | | | 1225 6.0 | | | | | | |
|  Pressure Seal – Bonnet, Gate | | | | | | 3230 7.0 | 8130 8.0 | | | |
|  Pressure Seal – Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|--------------------------------------|-----------|-----------|------------|-----------|-----------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 6.9 | 1½ 6.9 | 2 9.33 | 2½ 12.0 | 3 14.6 | 3 14.6 | 3½ 17.5 | 4 20.5 | 4 20.5 | 4½ 23.6 | 4½ 23.6 |
| Combination | | | | | | 3 20.3 | 3½ 25.2 | 4 30.7 | 4 30.7 | 4½ 36.0 | 4½ 36.0 |

Weight of Piping Materials – 18" PIPE (18" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 10 | 20 | Std. | 30 | XS | 40 | 60 | 80 | 120 | 160 |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.165 | 0.188 | 0.25 | 0.312 | 0.375 | 0.438 | 0.500 | 0.562 | 0.75 | 0.937 | 1.375 | 1.781 |
| Pipe -- Lbs/Ft. | 31.0 | 36.0 | 47.4 | 59.0 | 70.6 | 82.1 | 93.5 | 104.8 | 138.2 | 170.8 | 244.1 | 308.5 |
| Water -- Lbs/Ft | 106.2 | 105.7 | 104.3 | 102.8 | 101.2 | 99.9 | 98.4 | 97.0 | 92.7 | 88.5 | 79.2 | 71.0 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | |
|--------------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|---------------------|
|  L.R. 90° Elbow | 114.0 4.5 | 129.0 4.5 | 256.0 4.5 | 332.0 4.5 |
|  S.R. 90° Elbow | 75.7 2.8 | 85.7 2.8 | 176.0 2.8 | 225.0 2.8 |
|  L.R. 45° Elbow | 57.2 1.9 | 64.5 1.9 | 132.0 1.9 | 168.0 1.9 |
|  Tee | 83.2 3.6 | 94.7 3.6 | 282.0 3.6 | 351.0 3.6 |
|  Lateral | 157.0 7.5 | 179.0 7.5 | 326.0 7.5 | 525.0 7.5 |
|  Reducer | 42.6 1.3 | 48.5 1.3 | 94.0 1.3 | 123.0 1.3 |
|  Cap | 12.7 2.1 | 14.5 2.1 | 57.0 2.1 | 75.0 2.1 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|------|--|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 125 1.5 | 139 1.5 | 331 1.5 | 380 1.5 | 573 1.5 | 797 1.5 | 1694 1.5 | | | |
|  Welding Neck | | | 159 1.5 | 355 1.5 | 430 1.5 | 652 1.5 | 1074 1.5 | 2069 1.5 | | |
|  Lap Joint | | | 165 1.5 | 415 1.5 | 566 1.5 | 820 1.5 | 1769 1.5 | | | |
|  Blind | 209 1.5 | 396 1.5 | 228 1.5 | 440 1.5 | 572 1.5 | 762 1.5 | 1030 1.5 | | | |
|  S.R. 90° Elbow | 599 5.8 | 1060 6.0 | 711 5.8 | 1126 6.0 | 1340 6.2 | 1793 6.6 | 2817 7.0 | | | |
|  L.R. 90° Elbow | | | 1350 7.4 | 941 7.4 | 1426 7.4 | | | | | |
|  45° Elbow | 439 4.4 | 870 4.7 | 521 4.4 | 901 4.7 | 1040 4.8 | 1543 5 | 2252 5.2 | | | |
|  Tee | 879 8.6 | 1625 9.0 | 1010 8.6 | 1602 9.0 | 1909 9.0 | 2690 9.9 | 4327 10.5 | | | |
|  Flanged Bonnet Gate | 1629 8.2 | 2578 9.3 | 1510 6.0 | 2505 6.5 | 3765 7.0 | 4460 7.8 | 6675 8.5 | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | | |
|  Flanged Bonnet - Check | 1371 10.5 | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | 3100 5.5 | 3400 5.6 | 4200 6.0 | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 - 199 | 200 - 299 | 300 - 399 | 400 - 499 | 500 - 599 | 600 - 699 | 700 - 799 | 800 - 899 | 900 - 999 | 1,000 - 1,099 | 1,100 - 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|-----------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 7.73 | 1½ 7.73 | 2 10.4 | 2½ 13.3 | 3 16.3 | 3 16.3 | 3½ 19.3 | 4 22.6 | 4 22.6 | 4½ 25.9 | 4½ 25.9 |
| Combination | | | | | | 3 22.7 | 3½ 28.0 | 4 33.8 | 4 33.8 | 4½ 39.5 | 4½ 39.5 |

Weight of Piping Materials – 20" PIPE (20" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10S | 10 | 20/Std. | 30/XS | 40 | 60 | 80 | 100 | 120 | 140 | 160 |
|---------------------------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.188 | 0.218 | 0.250 | 0.375 | 0.500 | 0.593 | 0.812 | 1.031 | 1.281 | 1.500 | 1.750 | 1.968 |
| Pipe -- Lbs/Ft. | 40.0 | 46.0 | 52.7 | 78.6 | 104.1 | 122.9 | 166.4 | 208.9 | 256.1 | 296.4 | 341.1 | 379 |
| Water -- Lbs/Ft | 131.0 | 130.2 | 129.5 | 126.0 | 122.8 | 120.4 | 115.0 | 109.4 | 103.4 | 98.3 | 92.6 | 87.9 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | |
|--------------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|---------------------|
|  L.R. 90° Elbow | 160.0 5.0 | 185.0 5.0 | 322.0 5.0 | 438.0 5.0 |
|  S.R. 90° Elbow | 106.0 3.4 | 122.0 3.4 | 238.0 3.4 | 278.0 3.4 |
|  L.R. 45° Elbow | 80.3 2.1 | 92.5 2.1 | 160.0 2.1 | 228.0 2.1 |
|  Tee | 112.0 4.0 | 130.0 4.0 | 378.0 4.0 | 490.0 4.0 |
|  Lateral | 228.0 8.3 | 265.0 8.3 | 396.0 8.3 | 625.0 8.3 |
|  Reducer | 71.6 1.7 | 87.6 1.7 | 142.0 1.7 | 186.0 1.7 |
|  Cap | 17.7 2.3 | 20.5 2.3 | 71.0 2.3 | 93.0 2.3 |

Note: Boldface black type is weight in pounds and light grey type underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|---------------------|---------------------|--------------------|------|--|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | 153 1.5 | | 180 1.5 | 378 1.5 | 468 1.5 | 733 1.5 | 972 1.5 | 2114 1.5 | | |
|  Welding Neck | | | 195 1.5 | 431 1.5 | 535 1.5 | 811 1.5 | 1344 1.5 | 2614 1.5 | | |
|  Lap Joint | | | 210 1.5 | 428 1.5 | 510 1.5 | 725 1.5 | 1048 1.5 | 2189 1.5 | | |
|  Blind | 275 1.5 | 487 1.5 | 297 1.5 | 545 1.5 | 711 1.5 | 976 1.5 | 1287 1.5 | | | |
|  S.R. 90° Elbow | 792 6.0 | 1315 6.3 | 922 6.0 | 1375 6.3 | 1680 6.5 | 2314 6.9 | 3610 7.3 | | | |
|  L.R. 90° Elbow | 1132 7.8 | 1725 7.8 | 1352 7.8 | 1705 7.8 | | | | | | |
|  45° Elbow | 592 4.6 | 1055 4.8 | 652 4.6 | 1105 4.8 | 1330 4.9 | 1917 5.2 | 2848 5.4 | | | |
|  Tee | 1178 9.0 | 2022 9.5 | 1378 9.0 | 1908 9.5 | 2370 9.7 | 3463 10.1 | 5520 11.0 | | | |
|  Flanged Bonnet Gate | 1934 8.3 | 3823 9.5 | 1855 6.0 | 3370 7.0 | 5700 8.0 | 5755 8.0 | | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | | |
|  Flanged Bonnet - Check | 1772 11.0 | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|------------------------------------------|------------|-----------|------------|-----------|-----------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 8.45 | 1½ 8.45 | 2 11.6 | 2½ 14.6 | 3 17.7 | 3 17.7 | 3½ 21.1 | 4 24.6 | 4 24.6 | 4½ 28.1 | 4½ 28.1 |
| Combination | Nom. Thick., In. Lbs/Ft | | | | | 3 24.7 | 3½ 30.7 | 4 37.0 | 4 37.0 | 4½ 43.1 | 4½ 43.1 |

Weight of Piping Materials – 24" PIPE (24" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10 | 20/Std. | XS | 30 | 40 | 60 | 80 | 100 | 140 | 160 |
|---------------------------|-------|-------|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.218 | 0.250 | 0.375 | 0.500 | 0.562 | 0.687 | 0.968 | 1.218 | 1.812 | 2.062 | 2.343 |
| Pipe -- Lbs/Ft. | 55.0 | 63.4 | 94.6 | 125.5 | 140.8 | 171.2 | 238.1 | 296.4 | 429.4 | 483.1 | 541.9 |
| Water -- Lbs/Ft | 188.9 | 188.0 | 183.8 | 180.1 | 178.1 | 174.3 | 165.8 | 158.3 | 141.4 | 134.5 | 127.0 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | |
|--------------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|
|  L.R. 90° Elbow | 260.0 6.0 | 500.0 6.0 | 578.0 6.0 |
|  S.R. 90° Elbow | 178.0 3.7 | 304.0 3.7 | 404.0 3.7 |
|  L.R. 45° Elbow | 130.0 2.5 | 252.0 2.5 | 292.0 2.5 |
|  Tee | 174.0 4.9 | 544.0 4.9 | 607.0 4.9 |
|  Lateral | 361.0 10.0 | 544.0 10.0 | 875.0 10.0 |
|  Reducer | 107.0 1.7 | 167.0 1.7 | 220 1.7 |
|  Cap | 28.6 2.8 | 102.0 2.8 | 134.0 2.8 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------|------|
| | Cast Iron | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | 236 1.5 | 245 1.5 | 577 1.5 | 676 1.5 | 1056 1.5 | 1823 1.5 | 3378 1.5 | | |
|  Welding Neck | | | 295 1.5 | 632 1.5 | 777 1.5 | 1157 1.5 | 2450 1.5 | 4153 1.5 | |
|  Lap Joint | | | 295 1.5 | 617 1.5 | 752 1.5 | 1046 1.5 | 2002 1.5 | 3478 1.5 | |
|  Blind | 404 1.5 | 757 1.5 | 446 1.5 | 841 1.5 | 1073 1.5 | 1355 1.5 | 2442 1.5 | | |
|  S.R. 90° Elbow | 1231 6.7 | 2014 6.8 | 1671 6.7 | 2174 6.8 | 2474 7.1 | 3506 7.6 | 6155 8.1 | | |
|  L.R. 90° Elbow | 1711 8.7 | 2644 8.7 | 1821 8.7 | 2874 8.7 | | | | | |
|  45° Elbow | 871 4.8 | 1604 5.0 | 1121 4.8 | 1634 5 | 1974 5.1 | 2831 5.5 | 5124 6.0 | | |
|  Tee | 1836 10.0 | 3061 10.2 | 2276 10.0 | 3161 10.2 | 3811 10.6 | 5184 11.4 | 9387 12.1 | | |
|  Flanged Bonnet Gate | 3062 8.5 | 6484 9.8 | 2500 5.0 | 4675 7.0 | 6995 8.7 | 8020 9.5 | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | |
|  Flanged Bonnet - Check | 2956 12.0 | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|----------------------------|------------|------------|-----------|-----------|-----------|------------|-----------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. 10.0 | 1½ 10.0 | 1½ 13.4 | 2 17.0 | 3 21.0 | 3 21.0 | 3½ 24.8 | 4 28.7 | 4 28.7 | 4½ 32.9 | 4½ 32.9 |
| Combination | Nom. Thick., In. Lbs/Ft | | | | | 3 29.2 | 3½ 36 | 4 43.1 | 4 43.1 | 4½ 50.6 | 4½ 50.6 |

Weight of Piping Materials – 26" PIPE (26" O.D.)

Pipe

| Sch./Wall Designation --> | 10 | Std. | 20/XS | | | | | | |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Thickness -- In. | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.000 | 1.125 |
| Pipe -- Lbs/Ft. | 670.0 | 85.7 | 102.6 | 136.2 | 169.0 | 202.0 | 235.0 | 267.0 | 299.0 |
| Water -- Lbs/Ft | 221.4 | 219.2 | 216.8 | 212.5 | 208.6 | 204.4 | 200.2 | 196.1 | 192.10 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | |
|-----------------------------------------------------------------------------------------------------|---------------------|---------------------|
|  L.R. 90° Elbow | 602.0 8.5 | 713.0 8.5 |
|  S.R. 90° Elbow | 359.0 5.0 | 474.0 5.0 |
|  L.R. 45° Elbow | 269.0 3.5 | 355.0 3.5 |
|  Tee | 634.0 6.8 | 794.0 6.8 |
|  Lateral | | |
|  Reducer | 200.0 2.5 | 272.0 2.5 |
|  Cap | 110.0 4.3 | 145.0 4.3 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|-------------------|--------------------|--------------------|--------------------|--------------------|------|------|
| | Cast Iron | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | | | 292 1.5 | 699 1.5 | 650 1.5 | 950 1.5 | 1525 1.5 | | |
|  Welding Neck | | | 342 1.5 | 799 1.5 | 750 1.5 | 1025 1.5 | 1575 1.5 | | |
|  Lap Joint | | | | | | | | | |
|  Blind | | | 567 1.5 | 1179 1.5 | 1125 1.5 | 1525 1.5 | 2200 1.5 | | |
|  S.R. 90° Elbow | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | |
|  45° Elbow | | | | | | | | | |
|  Tee | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | |
|  Flanged Bonnet – Globe or Angle | | | | | | | | | |
|  Flanged Bonnet – Check | | | | | | | | | |
|  Pressure Seal – Bonnet, Gate | | | | | | | | | |
|  Pressure Seal – Bonnet, Globe | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|------------|------------|------------|-------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 10.4 | 1½ 10.4 | 2 14.1 | 2½ 18.0 | 3 21.9 | 3½ 26.0 | 4 30.2 | 4½ 34.6 | 5 39.1 | 5 39.1 | 6 48.4 |
| Combination | | | | | | 3½ 37.0 | 4½ 51.9 | 5½ 67.8 | 6.0 76.0 | 6½ 84.5 | 7 93.2 |

Weight of Piping Materials – 28" PIPE (28" O.D.)

Pipe

| Sch./Wall Designation --> | 10 | Std. | 20/XS | 30 | | | | | |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.000 | 1.125 |
| Pipe -- Lbs/Ft. | 74.0 | 92.4 | 110.6 | 146.9 | 182.7 | 218.0 | 253.0 | 288.0 | 323.0 |
| Water -- Lbs/Ft | 257.3 | 255.0 | 252.7 | 248.1 | 243.6 | 238.9 | 234.4 | 230.0 | 225.6 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | |
|--------------------------------------------------------------------------------------------------|--------------|--------------|-----|-----|
|  L.R. 90° Elbow | 626.0 | 829.0 | 9.0 | 9.0 |
|  S.R. 90° Elbow | 415.0 | 551.0 | 5.4 | 5.4 |
|  L.R. 45° Elbow | 312.0 | 413.0 | 3.6 | 3.6 |
|  Tee | 729.0 | 910.0 | 7.0 | 7.0 |
|  Lateral | | | | |
|  Reducer | 210.0 | 290.0 | 2.7 | 2.7 |
|  Cap | 120.0 | 160.0 | 4.5 | 4.5 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-----|------------|-------------|-------------|-------------|-------------|------|------|--|
| | Cast Iron | | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | | | 334 | 853 | 780 | 1075 | 1800 | | | |
| | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | |
|  Welding Neck | | | 364 | 943 | 880 | 1175 | 1850 | | | |
| | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | |
|  Lap Joint | | | | | | | | | | |
|  Blind | | | 669 | 1408 | 1425 | 1750 | 2575 | | | |
| | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | |
|  S.R. 90° Elbow | | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | | |
|  45° Elbow | | | | | | | | | | |
|  Tee | | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | | |
|  Flanged Bonnet - Check | | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation







| Temp. Range ---> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|-----------------------------------|---------------|-----------|---------------|-----------|---------------|---------------|---------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. 1 1/2 11.2 | 1 1/2 11.2 | 2 15.1 | 2 1/2 19.2 | 3 23.4 | 3 1/2 27.8 | 4 32.3 | 4 1/2 36.9 | 5 41.6 | 5 41.6 | 6 51.4 |
| Combination | | | | | | 3 1/2 39.5 | 4 1/2 55.4 | 5 1/2 72.2 | 6 80.9 | 6 1/2 89.8 | 7 99.0 |

Weight of Piping Materials – 30" PIPE (30" O.D.)

Pipe

| Sch./Wall Designation --> | 5S | 10 & 10S | Std. | 20/XS | 30 | | | | |
|---------------------------|-------|----------|-------|--------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.75 | 0.875 | 1.000 | 1.125 |
| Pipe -- Lbs/Ft. | 79.0 | 98.9 | 118.7 | 1576.0 | 196.1 | 234.0 | 272.0 | 310.0 | 347.0 |
| Water -- Lbs/Ft | 296.3 | 293.5 | 2910 | 286.0 | 281.1 | 276.6 | 271.8 | 267 | 262.2 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | | | |
|-----------------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|----------------------|
|  L.R. 90° Elbow | 478.0 10.0 | 775.0 10.0 | 953.0 10.0 | 596.0 10.0 |
|  S.R. 90° Elbow | 319.0 5.9 | 470.0 5.9 | 644.0 5.9 | 388.0 5.9 |
|  L.R. 45° Elbow | 239.0 3.9 | 358.0 3.9 | 475.0 3.9 | 298.0 3.9 |
|  Tee | | 855.0 7.8 | 1065.0 7.8 | |
|  Lateral | | | | |
|  Reducer | | 220.0 3.9 | 315.0 3.9 | |
|  Cap | | 125.0 4.8 | 175.0 4.8 | |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|-------------------|--------------------|--------------------|--------------------|--------------------|------|------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | | | 365 1.5 | 975 1.5 | 900 1.5 | 1175 1.5 | 2075 1.5 | | | |
|  Welding Neck | | | 410 1.5 | 1095 1.5 | 1000 1.5 | 1300 1.5 | 2150 1.5 | | | |
|  Lap Joint | | | | | | | | | | |
|  Blind | | | 770 1.5 | 1665 1.5 | 1675 1.5 | 2000 1.5 | 3025 1.5 | | | |
|  S.R. 90° Elbow | | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | | |
|  45° Elbow | | | | | | | | | | |
|  Tee | | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | | |
|  Flanged Bonnet - Check | | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|------------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 11.9 | 1½ 11.9 | 2 16.1 | 2½ 20.5 | 3 25.0 | 3½ 29.5 | 4 34.3 | 4½ 39.1 | 5 44.1 | 5 44.1 | 6 54.4 |
| Combination | | | | | | 3½ 42.1 | 4½ 58.9 | 5½ 76.5 | 6 85.7 | 6½ 95.1 | 7 104.7 |

Weight of Piping Materials – 32" PIPE (32" O.D.)

Pipe

| Sch./Wall Designation --> | 10 | Std. | 20/XS | 30 | 40 | | | | | |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.688 | 0.750 | 0.875 | 1.000 | 1.125 |
| Pipe -- Lbs/Ft. | 85.0 | 105.8 | 126.7 | 168.2 | 209.4 | 229.9 | 250.0 | 291.0 | 331.0 | 371.0 |
| Water -- Lbs/Ft. | 337.8 | 335.0 | 323.3 | 327.0 | 321.8 | 319.2 | 316.7 | 311.6 | 306.4 | 301.3 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | |
|-----------------------------------------------------------------------------------------------------|----------------------|-----------------------|
|  L.R. 90° Elbow | 818.0 10.5 | 1090.0 10.5 |
|  S.R. 90° Elbow | 546.0 6.3 | 722.0 6.3 |
|  L.R. 45° Elbow | 408.0 4.2 | 541.0 4.2 |
|  Tee | 991.0 8.4 | 1230.0 8.4 |
|  Lateral | | |
|  Reducer | 255.0 3.1 | 335.0 3.1 |
|  Cap | 145.0 5.2 | 190.0 5.2 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|-------------------|--------------------|--------------------|--------------------|--------------------|------|------|
| | Cast Iron | | Steel | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | | | 476 1.5 | 1093 1.5 | 1025 1.5 | 1375 1.5 | 2500 1.5 | | |
|  Welding Neck | | | 516 1.5 | 1228 1.5 | 1150 1.5 | 1500 1.5 | 2575 1.5 | | |
|  Lap Joint | | | | | | | | | |
|  Blind | | | 951 1.5 | 1978 1.5 | 1975 1.5 | 2300 1.5 | 3650 1.5 | | |
|  S.R. 90° Elbow | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | |
|  45° Elbow | | | | | | | | | |
|  Tee | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | |
|  Flanged Bonnet – Globe or Angle | | | | | | | | | |
|  Flanged Bonnet – Check | | | | | | | | | |
|  Pressure Seal – Bonnet, Gate | | | | | | | | | |
|  Pressure Seal – Bonnet, Globe | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|------------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 12.7 | 1½ 12.7 | 2 17.1 | 2½ 21.7 | 3 26.5 | 3½ 31.3 | 4 36.3 | 4½ 41.4 | 5 46.6 | 5 46.6 | 6 57.5 |
| Combination | | | | | | 3½ 44.7 | 4½ 62.3 | 5½ 80.9 | 6 90.5 | 6½ 100.4 | 7 110.5 |

Weight of Piping Materials – 34" PIPE (34" O.D.)

Pipe

| Sch./Wall Designation --> | 10 | Std. | 20/XS | 30 | 40 | | | | | | |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| Thickness -- In. | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.688 | 0.750 | 0.875 | 1.000 | 1.125 | |
| Pipe -- Lbs/Ft. | 90.0 | 112.4 | 134.7 | 178.9 | 222.8 | 244.6 | 266 | 310.0 | 353.0 | 395.0 | |
| Water -- Lbs/Ft | 382.0 | 379.1 | 376.0 | 370.3 | 365.0 | 362.2 | 359.5 | 354.1 | 348.6 | 343.2 | |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | |
|-----------------------------------------------------------------------------------------------------|----------------------|-----------------------|
|  L.R. 90° Elbow | 926.0 11.0 | 1230.0 11.0 |
|  S.R. 90° Elbow | 617.0 5.5 | 817.0 5.5 |
|  L.R. 45° Elbow | 463.0 4.4 | 615.0 4.4 |
|  Tee | 1136.0 8.9 | 1420.0 8.9 |
|  Lateral | | |
|  Reducer | 270.0 3.3 | 355.0 3.3 |
|  Cap | 160.0 5.6 | 210.0 5.6 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|--------------------|--------------------|--------------------|--------------------|--------------------|------|------|
| | Cast Iron | | | | Steel | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | | | 515 1.5 | 1281 1.5 | 1150 1.5 | 1500 1.5 | 2950 1.5 | | |
|  Welding Neck | | | 560 1.5 | 1406 1.5 | 1300 1.5 | 1650 1.5 | 3025 1.5 | | |
|  Lap Joint | | | | | | | | | |
|  Blind | | | 1085 1.5 | 2231 1.5 | 2250 1.5 | 2575 1.5 | 4275 1.5 | | |
|  S.R. 90° Elbow | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | |
|  45° Elbow | | | | | | | | | |
|  Tee | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | |
|  Flanged Bonnet – Globe or Angle | | | | | | | | | |
|  Flanged Bonnet – Check | | | | | | | | | |
|  Pressure Seal – Bonnet, Gate | | | | | | | | | |
|  Pressure Seal – Bonnet, Globe | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|------------|------------|------------|-----------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 13.4 | 1½ 13.4 | 2 18.2 | 2½ 23.0 | 3 28.0 | 3½ 33.1 | 4 38.3 | 4½ 43.7 | 5 49.1 | 5 49.1 | 6 60.5 |
| Combination | | | | | | 3½ 47.2 | 4½ 65.8 | 5½ 85.3 | 6 95.4 | 6½ 105.7 | 7 116.3 |

Weight of Piping Materials – 36" PIPE (36" O.D.)

Pipe

| Sch./Wall Designation --> | 10 | Std. | 20/XS | 30 | 40 | | | | |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.000 | 1.125 |
| Pipe -- Lbs/Ft. | 96.0 | 119.1 | 142.7 | 189.6 | 236.1 | 282.4 | 328.0 | 374.0 | 419.0 |
| Water -- Lbs/Ft | 429.1 | 425.9 | 422.6 | 416.6 | 411.0 | 405.1 | 399.4 | 393.6 | 387.9 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | |
|--------------------------------------------------------------------------------------------------|-----------------------|-----------------------|
|  L.R. 90° Elbow | 1040.0 12.0 | 1380.0 12.0 |
|  S.R. 90° Elbow | 692.0 5.0 | 913.0 5.0 |
|  L.R. 45° Elbow | 518.0 4.8 | 686.0 4.8 |
|  Tee | 1294.0 9.5 | 1610.0 9.5 |
|  Lateral | | |
|  Reducer | 340.0 3.6 | 360.0 3.6 |
|  Cap | 175.0 6.0 | 235.0 6.0 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|-----|--------------------|--------------------|--------------------|--------------------|--------------------|------|------|--|
| | Cast Iron | | Steel | | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 | |
|  Screwed or Slip On | | | 588 1.5 | 1485 1.5 | 1325 1.5 | 1600 1.5 | 3350 1.5 | | | |
|  Welding Neck | | | 628 1.5 | 1585 1.5 | 1475 1.5 | 1750 1.5 | 3450 1.5 | | | |
|  Lap Joint | | | | | | | | | | |
|  Blind | | | 1233 1.5 | 2560 1.5 | 2525 1.5 | 2950 1.5 | 4900 1.5 | | | |
|  S.R. 90° Elbow | | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | | |
|  45° Elbow | | | | | | | | | | |
|  Tee | | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | | |
|  Flanged Bonnet - Check | | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | | |

Pipe Insulation








| Temp. Range --> | 100 - 199 | 200 - 299 | 300 - 399 | 400 - 499 | 500 - 599 | 600 - 699 | 700 - 799 | 800 - 899 | 900 - 999 | 1,000 - 1,099 | 1,100 - 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|------------|------------|------------|------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 14.2 | 1½ 14.2 | 2 19.2 | 2½ 24.2 | 3 29.5 | 3½ 34.8 | 4 40.3 | 4½ 45.9 | 5 51.7 | 5 51.7 | 6 63.5 |
| Combination | | | | | | 3½ 49.8 | 4½ 69.3 | 5½ 89.7 | 6 100.2 | 6½ 111.0 | 7 122.0 |

Weight of Piping Materials – 42" PIPE (42" O.D.)

Pipe

| Sch./Wall Designation --> | Std. | 20/XS | 30 | 40 | | | | |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Thickness -- In. | 0.250 | 0.375 | 0.500 | 0.625 | 0.75 | 1000 | 1.250 | 1.500 |
| Pipe -- Lbs/Ft. | 112.0 | 166.7 | 221.6 | 276.0 | 330.0 | 438.0 | 544.0 | 649.0 |
| Water -- Lbs/Ft | 586.4 | 578.7 | 571.7 | 565.4 | 558.4 | 544.8 | 531.2 | 517.9 |














Welded Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | | |
|-----------------------------------------------------------------------------------------------------|-----------------------|-----------------------|
|  L.R. 90° Elbow | 1420.0 15.0 | 1880.0 15.0 |
|  S.R. 90° Elbow | 1079 9.0 | 1430.0 9.0 |
|  L.R. 45° Elbow | 707.0 6.0 | 937.0 6.0 |
|  Tee | 1870.0 | 2415.0 |
|  Lateral | | |
|  Reducer | 310.0 4.5 | 410.0 4.5 |
|  Cap | 230.0 7.5 | 300.0 7.5 |

Note: Boldface black type is weight in pounds and **light grey type** underneath is weight factor for insulation.

- Insulation thicknesses and weights are based on average conditions and do not constitute a recommendation for specific thicknesses of materials.
- Insulation weights are based on 85% magnesia and hydrous calcium silicate at 11 lbs/cu. foot. The listed thicknesses and weights of combination covering are the sums of the inner layer of diatomaceous earth at 21 lbs/cu. foot and the outer layer at 11 lbs/cubic foot.
- Insulation weights include allowances for wire, cement, canvas, bands and paint but not special surface finishes.
- To find the weight of covering on flanges, valves or fittings, multiply the weight factor by the weight per foot of covering used on straight pipe.
- Valve weights are approximate. Whenever possible, obtain weights from the manufacturer.
- Cast iron valve weights are for flanged end valves; steel weights for welding end valves.
- All flanged fitting, flanged valve and flange weights include the proportional weight of bolts or studs to make up all joints.

Cast Iron & Steel Fittings – Line 1: Weight in Pounds, Line 2: Insulation Weight Factor

| | Pressure Rating (PSI) | | | | | | | | |
|----------------------------------------------------------------------------------------------------------------------|-----------------------|-----|--------------------|--------------------|--------------------|--------------------|-----|------|------|
| | Cast Iron | | Steel | | | | | | |
| | 125 | 250 | 150 | 300 | 400 | 600 | 900 | 1500 | 2500 |
|  Screwed or Slip On | | | 792 1.5 | 1895 1.5 | 1759 1.5 | 2320 1.5 | | | |
|  Welding Neck | | | 862 1.5 | 2024 1.5 | 1879 1.5 | 2414 1.5 | | | |
|  Lap Joint | | | | | | | | | |
|  Blind | | | 1733 1.5 | 3449 1.5 | 3576 1.5 | 4419 1.5 | | | |
|  S.R. 90° Elbow | | | | | | | | | |
|  L.R. 90° Elbow | | | | | | | | | |
|  45° Elbow | | | | | | | | | |
|  Tee | | | | | | | | | |
|  Flanged Bonnet Gate | | | | | | | | | |
|  Flanged Bonnet - Globe or Angle | | | | | | | | | |
|  Flanged Bonnet - Check | | | | | | | | | |
|  Pressure Seal - Bonnet, Gate | | | | | | | | | |
|  Pressure Seal - Bonnet, Globe | | | | | | | | | |

Pipe Insulation

| Temp. Range --> | 100 – 199 | 200 – 299 | 300 – 399 | 400 – 499 | 500 – 599 | 600 – 699 | 700 – 799 | 800 – 899 | 900 – 999 | 1,000 – 1,099 | 1,100 – 1,200 |
|-------------------------------|---------------------------------------|------------|-----------|------------|-----------|------------|------------|-------------|------------|---------------|---------------|
| 85% Magnesia Calcium Silicate | Nom. Thick., In. Lbs/Ft 1½ 16.5 | 1½ 16.5 | 2 22.2 | 2½ 28.0 | 3 34.0 | 3½ 40.1 | 4 46.4 | 4½ 52.7 | 5 59.2 | 5 59.2 | 6 72.6 |
| Combination | | | | | | 3½ 57.4 | 4½ 79.7 | 5½ 102.8 | 6 114.8 | 6½ 126.9 | 7 139.3 |

Thermal Expansion of Pipe Materials – Inches Per Foot

| Carbon Steel • Carbon Moly Steel • Low-Chrome Steel (Thru 3% Cr) – Temperature | | | | | | | | | | |
|--------------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Temp °F | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| -200 | -0.0180 | -0.0187 | -0.0192 | -0.0198 | -0.0203 | -0.0209 | -0.0215 | -0.0220 | -0.0225 | -0.0230 |
| -100 | -0.0121 | -0.0127 | -0.0133 | -0.014 | -0.0146 | -0.0152 | -0.0158 | -0.0163 | -0.0169 | -0.0171 |
| 0 | -0.0051 | -0.0058 | -0.0065 | -0.0073 | -0.0080 | -0.0087 | -0.0096 | -0.0103 | -0.0109 | -0.0116 |
| 0 | -0.0051 | -0.0044 | -0.0037 | -0.0029 | -0.0022 | -0.0015 | -0.0007 | 0.0000 | 0.0008 | 0.0015 |
| 100 | 0.0023 | 0.0030 | 0.0038 | 0.0046 | 0.0053 | 0.0061 | 0.0068 | 0.0076 | 0.0084 | 0.0091 |
| 200 | 0.0099 | 0.0107 | 0.0116 | 0.0124 | 0.0132 | 0.0141 | 0.0149 | 0.0157 | 0.0165 | 0.0174 |
| 300 | 0.0182 | 0.0191 | 0.0200 | 0.0208 | 0.0217 | 0.0226 | 0.0235 | 0.0244 | 0.0252 | 0.0261 |
| 400 | 0.027 | 0.0279 | 0.0288 | 0.0298 | 0.0307 | 0.0316 | 0.0325 | 0.0344 | 0.0344 | 0.0353 |
| 500 | 0.0362 | 0.0372 | 0.0382 | 0.0391 | 0.0401 | 0.0411 | 0.0421 | 0.0431 | 0.0440 | 0.0450 |
| 600 | 0.0460 | 0.047 | 0.0481 | 0.0491 | 0.0501 | 0.0512 | 0.0522 | 0.0532 | 0.0542 | 0.0553 |
| 700 | 0.0563 | 0.0574 | 0.0584 | 0.0595 | 0.0606 | 0.0617 | 0.0627 | 0.0638 | 0.0649 | 0.0659 |
| 800 | 0.0670 | 0.0681 | 0.0692 | 0.0703 | 0.0714 | 0.0726 | 0.0737 | 0.0748 | 0.0759 | 0.0770 |
| 900 | 0.0781 | 0.0792 | 0.0803 | 0.0813 | 0.0824 | 0.0835 | 0.0846 | 0.0857 | 0.0867 | 0.0878 |
| 1,000 | 0.0889 | 0.0901 | 0.0912 | 0.0924 | 0.9359 | 0.0946 | 0.0958 | 0.097 | 0.0981 | 0.3993 |
| 1,100 | 0.1004 | 0.1015 | 0.1025 | 0.1036 | 0.1046 | 0.1057 | 0.1068 | 0.1078 | 0.1089 | 0.1099 |
| 1,200 | 0.1110 | 0.1121 | 0.1132 | 0.1144 | 0.1155 | 0.1166 | 0.1177 | 0.1188 | 0.1200 | 0.1211 |
| 1,300 | 0.1222 | 0.1233 | 0.1244 | 0.1256 | 0.1267 | 0.1278 | 0.1299 | 0.1320 | 0.1342 | 0.1363 |
| 1,400 | 0.1334 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Thermal Expansion of Pipe Materials – Inches Per Foot

| Austenitic Stainless Steels (304,316, 347) – Temperature | | | | | | | | | | |
|----------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Temp °F | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| -200 | -0.0281 | -0.0295 | -0.0305 | -0.0314 | -0.0324 | -0.0334 | -0.0343 | -0.0353 | -0.0362 | -0.0372 |
| -100 | -0.0187 | -0.0197 | -0.0207 | -0.0216 | -0.0226 | -0.0236 | -0.0245 | -0.0254 | -0.0263 | -0.0272 |
| 0 | -0.0078 | -0.0089 | -0.0001 | -0.0112 | -0.0123 | -0.0134 | -0.0145 | -0.0155 | -0.0166 | -0.0176 |
| 0 | -0.0078 | -0.0067 | -0.0056 | -0.0044 | -0.0033 | -0.0022 | -0.0011 | 0.0000 | 0.0012 | 0.0023 |
| 100 | 0.0034 | 0.0045 | 0.0056 | 0.0068 | 0.0079 | 0.009 | 0.0101 | 0.0112 | 0.0124 | 0.0135 |
| 200 | 0.0146 | 0.0158 | 0.0169 | 0.0181 | 0.0192 | 0.0203 | 0.0215 | 0.0227 | 0.0238 | 0.0250 |
| 300 | 0.0261 | 0.0273 | 0.0285 | 0.0297 | 0.0309 | 0.0321 | 0.0332 | 0.0344 | 0.0356 | 0.0368 |
| 400 | 0.0380 | 0.0392 | 0.0404 | 0.0416 | 0.0428 | 0.044 | 0.0453 | 0.0465 | 0.0477 | 0.0489 |
| 500 | 0.0501 | 0.0513 | 0.0526 | 0.0538 | 0.0550 | 0.0562 | 0.0575 | 0.0587 | 0.0599 | 0.0612 |
| 600 | 0.0624 | 0.0637 | 0.0649 | 0.0662 | 0.0674 | 0.0687 | 0.0700 | 0.0712 | 0.0725 | 0.0737 |
| 700 | 0.0750 | 0.0763 | 0.0776 | 0.0789 | 0.0802 | 0.0815 | 0.0828 | 0.0841 | 0.0854 | 0.0867 |
| 800 | 0.0880 | 0.0893 | 0.0906 | 0.092 | 0.0933 | 0.0946 | 0.0959 | 0.0972 | 0.0986 | 0.0999 |
| 900 | 0.1012 | 0.1026 | 0.1039 | 0.1053 | 0.1066 | 0.108 | 0.1094 | 0.1107 | 0.1121 | 0.1134 |
| 1,000 | 0.1148 | 0.1162 | 0.1175 | 0.1189 | 0.1202 | 0.1216 | 0.1229 | 0.1243 | 0.1257 | 0.1270 |
| 1,100 | 0.1284 | 0.1298 | 0.1311 | 0.1325 | 0.1338 | 0.1352 | 0.1366 | 0.1379 | 0.1393 | 0.1406 |
| 1,200 | 0.1420 | 0.1434 | 0.1447 | 0.1461 | 0.1474 | 0.1488 | 0.1502 | 0.1515 | 0.1529 | 0.1542 |
| 1,300 | 0.1556 | 0.1570 | 0.1583 | 0.1597 | 0.1610 | 0.1624 | 0.1638 | 0.1651 | 0.1665 | 0.1678 |
| 1,400 | 0.1692 | 0.1704 | 0.1717 | 0.1731 | 0.1744 | 0.1757 | 0.1771 | 0.1784 | 0.1796 | 0.1811 |

Thermal Expansion of Pipe Materials

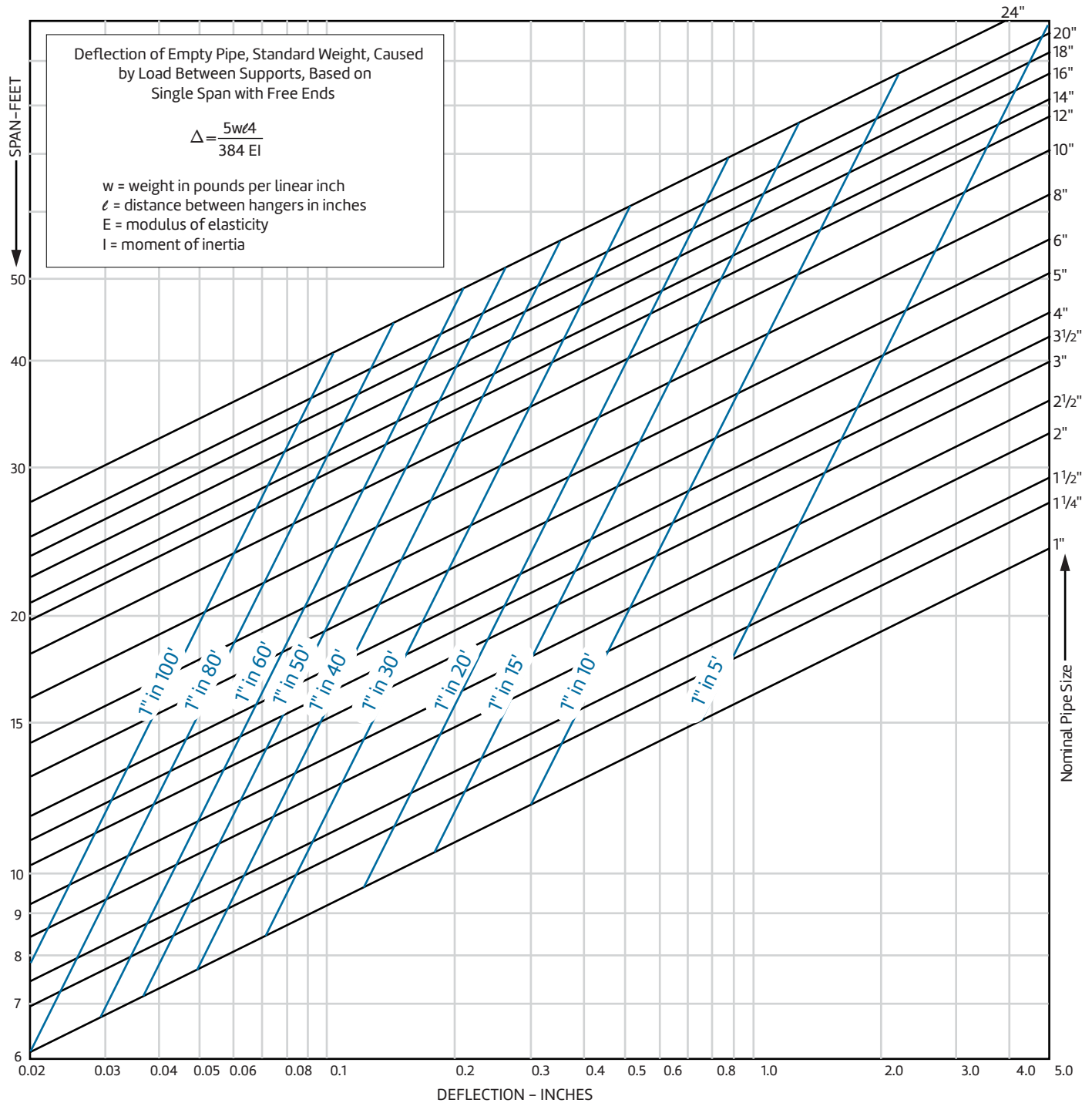
Thermal Expansion of Pipe Materials – Inches Per Foot

| Temp °F | Intermediate Alloy Steels (5% thru 9% Cr MO) | Copper | Brass | Aluminum |
|---------|----------------------------------------------|---------|---------|----------|
| -200 | - | -0.0275 | -0.2870 | -0.0373 |
| -150 | - | -0.0231 | -0.0241 | -0.0310 |
| -100 | - | -0.1830 | -0 1900 | -0.0244 |
| -50 | - | -0.1320 | -0.0137 | -0.0176 |
| 0 | - | -0.0790 | -0.0081 | -0.0104 |
| 50 | - | -0.0022 | -0.0023 | -0.0030 |
| 70 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 100 | 0.0022 | 0.0034 | 0.0035 | 0.0046 |
| 150 | 0.0058 | 0.0091 | 0.0093 | 0.0123 |
| 200 | 0.0094 | 0.0151 | 0.0152 | 0.0200 |
| 250 | 0.0132 | 0.0208 | 0.0214 | 0.0283 |
| 300 | 0.0171 | 0.0267 | 0.0276 | 0.0366 |
| 350 | 0.0210 | 0.0327 | 0.034 | 0.0452 |
| 400 | 0.0250 | 0.0388 | 0.0405 | 0.0539 |
| 450 | 0.0292 | 0.0449 | 0.0472 | 0.0628 |
| 500 | 0.0335 | 0.0512 | 0.0540 | 0.0717 |
| 550 | 0.0379 | 0.0574 | 0.0610 | 0.081 |
| 600 | 0.0424 | 0.0639 | 0.068 | 0.0903 |
| 650 | 0.0469 | 0.0703 | 0.0753 | - |
| 700 | 0.0514 | 0.0768 | 0.0826 | - |
| 750 | 0.0562 | 0.0834 | 0.0902 | - |
| 800 | 0.0610 | 0.09 | 0.0978 | - |
| 850 | 0.0658 | 0.0967 | 0 1056 | - |
| 900 | 0.0707 | 0.1037 | 0 1135 | - |
| 950 | 0.0756 | 0.1105 | 0 1216 | - |
| 1000 | 0.0806 | 0.1175 | 0 1298 | - |
| 1050 | 0.0855 | - | - | - |
| 1100 | 0.0905 | - | - | - |
| 1150 | 0.0952 | - | - | - |
| 1200 | 0.1000 | - | - | - |
| 1250 | 0.1053 | - | - | - |
| 1300 | 0.1106 | - | - | - |
| 1350 | 0.1155 | - | - | - |
| 1400 | 0.1205 | - | - | - |

Properties of Saturated Steam
(Standard Barometer 14,696 PSI)

| Gauge Pressure Lbs./Sq. Inch | Temp °F |
|------------------------------|---------|
| 0 | 212.00 |
| 5 | 227.14 |
| 10 | 239.39 |
| 15 | 249.75 |
| 20 | 258.76 |
| 25 | 266.78 |
| 30 | 274.02 |
| 35 | 280.62 |
| 40 | 286.71 |
| 45 | 292.37 |
| 50 | 297.66 |
| 55 | 302.62 |
| 60 | 307.32 |
| 65 | 311.77 |
| 70 | 316.00 |
| 75 | 320.03 |
| 80 | 323.90 |
| 85 | 327.59 |
| 90 | 331.15 |
| 95 | 334.57 |
| 100 | 337.88 |
| 150 | 365.85 |
| 200 | 387.78 |
| 250 | 406.01 |
| 300 | 421.71 |
| 350 | 435.59 |
| 400 | 448.12 |
| 450 | 459.59 |
| 500 | 469.99 |
| 550 | 479.93 |
| 600 | 488.79 |
| 650 | 497.29 |
| 700 | 505.15 |
| 750 | 512.75 |
| 800 | 520.92 |
| 850 | 526.97 |
| 900 | 533.63 |
| 950 | 540.26 |
| 1000 | 546.12 |
| 1050 | 551.98 |
| 1100 | 557.84 |

Deflection of Empty Pipe



Values are plotted for the pipes empty since this more nearly approaches the condition that exists for pocketing of condensation. Although the weight of fluid carried by the pipe will cause an increase in the deflection of the pipe between supports, this increased sag disappears during drainage. Therefore, the deflection produced by the weight of empty pipe should be considered in determining slope for drainage.

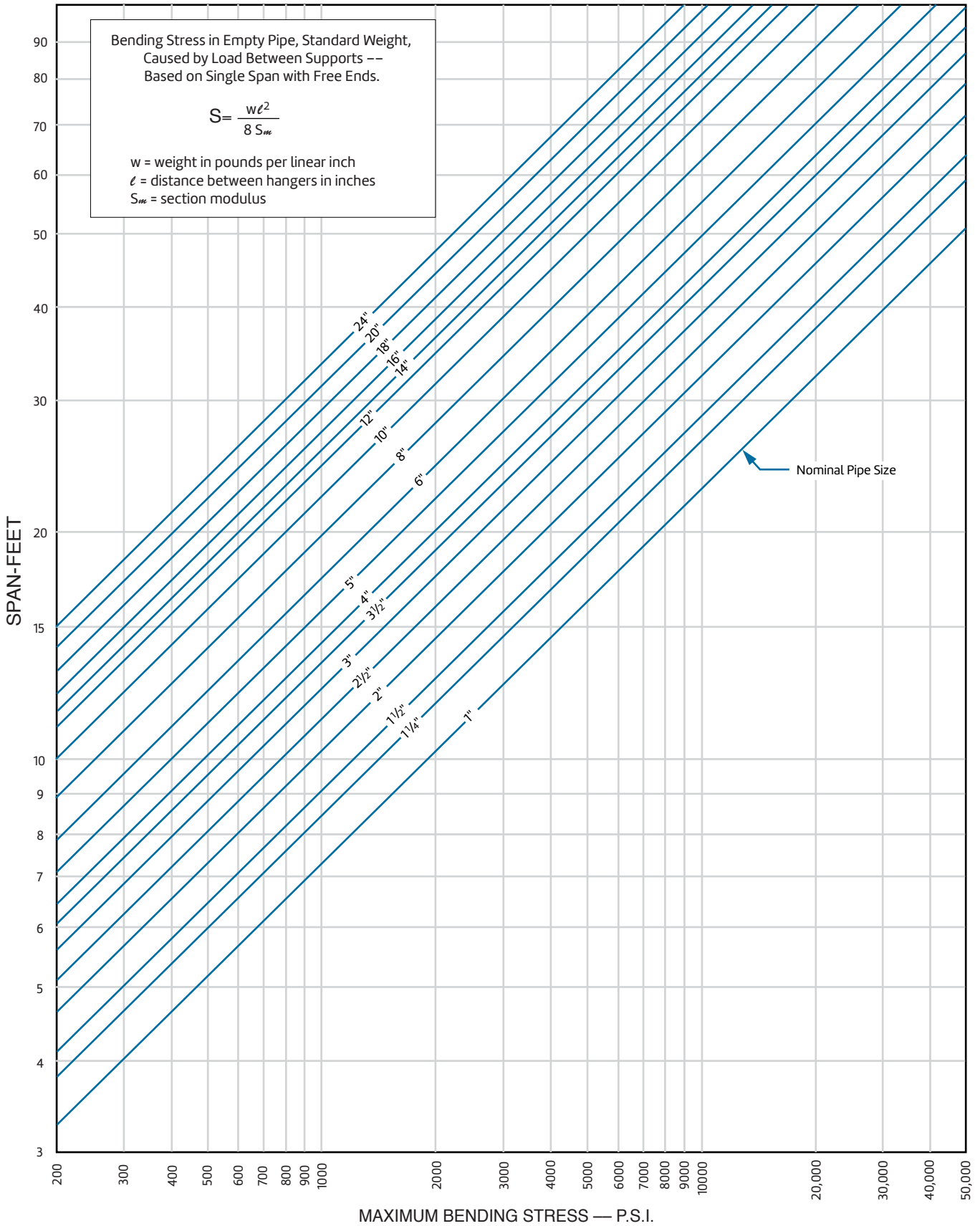
This chart is based on E = 29,000,000 P.S.I.



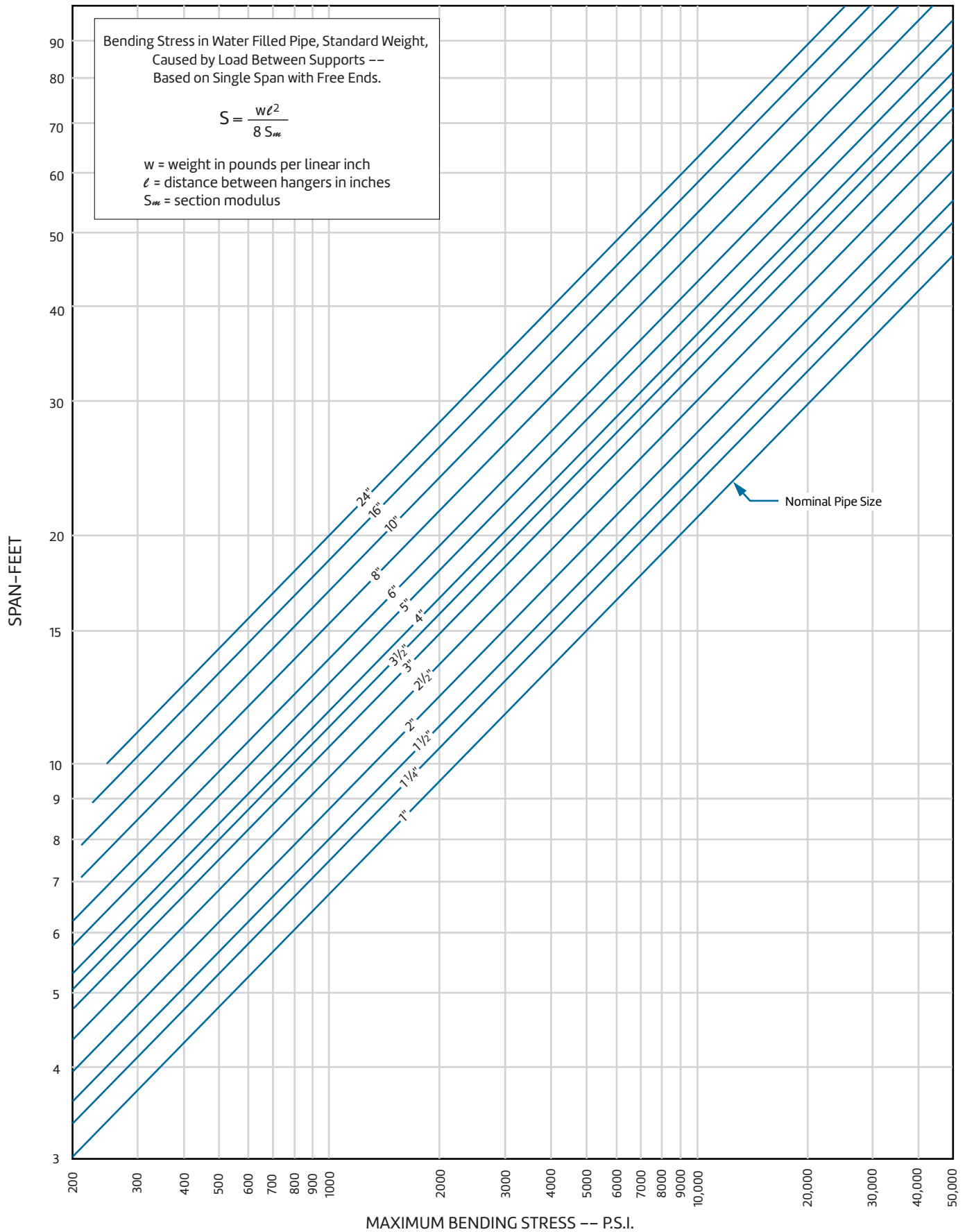
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Building connections that last™

Bending Stress in Empty Pipe



Bending Stress in Water Filled Pipe



Minimum Distance to First Hanger

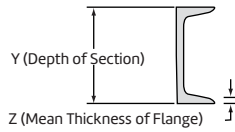
$$L = \sqrt{\frac{\Delta \times (\text{O.D. of Pipe}) \times 10^6}{1.6 \times S}} \quad S = 10,000 \text{ p.s.i}$$

Pipe Size, Pipe O.D.

| | 1 1.315 | 1¼ 1.66 | 1½ 1.900 | 2 2.375 | 2½ 2.875 | 3 3.5 | 3½ 4 | 4 4.5 | 5 5.563 | 6 6.625 | 8 8.625 | 10 10.75 | 12 12.75 | 14 14 | 16 16 | 18 18 | 20 20 |
|----|------------|------------|-------------|------------|-------------|----------|---------|----------|------------|------------|------------|-------------|-------------|----------|----------|----------|----------|
| ¼ | 4½ | 5 | 5½ | 6 | 6½ | 7½ | 8 | 8½ | 9½ | 10 | 11½ | 13 | 14 | 15 | 16 | 17 | 17½ |
| ½ | 6½ | 7 | 7½ | 8½ | 9½ | 10½ | 11 | 12 | 13 | 14½ | 16½ | 18½ | 20 | 21 | 22½ | 23½ | 25 |
| ¾ | 8 | 9 | 9½ | 10½ | 11½ | 13 | 13½ | 14½ | 16 | 17½ | 20 | 22½ | 24½ | 25½ | 27½ | 29 | 30½ |
| 1 | 9 | 10 | 11 | 12 | 13½ | 15 | 16 | 17 | 18½ | 20½ | 23 | 26 | 28 | 29½ | 31½ | 33½ | 35½ |
| 1¼ | 10 | 11½ | 12 | 13½ | 15 | 16¼ | 17½ | 19 | 21 | 23 | 26 | 29 | 31½ | 39 | 35½ | 37½ | 39½ |
| 1½ | 11 | 12½ | 13½ | 15 | 16½ | 18 | 19½ | 20½ | 23 | 25 | 28½ | 31½ | 34½ | 36 | 38½ | 41 | 43½ |
| 1¾ | 12 | 13½ | 14½ | 16 | 17½ | 19½ | 21 | 22 | 24½ | 27 | 30½ | 34½ | 37½ | 39 | 42 | 44½ | 47 |
| 2 | 13 | 14½ | 15½ | 17 | 19 | 21 | 22½ | 23½ | 26½ | 29 | 33 | 36½ | 40 | 42 | 44½ | 47½ | 50 |
| 2¼ | 13½ | 15½ | 16½ | 18½ | 20 | 22 | 23½ | 25 | 28 | 30¼ | 35 | 39 | 42½ | 44½ | 47½ | 50½ | 53 |
| 2½ | 14½ | 16 | 17 | 19½ | 21 | 23½ | 25 | 26½ | 29½ | 32 | 36½ | 41 | 44½ | 47 | 50 | 53 | 56 |
| 2¾ | 15 | 17 | 18 | 20 | 22 | 24½ | 26 | 28 | 31 | 33½ | 38½ | 43 | 47 | 49 | 52½ | 55½ | 58½ |
| 3 | 15½ | 17½ | 19 | 21 | 23 | 25½ | 27½ | 29 | 32½ | 35 | 40 | 45 | 49 | 51 | 55 | 58 | 61 |
| 3½ | 17 | 19 | 20½ | 23 | 25 | 27½ | 29½ | 31½ | 35 | 38 | 43½ | 48½ | 53 | 55½ | 59 | 62½ | 66 |
| 4 | 18 | 20½ | 22 | 24½ | 27 | 29½ | 31½ | 33½ | 37½ | 40½ | 46½ | 52 | 56½ | 59 | 59 | 63 | 70½ |
| 4½ | 19 | 21½ | 23 | 26 | 28½ | 31½ | 33½ | 35½ | 39½ | 43 | 49½ | 55 | 60 | 62½ | 67 | 71 | 75 |
| 5 | 20½ | 23 | 24½ | 27 | 30 | 33 | 35½ | 37½ | 41½ | 45½ | 52 | 58 | 63 | 66 | 70½ | 75 | 79 |
| 5½ | 21½ | 24 | 25½ | 28½ | 31½ | 34½ | 37 | 39½ | 43½ | 47½ | 54½ | 61 | 66 | 69½ | 74 | 78½ | 83 |
| 6 | 22 | 25 | 26½ | 30 | 33 | 36 | 38½ | 41 | 45½ | 50 | 57 | 63½ | 69 | 72½ | 77½ | 82 | 86½ |

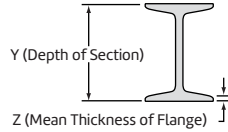
Definition

American Standard Channels



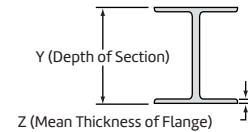
| Y in | Wt. / Ft. lb | Width in | Z in |
|---------|--------------|-------------------------------|---------|
| 3 | 4.1 | 1 ⁵ / ₈ | 0.250 |
| | 5.0 | 1 ¹ / ₂ | |
| | 6.0 | 1 ⁵ / ₈ | |
| 4 | 5.4 | 1 ⁵ / ₈ | 0.313 |
| | 7.25 | 1 ³ / ₄ | |
| 5 | 6.7 | 1 ³ / ₄ | 0.313 |
| | 9.0 | 1 ⁷ / ₈ | |
| 6 | 8.2 | 1 ⁷ / ₈ | 0.375 |
| | 10.5 | 2 | |
| 7 | 13.0 | 2 ¹ / ₈ | 0.375 |
| | 9.8 | 2 ¹ / ₈ | |
| 8 | 12.15 | 2 ¹ / ₄ | 0.375 |
| | 14.75 | 2 ³ / ₈ | |
| | 11.5 | 2 ¹ / ₄ | |
| 9 | 13.75 | 2 ¹ / ₄ | 0.375 |
| | 18.75 | 2 ¹ / ₂ | |
| | 13.4 | 2 ³ / ₈ | |
| 10 | 15.0 | 2 ¹ / ₂ | 0.438 |
| | 20.0 | 2 ⁵ / ₈ | |
| | 15.3 | 2 ⁵ / ₈ | |
| 12 | 20.0 | 2 ³ / ₄ | 0.438 |
| | 25.0 | 2 ⁷ / ₈ | |
| | 30.0 | 3 | |
| 15 | 20.7 | 3 | 0.500 |
| | 25.0 | 3 | |
| | 30.0 | 3 ¹ / ₈ | |
| 18 | 33.9 | 3 ³ / ₈ | 0.625 |
| | 40.0 | 3 ¹ / ₂ | |
| | 50.0 | 3 ³ / ₄ | |
| 18 | 42.7 | 4 | 0.625 |
| | 45.8 | 4 | |
| | 51.9 | 4 ¹ / ₄ | |
| | 58.0 | 4 ¹ / ₄ | |

S Shapes



| Y in | Wt. / Ft. lb | Width in | Z in |
|---------|--------------|-------------------------------|---------|
| 3 | 5.7 | 2 ³ / ₈ | 0.250 |
| | 7.5 | 2 ¹ / ₂ | |
| 4 | 7.7 | 2 ⁵ / ₈ | 0.313 |
| | 9.5 | 2 ³ / ₄ | |
| 5 | 10.0 | 3 | 0.313 |
| | 14.75 | 3 ¹ / ₄ | |
| 6 | 12.5 | 3 ¹ / ₈ | 0.375 |
| | 12.25 | 3 ⁵ / ₈ | |
| 7 | 15.3 | 3 ⁵ / ₈ | 0.375 |
| | 20.0 | 3 ⁷ / ₈ | |
| 8 | 18.4 | 4 | 0.438 |
| | 23.0 | 4 ¹ / ₈ | |
| 10 | 25.4 | 4 ⁵ / ₈ | 0.500 |
| | 35.0 | 5 | |
| 12 | 31.8 | 5 | 0.563 |
| | 35.0 | 5 ¹ / ₈ | |
| 15 | 40.8 | 5 ¹ / ₄ | 0.688 |
| | 50.0 | 5 ¹ / ₂ | |
| | 42.9 | 5 ¹ / ₂ | |
| 18 | 50.0 | 5 ⁵ / ₈ | 0.625 |
| | 54.7 | 6 ¹ / ₄ | |
| 20 | 60.0 | 6 ¹ / ₄ | 0.688 |
| | 70.0 | 6 ¹ / ₄ | |
| 20.3 | 66.0 | 6 ¹ / ₄ | 0.813 |
| | 96.0 | 6 ³ / ₈ | |
| 24 | 86.0 | 7 | 0.938 |
| | 96.0 | 7 ¹ / ₄ | |
| | 80.0 | 7 | |
| 24 | 90.0 | 7 ¹ / ₈ | 0.875 |
| | 100.0 | 7 ¹ / ₄ | |

W Shapes



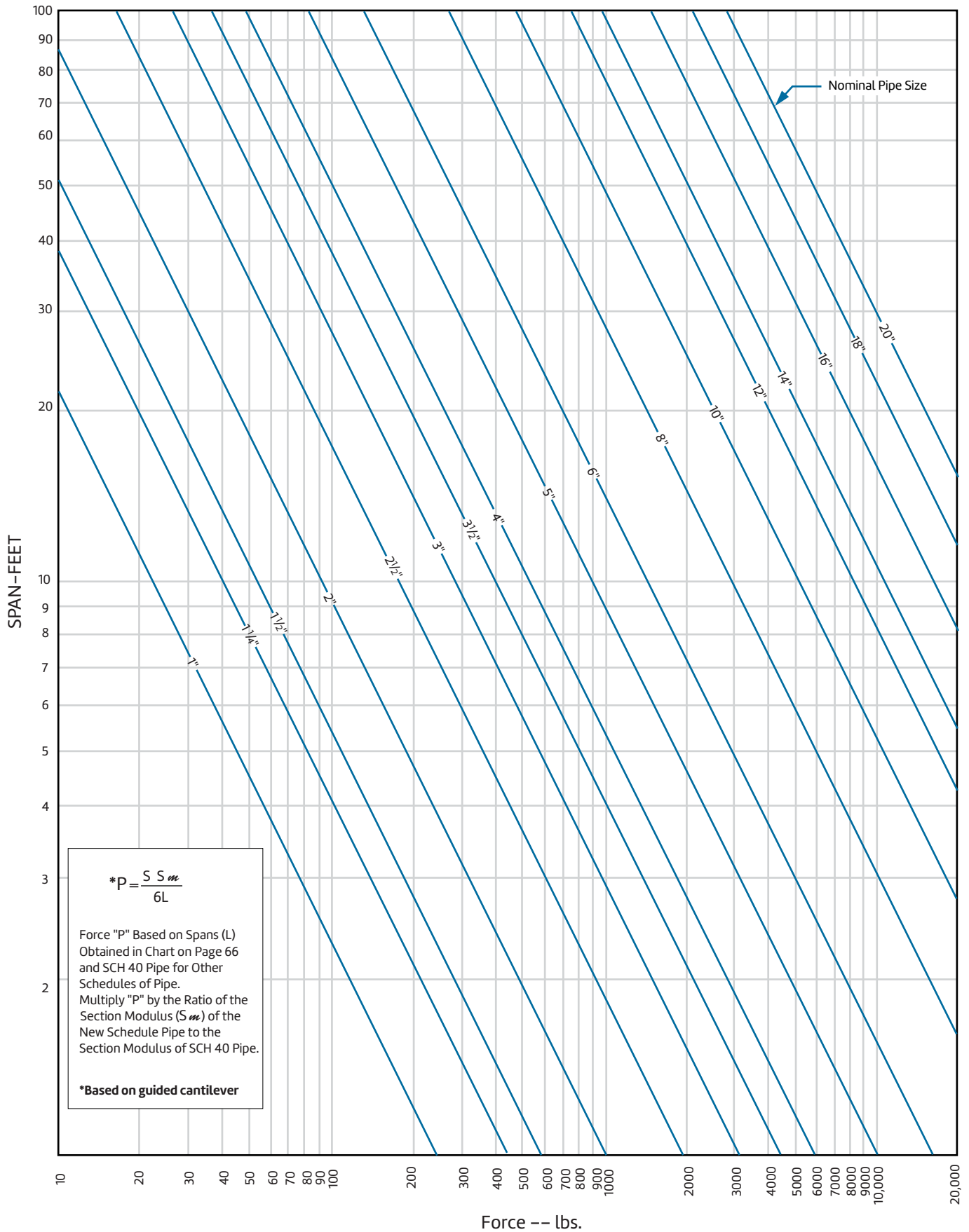
| Y in | Wt. / Ft. lb | Width in | Z in | Y in | Wt. / Ft. lb | Width in | Z in |
|---------|--------------|--------------------------------|---------|---------|--------------|--------------------------------|---------|
| 5 | 19.0 | 5 | 0.430 | 16 | 36.0 | 7 | 0.430 |
| | 25.0 | 6 ¹ / ₈ | 0.455 | | 40.0 | 7 | 0.505 |
| 6 | 18.0 | 5 ¹ / ₄ | 0.33 | 16 | 45.0 | 7 | 0.565 |
| | 21.0 | 5 ¹ / ₄ | 0.400 | | 50.0 | 7 ¹ / ₈ | 0.630 |
| 8 | 24.0 | 6 ¹ / ₂ | 0.400 | 16 | 57.0 | 7 ¹ / ₈ | 0.715 |
| | 28.0 | 6 ¹ / ₂ | 0.465 | | 67.0 | 10 ¹ / ₄ | 0.665 |
| 8 | 31.0 | 8 | 0.435 | 16 | 77.0 | 10 ¹ / ₄ | 0.760 |
| | 35.0 | 8 | 0.495 | | 89.0 | 10 ³ / ₈ | 0.875 |
| 10 | 40.0 | 8 ¹ / ₈ | 0.560 | 16 | 100.0 | 10 ³ / ₈ | 0.985 |
| | 48.0 | 8 ¹ / ₈ | 0.685 | | 50.0 | 7 ¹ / ₂ | 0.570 |
| 10 | 58.0 | 8 ¹ / ₄ | 0.810 | 16 | 55.0 | 7 ¹ / ₂ | 0.630 |
| | 67.0 | 8 ¹ / ₄ | 0.935 | | 60.0 | 7 ¹ / ₂ | 0.695 |
| 10 | 22.0 | 5 ³ / ₄ | 0.360 | 18 | 65.0 | 7 ⁵ / ₈ | 0.750 |
| | 26.0 | 5 ³ / ₄ | 0.440 | | 71.0 | 7 ⁵ / ₈ | 0.810 |
| 10 | 30.0 | 5 ³ / ₄ | 0.510 | 18 | 76.0 | 11 | 0.680 |
| | 33.0 | 8 | 0.435 | | 86.0 | 11 ¹ / ₈ | 0.770 |
| 10 | 39.0 | 8 | 0.530 | 18 | 97.0 | 11 ¹ / ₈ | 0.870 |
| | 45.0 | 8 | 0.620 | | 106.0 | 11 ¹ / ₄ | 0.940 |
| 12 | 49.0 | 10 | 0.560 | 18 | 62.0 | 8 ¹ / ₄ | 0.615 |
| | 54.0 | 10 | 0.615 | | 68.0 | 8 ¹ / ₄ | 0.685 |
| 12 | 60.0 | 10 ¹ / ₈ | 0.680 | 18 | 73.0 | 8 ¹ / ₄ | 0.740 |
| | 68.0 | 10 ¹ / ₈ | 0.770 | | 83.0 | 8 ³ / ₈ | 0.835 |
| 12 | 77.0 | 10 ¹ / ₄ | 0.870 | 18 | 93.0 | 12 ¹ / ₄ | 0.930 |
| | 88.0 | 10 ¹ / ₄ | 0.990 | | 101.0 | 12 ³ / ₈ | 0.800 |
| 12 | 26.0 | 6 ¹ / ₂ | 0.380 | 21 | 111.0 | 12 ³ / ₈ | 0.875 |
| | 30.0 | 6 ¹ / ₂ | 0.440 | | 122.0 | 12 ³ / ₈ | 0.960 |
| 12 | 40.0 | 8 | 0.515 | 21 | 76.0 | 9 | 0.680 |
| | 50.0 | 8 | 0.575 | | 84.0 | 9 | 0.770 |
| 12 | 53.0 | 8 ¹ / ₈ | 0.640 | 21 | 94.0 | 9 ¹ / ₈ | 0.875 |
| | 58.0 | 10 | 0.575 | | 104.0 | 12 ³ / ₄ | 0.750 |
| 12 | 65.0 | 12 | 0.605 | 21 | 117.0 | 12 ³ / ₄ | 0.850 |
| | 72.0 | 12 | 0.670 | | 131.0 | 12 ⁷ / ₈ | 0.960 |
| 12 | 79.0 | 12 ¹ / ₈ | 0.735 | 21 | 94.0 | 10 | 0.745 |
| | 87.0 | 12 ¹ / ₈ | 0.810 | | 102.0 | 10 | 0.830 |
| 12 | 96.0 | 12 ¹ / ₈ | 0.900 | 21 | 114.0 | 10 ¹ / ₈ | 0.930 |
| | 106.0 | 12 ¹ / ₄ | 0.990 | | 146.0 | 14 | 0.975 |
| 14 | 30.0 | 6 ³ / ₄ | 0.385 | 24 | 108.0 | 10 ¹ / ₂ | 0.760 |
| | 34.0 | 6 ³ / ₄ | 0.455 | | 116.0 | 10 ¹ / ₂ | 0.850 |
| 14 | 38.0 | 6 ³ / ₄ | 0.515 | 24 | 124.0 | 10 ¹ / ₂ | 0.930 |
| | 43.0 | 8 | 0.530 | | 132.0 | 10 ¹ / ₂ | 1.000 |
| 14 | 48.0 | 8 | 0.595 | 24 | 118.0 | 11 ¹ / ₂ | 0.740 |
| | 53.0 | 8 | 0.660 | | 130.0 | 11 ¹ / ₂ | 0.855 |
| 14 | 61.0 | 10 | 0.645 | 24 | 141.0 | 11 ¹ / ₂ | 0.960 |
| | 68.0 | 10 | 0.720 | | 135.0 | 12 | 0.790 |
| 14 | 74.0 | 10 ¹ / ₈ | 0.785 | 24 | 150.0 | 12 | 0.940 |
| | 82.0 | 10 ¹ / ₈ | 0.855 | | 168.0 | 12 | 1.020 |
| 14 | 90.0 | 14 ¹ / ₂ | 0.710 | | | | |
| | 99.0 | 14 ³ / ₈ | 0.780 | | | | |
| 14 | 109.0 | 14 ³ / ₈ | 0.860 | | | | |
| | 120.0 | 14 ³ / ₈ | 0.940 | | | | |
| 14 | 132.0 | 14 ³ / ₄ | 1.030 | | | | |



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Building connections that last™

Force Based on Span



Pressure Conversions

To convert C° to F°, find C° value in the middle column and read F° in right hand column.
 To convert F° to C°, find F° value in the middle column and read C° in left hand column.

| PSI | Feet of Water | | PSI | Feet of Water | | PSI | Feet of Water | | PSI | Feet of Water | | PSI | Feet of Water | |
|-------|---------------|--------|-------|---------------|--------|-------|---------------|--------|--------|---------------|--------|--------|---------------|--------|
| 0.43 | 1 | 2.31 | 281.4 | 65 | 150.15 | 55.84 | 129 | 297.99 | 83.55 | 193 | 445.83 | 111.26 | 257 | 593.67 |
| 0.87 | 2 | 4.62 | 28.57 | 66 | 152.46 | 56.28 | 130 | 300.3 | 83.98 | 194 | 448.14 | 111.69 | 258 | 595.98 |
| 1.30 | 3 | 6.93 | 29.00 | 67 | 154.77 | 56.71 | 131 | 302.61 | 84.42 | 195 | 450.45 | 112.12 | 259 | 598.29 |
| 1.73 | 4 | 9.24 | 29.44 | 68 | 157.08 | 57.14 | 132 | 304.92 | 84.85 | 196 | 452.76 | 112.55 | 260 | 600.6 |
| 2.16 | 5 | 11.55 | 29.87 | 69 | 159.39 | 57.58 | 133 | 307.23 | 85.28 | 197 | 455.07 | 112.99 | 261 | 602.91 |
| 2.6 | 6 | 13.86 | 30.3 | 70 | 161.7 | 58.01 | 134 | 309.54 | 85.71 | 198 | 457.38 | 113.42 | 262 | 605.22 |
| 3.03 | 7 | 16.17 | 30.74 | 71 | 164.01 | 58.44 | 135 | 311.85 | 86.15 | 199 | 459.69 | 113.85 | 263 | 607.53 |
| 3.46 | 8 | 18.48 | 31.17 | 72 | 166.32 | 58.87 | 136 | 314.16 | 86.58 | 200 | 462 | 114.29 | 264 | 609.84 |
| 3.9 | 9 | 20.79 | 31.60 | 73 | 168.63 | 59.31 | 137 | 316.47 | 87.01 | 201 | 464.31 | 114.72 | 265 | 612.15 |
| 4.33 | 10 | 23.1 | 32.03 | 74 | 170.94 | 59.74 | 138 | 318.78 | 87.45 | 202 | 466.62 | 116.88 | 270 | 623.7 |
| 4.76 | 11 | 25.41 | 32.47 | 75 | 173.25 | 60.17 | 139 | 321.09 | 87.88 | 203 | 468.93 | 119.05 | 275 | 635.25 |
| 5.19 | 12 | 27.72 | 32.9 | 76 | 175.56 | 60.61 | 140 | 323.4 | 88.31 | 204 | 471.24 | 121.21 | 280 | 646.8 |
| 5.63 | 13 | 30.03 | 33.33 | 77 | 177.87 | 61.04 | 141 | 325.71 | 88.74 | 205 | 473.55 | 123.38 | 285 | 658.35 |
| 6.06 | 14 | 32.34 | 33.77 | 78 | 180.18 | 61.47 | 142 | 328.02 | 89.18 | 206 | 475.86 | 125.54 | 290 | 669.9 |
| 6.49 | 15 | 34.65 | 34.2 | 79 | 182.49 | 61.9 | 143 | 330.33 | 89.61 | 207 | 478.17 | 127.71 | 295 | 681.45 |
| 6.93 | 16 | 36.96 | 34.63 | 80 | 184.8 | 62.34 | 144 | 332.64 | 90.04 | 208 | 480.48 | 129.87 | 300 | 693 |
| 7.36 | 17 | 39.27 | 35.06 | 81 | 187.11 | 62.77 | 145 | 334.95 | 90.48 | 209 | 482.79 | 132.03 | 305 | 704.55 |
| 7.79 | 18 | 41.58 | 35.5 | 82 | 189.42 | 63.2 | 146 | 337.26 | 90.91 | 210 | 485.1 | 134.2 | 310 | 716.1 |
| 8.23 | 19 | 43.89 | 35.93 | 83 | 191.73 | 63.64 | 147 | 339.57 | 91.34 | 211 | 487.41 | 136.36 | 315 | 727.65 |
| 8.66 | 20 | 46.2 | 36.36 | 84 | 194.04 | 64.07 | 148 | 341.88 | 91.77 | 212 | 489.72 | 138.53 | 320 | 739.20 |
| 9.09 | 21 | 48.51 | 36.8 | 85 | 196.35 | 64.5 | 149 | 344.19 | 92.21 | 213 | 492.03 | 140.69 | 325 | 750.75 |
| 9.52 | 22 | 50.82 | 37.23 | 86 | 198.66 | 64.94 | 150 | 346.5 | 92.64 | 214 | 494.34 | 142.86 | 330 | 762.30 |
| 9.96 | 23 | 53.13 | 37.66 | 87 | 200.97 | 65.37 | 151 | 348.81 | 93.07 | 215 | 496.65 | 145.02 | 335 | 773.85 |
| 10.39 | 24 | 55.44 | 38.10 | 88 | 203.28 | 65.8 | 152 | 351.12 | 93.51 | 216 | 498.96 | 147.19 | 340 | 785.40 |
| 10.82 | 25 | 57.75 | 38.53 | 89 | 205.59 | 66.23 | 153 | 353.43 | 93.94 | 217 | 501.27 | 149.35 | 345 | 796.95 |
| 11.26 | 26 | 60.06 | 38.96 | 90 | 207.9 | 66.67 | 154 | 355.74 | 94.37 | 218 | 503.58 | 151.52 | 350 | 808.50 |
| 11.69 | 27 | 62.37 | 39.39 | 91 | 210.21 | 67.1 | 155 | 358.05 | 94.81 | 219 | 505.89 | 153.68 | 355 | 820.05 |
| 12.12 | 28 | 64.68 | 39.83 | 92 | 212.52 | 67.53 | 156 | 360.36 | 95.24 | 220 | 508.2 | 155.84 | 360 | 831.60 |
| 12.55 | 29 | 66.99 | 40.26 | 93 | 214.83 | 67.97 | 157 | 362.67 | 95.67 | 221 | 510.51 | 158.01 | 365 | 843.15 |
| 12.99 | 30 | 69.3 | 40.69 | 94 | 217.14 | 68.4 | 158 | 364.98 | 96.10 | 222 | 512.82 | 160.17 | 370 | 854.70 |
| 13.42 | 31 | 71.61 | 41.13 | 95 | 219.45 | 68.83 | 159 | 367.29 | 96.54 | 223 | 515.13 | 162.34 | 375 | 866.25 |
| 13.85 | 32 | 73.92 | 41.56 | 96 | 221.76 | 69.26 | 160 | 369.6 | 96.97 | 224 | 517.44 | 164.5 | 380 | 877.80 |
| 14.29 | 33 | 76.23 | 41.99 | 97 | 224.07 | 69.7 | 161 | 371.91 | 97.40 | 225 | 519.75 | 166.67 | 385 | 889.35 |
| 14.72 | 34 | 78.54 | 42.42 | 98 | 226.38 | 70.13 | 162 | 374.22 | 97.84 | 226 | 522.06 | 168.83 | 390 | 900.9 |
| 15.15 | 35 | 80.85 | 42.86 | 99 | 228.69 | 70.56 | 163 | 376.53 | 98.27 | 227 | 524.37 | 171.00 | 395 | 912.45 |
| 15.58 | 36 | 83.16 | 43.29 | 100 | 231 | 71 | 164 | 378.84 | 98.7 | 228 | 526.68 | 173.16 | 400 | 924 |
| 16.02 | 37 | 85.47 | 43.72 | 101 | 233.31 | 71.43 | 165 | 381.15 | 99.13 | 229 | 528.99 | 183.98 | 425 | 981.75 |
| 16.45 | 38 | 87.78 | 44.16 | 102 | 235.62 | 71.86 | 166 | 383.46 | 99.57 | 230 | 531.3 | 194.81 | 450 | 1,040 |
| 16.88 | 39 | 90.09 | 44.59 | 103 | 237.93 | 72.29 | 167 | 385.77 | 100.00 | 231 | 533.61 | 205.63 | 475 | 1,097 |
| 17.32 | 40 | 92.4 | 45.02 | 104 | 240.24 | 72.73 | 168 | 388.08 | 100.43 | 232 | 535.92 | 216.45 | 500 | 1,155 |
| 17.75 | 41 | 94.71 | 45.45 | 105 | 242.55 | 73.16 | 169 | 390.39 | 100.87 | 233 | 538.23 | 227.27 | 525 | 1,213 |
| 18.18 | 42 | 97.02 | 45.89 | 106 | 244.86 | 73.59 | 170 | 392.7 | 101.30 | 234 | 540.54 | 238.10 | 550 | 1,271 |
| 18.61 | 43 | 99.33 | 46.32 | 107 | 247.17 | 74.03 | 171 | 395.01 | 101.73 | 235 | 542.85 | 248.92 | 575 | 1,328 |
| 19.05 | 44 | 101.64 | 46.75 | 108 | 249.48 | 74.46 | 172 | 397.32 | 102.16 | 236 | 545.16 | 259.74 | 600 | 1,386 |
| 19.48 | 45 | 103.95 | 47.19 | 109 | 251.79 | 74.89 | 173 | 399.63 | 102.6 | 237 | 547.47 | 270.56 | 625 | 1,444 |
| 19.91 | 46 | 106.26 | 47.62 | 110 | 254.1 | 75.32 | 174 | 401.94 | 103.03 | 238 | 549.78 | 281.39 | 650 | 1,502 |
| 20.35 | 47 | 108.57 | 48.05 | 111 | 256.41 | 75.76 | 175 | 404.25 | 103.46 | 239 | 552.09 | 292.21 | 675 | 1,559 |
| 20.78 | 48 | 110.88 | 48.48 | 112 | 258.72 | 76.19 | 176 | 406.56 | 103.90 | 240 | 554.4 | 303.03 | 700 | 1,617 |
| 21.21 | 49 | 113.19 | 48.92 | 113 | 261.03 | 76.62 | 177 | 408.87 | 104.33 | 241 | 556.71 | 313.85 | 725 | 1,675 |
| 21.65 | 50 | 115.5 | 49.35 | 114 | 263.34 | 77.06 | 178 | 411.18 | 104.76 | 242 | 559.02 | 324.68 | 750 | 1,733 |
| 22.08 | 51 | 117.81 | 49.78 | 115 | 265.65 | 77.49 | 179 | 413.49 | 105.19 | 243 | 561.33 | 335.50 | 775 | 1,790 |
| 22.51 | 52 | 120.12 | 50.22 | 116 | 267.96 | 77.92 | 180 | 415.8 | 105.63 | 244 | 563.64 | 346.32 | 800 | 1,848 |
| 22.94 | 53 | 122.43 | 50.65 | 117 | 270.27 | 78.35 | 181 | 418.11 | 106.06 | 245 | 565.95 | 357.14 | 825 | 1,906 |
| 23.38 | 54 | 124.74 | 51.08 | 118 | 272.58 | 78.79 | 182 | 420.42 | 106.49 | 246 | 568.26 | 367.97 | 850 | 1,964 |
| 23.81 | 55 | 127.05 | 51.52 | 119 | 274.89 | 79.22 | 183 | 422.73 | 106.93 | 247 | 570.57 | 378.79 | 875 | 2,021 |
| 24.24 | 56 | 129.36 | 51.95 | 120 | 277.2 | 79.65 | 184 | 425.04 | 107.36 | 248 | 572.88 | 389.61 | 900 | 2,079 |
| 24.68 | 57 | 131.67 | 52.38 | 121 | 279.51 | 80.09 | 185 | 427.35 | 107.79 | 249 | 575.19 | 400.43 | 925 | 2,137 |
| 25.11 | 58 | 133.98 | 52.81 | 12 | 281.82 | 80.52 | 186 | 429.66 | 108.23 | 250 | 577.5 | 411.26 | 950 | 2,195 |
| 25.54 | 59 | 136.29 | 53.25 | 123 | 284.13 | 80.95 | 187 | 431.97 | 108.66 | 251 | 579.81 | 422.08 | 975 | 2,252 |
| 25.97 | 60 | 138.6 | 53.68 | 124 | 286.44 | 81.39 | 188 | 434.28 | 109.09 | 252 | 582.12 | 432.9 | 1000 | 2,310 |
| 26.41 | 61 | 140.91 | 54.11 | 125 | 288.75 | 81.82 | 189 | 436.59 | 109.52 | 253 | 584.43 | 649.4 | 1500 | 3,465 |
| 26.84 | 62 | 143.22 | 54.55 | 126 | 291.06 | 82.25 | 190 | 438.9 | 109.96 | 254 | 586.74 | 865.8 | 2000 | 4,620 |
| 27.27 | 63 | 145.53 | 54.98 | 127 | 293.37 | 82.68 | 191 | 441.21 | 110.39 | 255 | 589.05 | 1,082 | 2500 | 5,780 |
| 27.71 | 64 | 147.84 | 55.41 | 128 | 295.68 | 83.12 | 192 | 443.52 | 110.82 | 256 | 591.36 | 1,300 | 3000 | 6,930 |

Properties of Water, Fractional Conversions

Properties of Water at Saturation Pressure

| Temp °F | Saturation Pressure PSI (abs) | Density lb/ft ³ | Density lb/gallon | Covert Factor ft. of water to PSI | Absolute Viscosity lb./sec. ft. |
|---------|-------------------------------|----------------------------|-------------------|-----------------------------------|---------------------------------|
| 32 | 0.0885 | 62.42 | 8.346 | 2.307 | 0.001203 |
| 40 | 0.1217 | 62.43 | 8.347 | 2.307 | 0.001042 |
| 50 | 0.1781 | 62.41 | 8.344 | 2.307 | 0.000880 |
| 60 | 0.2563 | 62.37 | 8.339 | 2.309 | 0.000753 |
| 70 | 0.3631 | 62.30 | 8.33 | 2.311 | 0.000657 |
| 80 | 0.5069 | 62.22 | 8.319 | 2.315 | 0.000579 |
| 90 | 0.6982 | 62.12 | 8.305 | 2.318 | 0.000513 |
| 100 | 0.9492 | 62.00 | 8.289 | 2.323 | 0.000460 |
| 110 | 1.275 | 61.84 | 8.268 | 2.328 | 0.000415 |
| 120 | 1.692 | 61.73 | 8.253 | 2.333 | 0.000376 |
| 130 | 2.222 | 61.54 | 8.228 | 2.34 | 0.000343 |
| 140 | 2.889 | 61.39 | 8.208 | 2.346 | 0.000316 |
| 150 | 3.718 | 61.2 | 8.182 | 2.353 | 0.000290 |
| 160 | 4.741 | 61.01 | 8.157 | 2.36 | 0.000269 |
| 170 | 5.992 | 60.79 | 8.128 | 2.369 | 0.000250 |
| 180 | 7.51 | 60.57 | 8.098 | 2.377 | 0.000233 |
| 190 | 9.339 | 60.35 | 8.069 | 2.386 | 0.000218 |
| 200 | 11.53 | 60.13 | 8.039 | 2.395 | 0.000205 |
| 210 | 14.12 | 59.88 | 8.006 | 2.405 | 0.0001930 |
| 212 | 14.696 | 59.81 | 7.997 | 2.408 | 0.0001910 |
| 220 | 17.19 | 59.63 | 7.973 | 2.415 | 0.0001810 |
| 230 | 20.78 | 59.38 | 7.939 | 2.425 | 0.0001710 |
| 240 | 24.97 | 59.10 | 7.902 | 2.436 | 0.0001630 |
| 250 | 29.82 | 58.82 | 7.864 | 2.448 | 0.0001540 |
| 275 | 45.42 | 58.09 | 7.767 | 2.479 | 0.0001360 |
| 300 | 67.01 | 57.31 | 7.662 | 2.513 | 0.0001240 |
| 350 | 134.6 | 55.59 | 7.432 | 2.591 | 0.0001080 |
| 400 | 247.3 | 53.65 | 7.173 | 2.684 | 0.0000874 |
| 450 | 422.6 | 51.55 | 6.892 | 2.793 | 0.0000806 |
| 500 | 680.8 | 49.02 | 6.554 | 2.938 | 0.0000672 |
| 550 | 1045 | 45.87 | 6.133 | 3.139 | 0.0000605 |
| 600 | 1543 | 42.37 | 5.665 | 3.399 | 0.0000538 |
| 650 | 2208 | 37.31 | 4.988 | 3.86 | 0.0000470 |
| 700 | 3094 | 27.10 | 3.623 | 5.314 | 0.0000269 |

Decimal -- Inch -- Foot -- Measurement

| Decimal Equiv. | Inch |
|----------------|--------|
| 0.001312 | 1/64" |
| 0.002604 | 1/32" |
| 0.003906 | 3/64" |
| 0.005208 | 1/16" |
| 0.006510 | 5/64" |
| 0.007813 | 3/32" |
| 0.009115 | 7/64" |
| 0.010417 | 1/8" |
| 0.011719 | 9/64" |
| 0.013021 | 5/32" |
| 0.014323 | 11/64" |
| 0.015625 | 3/16" |
| 0.016927 | 13/64" |
| 0.018229 | 7/32" |
| 0.019531 | 15/64" |
| 0.020833 | 1/4" |
| 0.022135 | 17/64" |
| 0.023438 | 9/32" |
| 0.024740 | 19/64" |
| 0.026042 | 5/16" |
| 0.027344 | 21/64" |
| 0.028646 | 11/32" |
| 0.029948 | 23/64" |
| 0.031250 | 3/8" |
| 0.032552 | 25/64" |
| 0.033854 | 13/32" |
| 0.035156 | 27/64" |
| 0.036458 | 7/16" |
| 0.037760 | 29/64" |
| 0.039063 | 15/32" |
| 0.040365 | 31/64" |
| 0.041667 | 1/2" |

Decimal -- Inch -- Foot -- Measurement

| Decimal Equiv. | Inch |
|----------------|--------|
| 0.042969 | 33/64" |
| 0.044271 | 17/32" |
| 0.045573 | 35/64" |
| 0.046875 | 9/16" |
| 0.048177 | 37/64" |
| 0.049479 | 19/32" |
| 0.050781 | 39/64" |
| 0.052083 | 5/8" |
| 0.053385 | 41/64" |
| 0.054688 | 21/32" |
| 0.055990 | 43/64" |
| 0.057292 | 11/16" |
| 0.058594 | 45/64" |
| 0.059896 | 23/32" |
| 0.061198 | 47/64" |
| 0.062500 | 3/4" |
| 0.063802 | 49/64" |
| 0.065104 | 25/32" |
| 0.066406 | 51/64" |
| 0.067708 | 13/16" |
| 0.069010 | 53/64" |
| 0.070313 | 27/32" |
| 0.071615 | 55/64" |
| 0.072917 | 7/8" |
| 0.074219 | 57/64" |
| 0.075521 | 29/32" |
| 0.076823 | 59/64" |
| 0.078125 | 15/16" |
| 0.079427 | 61/64" |
| 0.080729 | 31/32" |
| 0.082031 | 63/64" |
| 0.083333 | 1" |

Decimal -- Inch -- Foot -- Measurement

| Decimal Equiv. | Inch |
|----------------|------|
| 0.166667 | 2" |
| 0.250000 | 3" |
| 0.333333 | 4" |
| 0.416667 | 5" |
| 0.500000 | 6" |
| 0.583333 | 7" |
| 0.666667 | 8" |
| 0.750000 | 9" |
| 0.833333 | 10" |
| 0.916667 | 11" |
| 1.000000 | 12" |

Decimal Equivalent / Fraction

| Decimal Equiv. | Fraction |
|----------------|----------|
| 0.015625 | 1/64 |
| 0.031250 | 1/32 |
| 0.046875 | 3/64 |
| 0.062500 | 1/16 |
| 0.078125 | 5/64 |
| 0.093750 | 3/32 |
| 0.109375 | 7/64 |
| 0.125000 | 1/8 |
| 0.140625 | 9/64 |
| 0.156250 | 5/32 |
| 0.171875 | 11/64 |
| 0.187500 | 3/16 |
| 0.203125 | 13/64 |
| 0.218750 | 7/32 |
| 0.234375 | 15/64 |
| 0.250000 | 1/4 |

Decimal Equivalent / Fraction

| Decimal Equiv. | Fraction |
|----------------|----------|
| 0.296875 | 17/64 |
| 0.281250 | 9/32 |
| 0.296875 | 19/64 |
| 0.312500 | 5/16 |
| 0.328125 | 21/64 |
| 0.343750 | 11/32 |
| 0.359375 | 23/64 |
| 0.375000 | 3/8 |
| 0.390625 | 25/64 |
| 0.406250 | 13/32 |
| 0.421875 | 27/64 |
| 0.437500 | 7/16 |
| 0.453125 | 29/64 |
| 0.468750 | 15/32 |
| 0.484375 | 31/64 |
| 0.500000 | 1/2 |

Decimal Equivalent / Fraction

| Decimal Equiv. | Fraction |
|----------------|----------|
| 0.515625 | 33/64 |
| 0.531250 | 17/32 |
| 0.546875 | 35/64 |
| 0.562500 | 9/16 |
| 0.578125 | 37/64 |
| 0.593750 | 19/32 |
| 0.609375 | 39/64 |
| 0.625000 | 5/8 |
| 0.640625 | 41/64 |
| 0.656250 | 21/32 |
| 0.671875 | 43/64 |
| 0.687500 | 11/16 |
| 0.703125 | 45/64 |
| 0.718750 | 22/32 |
| 0.734375 | 47/64 |
| 0.750000 | 3/4 |

Decimal Equivalent / Fraction

| Decimal Equiv. | Fraction |
|----------------|----------|
| 0.765625 | 49/64 |
| 0.781250 | 25/32 |
| 0.796875 | 51/64 |
| 0.812500 | 13/16 |
| 0.828125 | 53/64 |
| 0.843750 | 27/32 |
| 0.859375 | 55/64 |
| 0.875000 | 7/8 |
| 0.890625 | 57/64 |
| 0.906250 | 29/32 |
| 0.921875 | 59/64 |
| 0.937500 | 15/16 |
| 0.953125 | 61/64 |
| 0.968750 | 31/32 |
| 0.984375 | 63/64 |
| 1.000000 | 1 |

Metric Conversion Table

| Inch | Millimeters |
|---------|-------------|
| 0 | 0 |
| 1/128 | 0.01984375 |
| 1/64 | 0.396875 |
| 3/128 | 5953125 |
| 1/32 | 0.79375 |
| 5/128 | 0.9921875 |
| 3/64 | 1.190625 |
| 7/128 | 1.3890625 |
| 1/16 | 1.5875 |
| 1/8 | 3.175 |
| 3/16 | 4.7625 |
| 1/4 | 6.35 |
| 5/16 | 7.9375 |
| 3/8 | 9.525 |
| 7/16 | 11.1125 |
| 1/2 | 12.7 |
| 9/16 | 14.2875 |
| 5/8 | 15.875 |
| 11/16 | 17.4625 |
| 3/4 | 19.05 |
| 13/16 | 20.6375 |
| 7/8 | 22.225 |
| 15/16 | 23.8125 |
| 1 | 25.4 |
| 1 1/16 | 26.9875 |
| 1 1/8 | 28.575 |
| 1 1/4 | 30.1625 |
| 1 1/2 | 31.75 |
| 1 5/8 | 33.3375 |
| 1 3/4 | 34.925 |
| 1 7/8 | 36.5125 |
| 1 1/2 | 38.1 |
| 1 9/16 | 39.6875 |
| 1 5/8 | 41.275 |
| 1 11/16 | 42.8625 |
| 1 3/4 | 44.45 |
| 1 13/16 | 46.0375 |
| 1 7/8 | 47.625 |
| 1 15/16 | 49.2125 |
| 2 | 50.8 |

Example:

Convert 3.7664 meters to feet, inches and fractions
 Using the feet to meter table, 12 ft. = 3.6576
 So now convert 3.7664m - 3.6576m = 108.8mm
 Using the inch to millimeter table, 4 1/4 in. = 107.95mm
 So now convert 108.8mm - 107.95mm = 0.85mm
 Using the inch to millimeter table, 1/32 = 0.79375

Example:

Convert 15 ft. 67/16 in. to meters
 Using the feet to meter table, 15 ft. = 4.572 meters
 Using the inch to millimeter table, 67/16 in. = .1635125 meters
 Thus, 15 ft. 67/16 in. = 4.7355125 meters

| Inch | Millimeters | Inch | Millimeters | Inch | Millimeters | Inch | Millimeters | Inch | Millimeters |
|---------|-------------|---------|-------------|---------|-------------|---------|-------------|----------|-------------|
| 2 1/16 | 52.3875 | 4 1/16 | 103.1875 | 6 1/16 | 153.9875 | 8 1/16 | 204.7875 | 10 1/16 | 255.5875 |
| 2 1/8 | 53.975 | 4 1/8 | 104.775 | 6 1/8 | 155.575 | 8 1/8 | 206.375 | 10 1/8 | 257.175 |
| 2 3/16 | 55.5625 | 4 3/16 | 106.3625 | 6 3/16 | 157.1625 | 8 3/16 | 207.9625 | 10 3/16 | 258.7625 |
| 2 1/4 | 57.15 | 4 1/4 | 107.95 | 6 1/4 | 158.75 | 8 1/4 | 209.55 | 10 1/4 | 260.35 |
| 2 5/16 | 58.7375 | 4 5/16 | 109.5375 | 6 5/16 | 160.3375 | 8 5/16 | 211.1375 | 10 5/16 | 261.9375 |
| 2 3/8 | 60.325 | 4 3/8 | 111.125 | 6 3/8 | 161.925 | 8 3/8 | 212.725 | 10 3/8 | 263.525 |
| 2 7/16 | 61.9125 | 4 7/16 | 112.7125 | 6 7/16 | 163.5125 | 8 7/16 | 214.3125 | 10 7/16 | 265.1125 |
| 2 1/2 | 63.5 | 4 1/2 | 114.3 | 6 1/2 | 165.1 | 8 1/2 | 215.9 | 10 1/2 | 266.7 |
| 2 9/16 | 65.0875 | 4 9/16 | 115.8875 | 6 9/16 | 166.6875 | 8 9/16 | 217.4875 | 10 9/16 | 268.2875 |
| 2 5/8 | 66.675 | 4 5/8 | 117.475 | 6 5/8 | 168.275 | 8 5/8 | 219.075 | 10 5/8 | 269.875 |
| 2 11/16 | 68.2625 | 4 11/16 | 119.0625 | 6 11/16 | 169.8625 | 8 11/16 | 220.6625 | 10 11/16 | 271.4625 |
| 2 3/4 | 69.85 | 4 3/4 | 120.65 | 6 3/4 | 171.45 | 8 3/4 | 222.25 | 10 3/4 | 273.05 |
| 2 13/16 | 71.4375 | 4 13/16 | 122.2375 | 6 13/16 | 173.0375 | 8 13/16 | 223.8375 | 10 13/16 | 274.6375 |
| 2 7/8 | 73.025 | 4 7/8 | 123.825 | 6 7/8 | 174.625 | 8 7/8 | 225.425 | 10 7/8 | 276.225 |
| 2 15/16 | 74.6125 | 4 15/16 | 125.4125 | 6 15/16 | 176.2125 | 8 15/16 | 227.0125 | 10 15/16 | 277.8125 |
| 3 | 76.2 | 5 | 127 | 7 | 177.8 | 9 | 228.6 | 11 | 279.4 |
| 3 1/16 | 77.7875 | 5 1/16 | 128.5875 | 7 1/16 | 179.3875 | 9 1/16 | 230.1875 | 11 1/16 | 280.9875 |
| 3 1/8 | 79.375 | 5 1/8 | 130.175 | 7 1/8 | 180.975 | 9 1/8 | 231.775 | 11 1/8 | 282.575 |
| 3 1/4 | 80.9625 | 5 1/4 | 131.7625 | 7 1/4 | 182.5625 | 9 1/4 | 233.3625 | 11 1/4 | 284.1625 |
| 3 3/8 | 82.55 | 5 3/8 | 133.35 | 7 3/8 | 184.15 | 9 3/8 | 234.95 | 11 3/8 | 285.75 |
| 3 5/16 | 84.1375 | 5 5/16 | 134.9375 | 7 5/16 | 185.7375 | 9 5/16 | 236.5375 | 11 5/16 | 287.3375 |
| 3 3/8 | 85.725 | 5 3/8 | 136.525 | 7 3/8 | 187.325 | 9 3/8 | 238.125 | 11 3/8 | 288.925 |
| 3 7/16 | 87.3125 | 5 7/16 | 138.1125 | 7 7/16 | 188.9125 | 9 7/16 | 239.7125 | 11 7/16 | 290.5125 |
| 3 1/2 | 88.9 | 5 1/2 | 139.7 | 7 1/2 | 190.5 | 9 1/2 | 241.3 | 11 1/2 | 292.1 |
| 3 9/16 | 90.4875 | 5 9/16 | 141.2875 | 7 9/16 | 192.0875 | 9 9/16 | 242.8875 | 11 9/16 | 293.6875 |
| 3 5/8 | 92.075 | 5 5/8 | 142.875 | 7 5/8 | 193.675 | 9 5/8 | 244.475 | 11 5/8 | 295.275 |
| 3 11/16 | 93.6625 | 5 11/16 | 144.4625 | 7 11/16 | 195.2625 | 9 11/16 | 246.0625 | 11 11/16 | 296.8625 |
| 3 3/4 | 95.25 | 5 3/4 | 146.05 | 7 3/4 | 196.85 | 9 3/4 | 247.65 | 11 3/4 | 298.45 |
| 3 13/16 | 96.8375 | 5 13/16 | 147.6375 | 7 13/16 | 198.4375 | 9 13/16 | 249.2375 | 11 13/16 | 300.0375 |
| 3 7/8 | 98.425 | 5 7/8 | 149.225 | 7 7/8 | 200.025 | 9 7/8 | 250.825 | 11 7/8 | 301.625 |
| 3 15/16 | 100.0125 | 5 15/16 | 150.8125 | 7 15/16 | 201.6125 | 9 15/16 | 252.4125 | 11 15/16 | 303.2125 |
| 4 | 101.6 | 6 | 152.4 | 8 | 203.2 | 10 | 254 | 12 | 304.8 |

| Feet | Meters | Feet | Meters | Feet | Meters | Feet | Meters | Feet | Meters |
|------|--------|------|---------|------|---------|------|---------|------|---------|
| 1 | 0.3048 | 21 | 6.4008 | 41 | 12.4968 | 61 | 18.5928 | 81 | 24.6888 |
| 2 | 0.6096 | 22 | 6.7056 | 42 | 12.8016 | 62 | 18.8976 | 82 | 24.9936 |
| 3 | 0.9144 | 23 | 7.0104 | 43 | 13.1064 | 63 | 19.2024 | 83 | 25.2984 |
| 4 | 1.2192 | 24 | 7.3152 | 44 | 13.4112 | 64 | 19.5072 | 84 | 25.6032 |
| 5 | 1.5240 | 25 | 7.6200 | 45 | 13.7160 | 66 | 19.8120 | 85 | 25.908 |
| 6 | 1.8288 | 26 | 7.9248 | 46 | 14.0208 | 66 | 20.1168 | 86 | 26.2128 |
| 7 | 2.1336 | 27 | 8.2296 | 47 | 14.3256 | 67 | 20.4216 | 87 | 26.5176 |
| 8 | 2.4384 | 28 | 8.5344 | 48 | 14.6304 | 68 | 20.7264 | 88 | 26.8224 |
| 9 | 2.7432 | 29 | 8.8392 | 49 | 14.9352 | 69 | 21.0312 | 89 | 27.1272 |
| 10 | 3.0480 | 30 | 9.1440 | 50 | 15.2400 | 70 | 21.3360 | 90 | 27.4320 |
| 11 | 3.3528 | 31 | 9.4488 | 51 | 15.5448 | 71 | 21.6408 | 91 | 27.7368 |
| 12 | 3.6576 | 32 | 9.7536 | 52 | 15.8496 | 72 | 21.9456 | 92 | 28.0416 |
| 13 | 3.9624 | 33 | 10.0584 | 53 | 16.1544 | 73 | 22.2504 | 93 | 28.3464 |
| 14 | 4.2672 | 34 | 10.3632 | 54 | 16.4592 | 74 | 22.5552 | 94 | 28.6512 |
| 15 | 4.5720 | 35 | 10.6680 | 55 | 16.7640 | 75 | 22.8600 | 95 | 28.9560 |
| 16 | 4.8768 | 36 | 10.9728 | 56 | 17.0688 | 76 | 23.1648 | 96 | 29.2608 |
| 17 | 5.1816 | 37 | 11.2776 | 57 | 17.3736 | 77 | 23.4696 | 97 | 29.5656 |
| 18 | 5.4864 | 38 | 11.5824 | 58 | 17.6784 | 78 | 23.7744 | 98 | 29.8704 |
| 19 | 5.7912 | 39 | 11.8872 | 59 | 17.9832 | 79 | 24.0792 | 99 | 30.1752 |
| 20 | 6.0960 | 40 | 12.1920 | 60 | 18.2880 | 80 | 24.3840 | 100 | 30.4800 |

Properties of Pipe

The following formulas are used in the computation of the values shown in the table:

† weight of pipe per foot (pounds) = $10.6802t(D - t)$
 weight of water per foot (pounds) = $0.3405 \times d^2$
 square feet outside surface per foot = $\pi/12 \times D$
 square feet inside surface per foot = $\pi/12 \times d$
 inside area (square inches) = $\pi/4 \times d^2$
 area of metal (square inches) = $\pi/4 \times (D^2 - d^2)$
 moment of inertia (inches⁴) = $\pi/64 \times (D^4 - d^4) = A_m R_g^2$
 section modulus (inches³) = $\pi/32 \times (D^4 - d^4)/D$
 radius of gyration (inches) = $\sqrt{(D^2 - d^2)/4}$

Where:

A_m = area of metal (square inches)

d = inside diameter (inches)

D = outside diameter (inches)

R_g = radius of gyration (inches)

t = pipewall thickness (inches)

Note:

† The ferritic steels may be about 5% less, and the austenitic stainless steels about 2% greater than the values shown in this table which are based on weights for carbon steel.

* Schedule Numbers

Standard weight pipe and schedule 40 are the same in all sizes through 10-inch; from 12-inch through 24-inch, standard weight pipe has a wall thickness of 3/8-inch.

Extra strong weight pipe and schedule 80 are the same in all sizes through 8-inch; from 8-inch through 24-inch, extra strong weight pipe has a wall thickness of 1/2-inch.

Double extra strong weight pipe has no corresponding schedule number.

a: ANSI B36.10 steel pipe schedule numbers

b: ANSI B36.10 steel pipe nominal wall thickness designation

c: ANSI B36.19 stainless steel pipe schedule numbers

Pressure Conversions

| Nom. Pipe Size, O.D. Inches | Schedule Number* | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration [‡] In. |
|-----------------------------|------------------|-----|-----|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | a | b | c | | | | | | | | | | | |
| 1/8 0.4050 | - | - | 10S | 0.049 | 0.307 | 0.0740 | 0.0548 | 0.106 | 0.0804 | 0.186 | 0.0321 | 0.00088 | 0.00437 | 0.1271 |
| | 40 | STD | 40S | 0.068 | 0.269 | 0.0568 | 0.0720 | 0.106 | 0.0704 | 0.245 | 0.0246 | 0.00106 | 0.00525 | 0.1215 |
| | 80 | XS | 80S | 0.095 | 0.215 | 0.0363 | 0.0925 | 0.106 | 0.0563 | 0.315 | 0.0157 | 0.00122 | 0.0060 | 0.1146 |
| 1/4 0.5400 | - | - | 10S | 0.065 | 0.410 | 0.1320 | 0.0970 | 0.141 | 0.1073 | 0.33 | 0.0572 | 0.00279 | 0.0103 | 0.1695 |
| | 40 | STD | 40S | 0.088 | 0.364 | 0.1040 | 0.1250 | 0.141 | 0.0953 | 0.425 | 0.0451 | 0.00331 | 0.01230 | 0.1628 |
| | 80 | XS | 80S | 0.119 | 0.302 | 0.0720 | 0.1570 | 0.141 | 0.0791 | 0.535 | 0.0311 | 0.00377 | 0.0139 | 0.1547 |
| 3/8 0.6750 | - | - | 10S | 0.065 | 0.545 | 0.2330 | 0.1250 | 0.177 | 0.1427 | 0.423 | 0.1011 | 0.00586 | 0.0174 | 0.2169 |
| | 40 | STD | 40S | 0.091 | 0.493 | 0.1910 | 0.1670 | 0.177 | 0.1291 | 0.568 | 0.0828 | 0.00729 | 0.0216 | 0.209 |
| | 80 | XS | 80S | 0.126 | 0.423 | 0.1410 | 0.2170 | 0.177 | 0.1107 | 0.739 | 0.0609 | 0.00862 | 0.0255 | 0.1991 |
| 1/2 0.8400 | - | - | 5S | 0.065 | 0.710 | 0.3960 | 0.1580 | 0.22 | 0.1859 | 0.538 | 0.172 | 0.01197 | 0.0285 | 0.275 |
| | - | - | 10S | 0.083 | 0.674 | 0.3570 | 0.1970 | 0.22 | 0.1765 | 0.671 | 0.155 | 0.01431 | 0.0341 | 0.2692 |
| | 40 | STD | 40s | 0.109 | 0.622 | 0.3040 | 0.2500 | 0.22 | 0.1628 | 0.851 | 0.132 | 0.01709 | 0.0407 | 0.2613 |
| | 80 | XS | 80s | 0.147 | 0.546 | 0.2340 | 0.3200 | 0.22 | 0.1429 | 1.09 | 0.102 | 0.02008 | 0.0478 | 0.2505 |
| | 160 | - | - | 0.187 | 0.466 | 0.1710 | 0.3840 | 0.22 | 0.1220 | 1.30 | 0.074 | 0.02212 | 0.0527 | 0.2402 |
| | - | XXS | - | 0.294 | 0.252 | 0.0500 | 0.5040 | 0.22 | 0.0660 | 1.71 | 0.022 | 0.02424 | 0.0577 | 0.2192 |
| 3/4 1.0500 | - | - | 5S | 0.065 | 0.920 | 0.6650 | 0.2010 | 0.275 | 0.2409 | 0.684 | 0.288 | 0.0245 | 0.0467 | 0.349 |
| | - | - | 10S | 0.083 | 0.884 | 0.6140 | 0.2520 | 0.275 | 0.2314 | 0.857 | 0.266 | 0.02969 | 0.0566 | 0.3430 |
| | 40 | STD | 40S | 0.113 | 0.824 | 0.5330 | 0.3330 | 0.275 | 0.2157 | 1.130 | 0.231 | 0.03704 | 0.0705 | 0.3340 |
| | 80 | XS | 80S | 0.154 | 0.742 | 0.4320 | 0.4330 | 0.275 | 0.1943 | 1.470 | 0.187 | 0.04479 | 0.0853 | 0.3210 |
| | 160 | - | - | 0.218 | 0.614 | 0.2960 | 0.5700 | 0.275 | 0.1607 | 1.94 | 0.128 | 0.05269 | 0.1004 | 0.3040 |
| | - | XXS | - | 0.308 | 0.434 | 0.1480 | 0.7180 | 0.275 | 0.1136 | 2.44 | 0.064 | 0.05792 | 0.1103 | 0.2840 |
| 1 1.3150 | - | - | 5S | 0.065 | 1.185 | 1.1030 | 0.2550 | 0.344 | 0.3102 | 0.868 | 0.478 | 0.04999 | 0.0760 | 0.4430 |
| | - | - | 10S | 0.109 | 1.097 | 0.9450 | 0.4130 | 0.344 | 0.2872 | 1.40 | 0.41 | 0.07569 | 0.1151 | 0.4280 |
| | 40 | STD | 40S | 0.133 | 1.049 | 0.8640 | 0.4940 | 0.344 | 0.2746 | 1.68 | 0.375 | 0.08734 | 0.1328 | 0.4210 |
| | 80 | XS | 80S | 0.179 | 0.957 | 0.7190 | 0.6390 | 0.344 | 0.2505 | 2.17 | 0.312 | 0.10561 | 0.1606 | 0.4070 |
| | 160 | - | - | 0.250 | 0.815 | 0.5220 | 0.8360 | 0.344 | 0.2134 | 2.84 | 0.226 | 0.12512 | 0.1903 | 0.3870 |
| | - | XXS | - | 0.358 | 0.599 | 0.2820 | 1.0760 | 0.344 | 0.1568 | 3.66 | 0.122 | 0.14046 | 0.2136 | 0.3610 |
| 1 1/4 1.6600 | - | - | 5S | 0.065 | 1.530 | 1.8390 | 0.3260 | 0.435 | 0.4006 | 1.11 | 0.797 | 0.10375 | 0.1250 | 0.5640 |
| | - | - | 10S | 0.109 | 1.442 | 1.6330 | 0.5310 | 0.435 | 0.3775 | 1.81 | 0.708 | 0.16049 | 0.1934 | 0.5500 |
| | 40 | STD | 40S | 0.140 | 1.380 | 1.4960 | 0.6690 | 0.435 | 0.3613 | 2.27 | 0.648 | 0.19471 | 0.2346 | 0.5400 |
| | 80 | XS | 80S | 0.191 | 1.278 | 1.2830 | 0.8810 | 0.435 | 0.3346 | 3.00 | 0.556 | 0.24179 | 0.2913 | 0.5240 |
| | 160 | - | - | 0.250 | 1.160 | 1.0570 | 1.1070 | 0.435 | 0.3037 | 3.76 | 0.458 | 0.28386 | 0.342 | 0.5060 |
| | - | XXS | - | 0.382 | 0.896 | 0.6310 | 1.5340 | 0.435 | 0.2346 | 5.21 | 0.273 | 0.34110 | 0.4110 | 0.4720 |

Properties of Pipe

| Nom. Pipe Size, O.D. Inches | Schedule Number* | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration ⁴ In. |
|-----------------------------|------------------|-----|-----|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | a | b | c | | | | | | | | | | | |
| 1½ 1.9000 | - | - | 5S | 0.065 | 1.770 | 2.461 | 0.375 | 0.497 | 0.4634 | 1.27 | 1.067 | 0.15792 | 0.1662 | 0.649 |
| | - | - | 10S | 0.109 | 1.682 | 2.222 | 0.613 | 0.497 | 0.4403 | 2.08 | 0.963 | 0.24682 | 0.2598 | 0.634 |
| | 40 | Std | 40s | 0.145 | 1.610 | 2.036 | 0.799 | 0.497 | 0.4215 | 2.72 | 0.883 | 0.30989 | 0.3262 | 0.623 |
| | 80 | XS | 80s | 0.200 | 1.500 | 1.767 | 1.068 | 0.497 | 0.3927 | 3.63 | 0.766 | 0.39121 | 0.4118 | 0.605 |
| | - | - | - | 0.281 | 1.338 | 1.406 | 1.429 | 0.497 | 0.3503 | 4.86 | 0.61 | 0.48239 | 0.5078 | 0.581 |
| | - | - | - | 0.400 | 1.100 | 0.95 | 1.885 | 0.497 | 0.288 | 6.41 | 0.412 | 0.56784 | 0.5977 | 0.549 |
| | - | - | - | 0.525 | 0.850 | 0.567 | 2.268 | 0.497 | 0.2225 | 7.71 | 0.246 | 0.61409 | 0.6464 | 0.52 |
| | - | - | - | 0.650 | 0.600 | 0.283 | 2.553 | 0.497 | 0.1571 | 8.68 | 0.123 | 0.63335 | 0.6667 | 0.498 |
| 2 2.3750 | - | - | 5S | 0.065 | 2.245 | 3.958 | 0.472 | 0.622 | 0.5877 | 1.60 | 1.716 | 0.31489 | 0.2652 | 0.817 |
| | 40 | Std | 10S | 0.109 | 2.157 | 3.654 | 0.776 | 0.622 | 0.5647 | 2.64 | 1.584 | 0.49919 | 0.4204 | 0.802 |
| | 80 | XS | 40s | 0.154 | 2.067 | 3.356 | 1.075 | 0.622 | 0.5411 | 3.65 | 1.455 | 0.66575 | 0.5606 | 0.787 |
| | 160 | - | 80s | 0.218 | 1.939 | 2.953 | 1.477 | 0.622 | 0.5076 | 5.02 | 1.28 | 0.86792 | 0.7309 | 0.766 |
| | - | XSS | - | 0.343 | 1.689 | 2.241 | 2.19 | 0.622 | 0.4422 | 7.44 | 0.971 | 1.16232 | 0.9788 | 0.729 |
| | - | - | - | 0.436 | 1.503 | 1.774 | 2.656 | 0.622 | 0.3935 | 9.03 | 0.769 | 1.3113 | 1.104 | 0.703 |
| | - | - | - | 0.562 | 1.251 | 1.229 | 3.201 | 0.622 | 0.3275 | 10.90 | 0.533 | 1.44157 | 1.214 | 0.671 |
| | - | - | - | 0.687 | 1.001 | 0.787 | 3.643 | 0.622 | 0.2621 | 12.40 | 0.341 | 1.51251 | 1.274 | 0.644 |
| 2½ 2.8750 | - | - | 5S | 0.083 | 2.709 | 5.764 | 0.728 | 0.753 | 0.7092 | 2.47 | 2.499 | 0.71002 | 0.4939 | 0.988 |
| | 40 | Std | 10S | 0.120 | 2.635 | 5.453 | 1.039 | 0.753 | 0.6898 | 3.53 | 2.364 | 0.98725 | 0.6868 | 0.975 |
| | 80 | XS | 40s | 0.203 | 2.469 | 4.788 | 1.704 | 0.753 | 0.6464 | 5.79 | 2.076 | 1.52955 | 1.064 | 0.947 |
| | 160 | - | 80s | 0.276 | 2.323 | 4.238 | 2.254 | 0.753 | 0.6082 | 7.66 | 1.837 | 1.92423 | 1.339 | 0.924 |
| | - | XSS | - | 0.375 | 2.125 | 3.547 | 2.945 | 0.753 | 0.5563 | 10.00 | 1.538 | 2.35274 | 1.637 | 0.894 |
| | - | - | - | 0.552 | 1.771 | 2.463 | 4.028 | 0.753 | 0.4636 | 13.70 | 1.068 | 2.87079 | 1.997 | 0.844 |
| | - | - | - | 0.675 | 1.525 | 1.827 | 4.665 | 0.753 | 0.3992 | 15.90 | 0.792 | 3.08819 | 2.148 | 0.814 |
| | - | - | - | 0.800 | 1.275 | 1.277 | 5.215 | 0.753 | 0.3338 | 17.70 | 0.554 | 3.22396 | 2.243 | 0.786 |
| 3 3.5000 | - | - | 5S | 0.083 | 3.334 | 8.73 | 0.891 | 0.916 | 0.8728 | 3.030 | 3.785 | 1.30116 | 0.7435 | 1.208 |
| | 40 | Std | 10S | 0.120 | 3.260 | 8.347 | 1.274 | 0.916 | 0.8535 | 4.330 | 3.619 | 1.82196 | 1.041 | 1.196 |
| | 80 | XS | 40s | 0.216 | 3.068 | 7.393 | 2.228 | 0.916 | 0.8032 | 7.580 | 3.205 | 3.01716 | 1.724 | 1.164 |
| | 160 | - | 80s | 0.300 | 2.900 | 6.605 | 3.016 | 0.916 | 0.7592 | 10.30 | 2.864 | 3.89432 | 2.225 | 1.136 |
| | - | XSS | - | 0.437 | 2.626 | 5.416 | 4.205 | 0.916 | 0.6875 | 14.30 | 2.348 | 5.03192 | 2.875 | 1.094 |
| | - | - | - | 0.600 | 2.300 | 4.155 | 5.466 | 0.916 | 0.6021 | 18.60 | 1.801 | 5.99251 | 3.424 | 1.047 |
| | - | - | - | 0.725 | 2.050 | 3.301 | 6.32 | 0.916 | 0.5367 | 21.00 | 1.431 | 6.49924 | 3.714 | 1.014 |
| | - | - | - | 0.850 | 1.800 | 2.545 | 7.076 | 0.916 | 0.4712 | 24.15 | 1.103 | 6.85088 | 3.915 | 0.984 |
| 3½ 4.0000 | - | - | 5S | 0.083 | 3.834 | 11.545 | 1.021 | 1.050 | 1.004 | 3.470 | 5.005 | 1.95972 | 0.9799 | 1.385 |
| | - | - | 10S | 0.120 | 3.760 | 11.104 | 1.463 | 1.050 | 0.9844 | 4.97 | 4.814 | 2.75519 | 1.378 | 1.372 |
| | 40 | Std | 40s | 0.226 | 3.548 | 9.887 | 2.68 | 1.050 | 0.9289 | 9.110 | 4.286 | 4.78772 | 2.394 | 1.337 |
| | 89 | XS | 80s | 0.318 | 3.364 | 8.888 | 3.678 | 1.050 | 0.8807 | 12.50 | 3.853 | 6.28009 | 3.14 | 1.307 |
| | - | XXS | - | 0.636 | 2.728 | 5.845 | 6.721 | 1.050 | 0.7142 | 22.90 | 2.534 | 9.84776 | 4.924 | 1.21 |
| | - | - | 5S | 0.083 | 4.334 | 14.753 | 1.152 | 1.180 | 1.135 | 3.92 | 6.396 | 2.80979 | 1.249 | 1.562 |
| | - | - | 10S | 0.120 | 4.260 | 14.253 | 1.651 | 1.180 | 1.115 | 5.61 | 6.179 | 3.96268 | 1.761 | 1.549 |
| | - | - | - | 0.188 | 4.124 | 13.358 | 2.547 | 1.180 | 1.08 | 8.66 | 5.791 | 5.93033 | 2.636 | 1.526 |
| 4 4.5000 | 40 | Std | 40S | 0.237 | 4.026 | 12.73 | 3.174 | 1.180 | 1.054 | 10.80 | 5.519 | 7.2326 | 3.214 | 1.51 |
| | 80 | XS | 80S | 0.337 | 3.826 | 11.497 | 4.407 | 1.180 | 1.002 | 15.00 | 4.984 | 9.61049 | 4.271 | 1.477 |
| | 120 | - | - | 0.437 | 3.626 | 10.326 | 5.578 | 1.180 | 0.9493 | 19.00 | 4.477 | 11.6433 | 5.175 | 1.445 |
| | - | - | - | 0.500 | 3.500 | 9.621 | 6.283 | 1.180 | 0.9163 | 21.4 | 4.171 | 12.7627 | 5.672 | 1.425 |
| | 160 | - | - | 0.531 | 3.438 | 9.283 | 6.621 | 1.180 | 0.9001 | 22.5 | 4.025 | 13.271 | 5.898 | 1.416 |
| | - | XXS | - | 0.674 | 3.152 | 7.803 | 8.101 | 1.180 | 0.8252 | 27.5 | 3.383 | 15.2837 | 6.793 | 1.374 |
| | - | - | - | 0.800 | 2.900 | 6.605 | 9.299 | 1.180 | 0.7592 | 31.6 | 2.864 | 16.657 | 7.403 | 1.338 |
| | - | - | - | 0.925 | 2.650 | 5.515 | 10.389 | 1.180 | 0.6938 | 35.3 | 2.391 | 17.7081 | 7.87 | 1.306 |



Properties of Pipe

| Nom. Pipe Size, O.D. Inches | Schedule Number* | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration ⁴ In. |
|-----------------------------|------------------|-----|-------|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | a | b | c | | | | | | | | | | | |
| 5 5.5630 | - | - | 5S | 0.109 | 5.345 | 22.438 | 1.868 | 146 | 1.399 | 6.35 | 9.728 | 6.94713 | 2.498 | 1.929 |
| | - | - | 10S | 0.134 | 5.295 | 22.02 | 2.285 | 146 | 1.386 | 7.77 | 9.547 | 8.42536 | 3.029 | 1.92 |
| | 40 | Std | 40s | 0.258 | 5.047 | 20.006 | 4.3 | 1.46 | 1.321 | 14.6 | 8.673 | 15.1622 | 5.451 | 1.878 |
| | 80 | XS | 80s | 0.375 | 4.813 | 18.194 | 6.112 | 146 | 1.26 | 20.8 | 7.888 | 206707 | 7.431 | 1.839 |
| | 120 | - | - | 0.500 | 4.563 | 16.353 | 7.953 | 146 | 1.195 | 27.0 | 7.09 | 25.7317 | 9.251 | 1.799 |
| | 160 | - | - | 0.625 | 4.313 | 14.61 | 9.696 | 146 | 1.129 | 33.0 | 6.334 | 300259 | 10.79 | 1.76 |
| | - | XXS | - | 0.750 | 4.063 | 12.965 | 11.34 | 146 | 1.064 | 38.6 | 5.621 | 33.6348 | 12.09 | 1.722 |
| | - | - | - | 0.875 | 3.813 | 11.419 | 12.887 | 1.46 | 0.9982 | 43.8 | 4.951 | 36.6355 | 13.17 | 1.686 |
| | - | - | - | 1.000 | 3.563 | 9.971 | 14.335 | 146 | 0.9328 | 48.7 | 4.323 | 39.1007 | 14.06 | 1.652 |
| | - | - | - | 1.125 | 3.313 | 8.454 | 16.088 | 146 | 0.8684 | 53.6 | 3.716 | 41.8391 | 15.01 | 1.618 |
| 6 6.6250 | - | - | 5S | 0.109 | 6.407 | 32.24 | 2.231 | 1.73 | 1.677 | 7.59 | 13.98 | 11.8454 | 3.576 | 2.304 |
| | - | - | 10S | 0.134 | 6.357 | 31.739 | 2.733 | 1.73 | 1.664 | 9.29 | 13.76 | 14.3974 | 4.346 | 2.295 |
| | - | - | - | 0.129 | 6.367 | 31.839 | 2.633 | 1.73 | 1.667 | 8.95 | 13.8 | 13.8918 | 4.194 | 2.297 |
| | 40 | Std | 40S | 0.28 | 6.065 | 28.89 | 5.581 | 1.73 | 1.588 | 19.0 | 12.53 | 28.1422 | 8.496 | 2.245 |
| | 80 | XS | 80S | 0.432 | 5.761 | 26.067 | 8.405 | 1.73 | 1.508 | 28.6 | 11.3 | 404907 | 12.22 | 2.195 |
| | 120 | - | - | 0.562 | 5.501 | 23.767 | 10.705 | 1.73 | 1.44 | 36.4 | 10.3 | 49.6106 | 14.98 | 2.153 |
| | 160 | - | - | 0.718 | 5.189 | 21.147 | 13.324 | 1.73 | 1.358 | 45.3 | 9.168 | 58.9732 | 17.8 | 2.104 |
| | - | XXS | - | 0.864 | 4.897 | 18.834 | 15.637 | 1.73 | 1.282 | 53.2 | 8.165 | 66.3326 | 20.02 | 2.06 |
| | - | - | - | 1.000 | 4.625 | 16.8 | 17.671 | 1.73 | 1.211 | 60.1 | 7.284 | 72.1009 | 21.77 | 2.02 |
| | - | - | - | 1.125 | 4.375 | 15.033 | 19.439 | 1.73 | 1.145 | 66.1 | 6.517 | 76.5775 | 23.12 | 1.985 |
| 8 8.6250 | - | - | 5S | 0.109 | 8.407 | 55.51 | 2.916 | 2.26 | 2.201 | 9.91 | 24.07 | 26.4402 | 6.131 | 3.011 |
| | - | - | 10S | 0.148 | 8.329 | 54.485 | 3.941 | 2.26 | 2.181 | 13.4 | 23.62 | 35.4145 | 8.212 | 2.998 |
| | - | - | - | 0.219 | 8.187 | 52.643 | 5.783 | 2.26 | 2.143 | 19.7 | 22.82 | 51.1172 | 11.85 | 2.973 |
| | 20 | - | - | 0.25 | 8.125 | 51.849 | 6.578 | 2.26 | 2.127 | 22.4 | 22.48 | 57.722 | 13.38 | 2.962 |
| | 30 | - | - | 0.277 | 8.071 | 51.162 | 7.265 | 2.26 | 2.113 | 24.7 | 22.18 | 63.3527 | 14.69 | 2.953 |
| | 40 | Std | 40S | 0.322 | 7.981 | 50.027 | 8.399 | 2.26 | 2.089 | 28.6 | 21.69 | 72.4892 | 16.81 | 2.938 |
| | 60 | - | - | 0.406 | 7.813 | 47.943 | 10.483 | 2.26 | 2.045 | 35.6 | 20.79 | 88.7363 | 20.58 | 2.909 |
| | 80 | XS | 80S | 0.500 | 7.625 | 45.664 | 12.763 | 2.26 | 1.996 | 43.4 | 19.8 | 105.716 | 24.51 | 2.878 |
| | 100 | - | - | 0.593 | 7.439 | 43.463 | 14.963 | 2.26 | 1.948 | 50.9 | 18.84 | 121.324 | 28.13 | 2.847 |
| | 120 | - | - | 0.718 | 7.189 | 40.591 | 17.836 | 2.26 | 1.882 | 60.6 | 17.6 | 140.535 | 32.59 | 2.807 |
| 10 10.7500 | 140 | - | - | 0.812 | 7.001 | 38.496 | 19.931 | 2.26 | 1.833 | 67.8 | 16.69 | 153.722 | 35.65 | 2.777 |
| | 160 | - | - | 0.906 | 6.813 | 36.456 | 21.97 | 2.26 | 1.784 | 74.7 | 15.8 | 165.887 | 38.47 | 2.748 |
| | - | - | - | 1.000 | 6.625 | 34.472 | 23.955 | 2.26 | 1.734 | 81.4 | 14.94 | 177.087 | 41.06 | 2.719 |
| | - | - | - | 1.125 | 6.375 | 31.919 | 26.507 | 2.26 | 1.669 | 90.1 | 13.84 | 190.572 | 44.19 | 2.681 |
| | - | - | 5S | 0.134 | 10.482 | 86.294 | 4.469 | 2.81 | 2.744 | 15.2 | 37.41 | 62.9675 | 11.71 | 3.75 |
| | - | - | 10S | 0.165 | 10.42 | 85.276 | 5.487 | 2.81 | 2.728 | 18.7 | 36.97 | 76.8638 | 14.3 | 3.74 |
| | - | - | - | 0.219 | 10.312 | 83.517 | 7.245 | 2.81 | 2.7 | 24.6 | 36.21 | 100.485 | 18.69 | 3.72 |
| | 20 | - | - | 0.250 | 10.25 | 82.516 | 8.247 | 2.81 | 2.683 | 28.0 | 35.77 | 113.714 | 21.16 | 3.71 |
| | 30 | - | - | 0.307 | 10.136 | 80.691 | 10.072 | 2.81 | 2.654 | 34.2 | 34.98 | 137.42 | 25.57 | 3.69 |
| | 40 | Std | 40S | 0.365 | 10.02 | 78.854 | 11.908 | 2.81 | 2.623 | 40.5 | 34.19 | 160.734 | 29.9 | 3.67 |
| 60 | XS | 80S | 0.500 | 9.75 | 74.662 | 16.101 | 2.81 | 2.553 | 54.7 | 32.37 | 211.95 | 39.43 | 3.63 | |
| 80 | - | - | 0.593 | 9.564 | 71.84 | 18.922 | 2.81 | 2.504 | 64.3 | 31.15 | 244.844 | 45.55 | 3.6 | |
| 100 | - | - | 0.718 | 9.314 | 68.134 | 22.629 | 2.81 | 2.438 | 76.9 | 29.54 | 286.132 | 53.23 | 3.56 | |
| 120 | - | - | 0.843 | 9.064 | 64.525 | 26.237 | 2.81 | 2.373 | 89.2 | 27.97 | 324.225 | 60.32 | 3.52 | |
| - | - | - | 0.875 | 9.000 | 63.617 | 27.145 | 2.81 | 2.356 | 92.3 | 27.58 | 333.485 | 62.04 | 3.51 | |
| 140 | - | - | 1.000 | 8.750 | 60.132 | 30.631 | 2.81 | 2.291 | 104 | 26.07 | 367.806 | 68.43 | 3.47 | |
| 160 | - | - | 1.125 | 8.500 | 56.745 | 34.018 | 2.81 | 2.225 | 116 | 24.6 | 399.308 | 74.29 | 3.43 | |
| - | - | - | 1.250 | 8.250 | 53.456 | 37.306 | 2.81 | 2.16 | 127 | 23.18 | 428.149 | 79.66 | 3.39 | |
| - | - | - | 1.500 | 7.750 | 47.173 | 43.59 | 2.81 | 2.029 | 148 | 20.45 | 478.464 | 89.02 | 3.31 | |



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Properties of Pipe

| Nom. Pipe Size, O.D. Inches | Number Schedule | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration ⁴ In. |
|-----------------------------|-----------------|-----|-------|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | a | b | c | | | | | | | | | | | |
| 12 12.7500 | - | - | 5S | 0.156 | 12.438 | 121.504 | 6.172 | 3.34 | 3.256 | 21 | 52.68 | 122.389 | 19.2 | 4.45 |
| | - | - | 10S | 0.180 | 12.39 | 120.568 | 7.108 | 3.34 | 3.244 | 24.2 | 52.27 | 140.419 | 22.03 | 4.44 |
| | 20 | - | - | 0.250 | 12.25 | 117.859 | 9.817 | 3.34 | 3.207 | 33.4 | 51.1 | 191.824 | 30.09 | 4.42 |
| | 30 | - | - | 0.330 | 12.09 | 114.8 | 12.876 | 3.34 | 3.165 | 43.8 | 49.77 | 248.453 | 38.97 | 4.39 |
| | - | Std | 40S | 0.375 | 12 | 113.097 | 14.579 | 3.34 | 3.142 | 49.6 | 49.03 | 279.335 | 43.82 | 4.38 |
| | 40 | - | - | 0.406 | 11.938 | 111.932 | 15.745 | 3.34 | 3.125 | 53.5 | 48.53 | 300.209 | 47.09 | 4.37 |
| | - | XS | 80S | 0.5 | 11.75 | 108.434 | 19.242 | 3.34 | 3.076 | 65.4 | 47.01 | 361.544 | 56.71 | 4.33 |
| | 60 | - | - | 0.562 | 11.626 | 106.157 | 21.519 | 3.34 | 3.044 | 73.2 | 46.02 | 400.42 | 62.81 | 4.31 |
| | 80 | - | - | 0.687 | 11.376 | 101.641 | 26.035 | 3.34 | 2.978 | 88.5 | 44.07 | 475.104 | 74.53 | 4.27 |
| | - | - | - | 0.75 | 11.25 | 99.402 | 28.274 | 3.34 | 2.945 | 96.1 | 43.09 | 510.926 | 80.15 | 4.25 |
| | 100 | - | - | 0.843 | 11.064 | 96.142 | 31.534 | 3.34 | 2.897 | 107 | 41.68 | 561.65 | 88.1 | 4.22 |
| | - | - | - | 0.875 | 11 | 95.033 | 32.643 | 3.34 | 2.88 | 111 | 41.2 | 578.523 | 90.75 | 4.21 |
| | 120 | - | - | 1.000 | 10.75 | 90.763 | 36.914 | 3.34 | 2.814 | 125 | 39.35 | 641.664 | 100.7 | 4.17 |
| | 140 | - | - | 1.125 | 10.5 | 86.59 | 41.086 | 3.34 | 2.749 | 140 | 37.54 | 700.551 | 109.9 | 4.13 |
| | - | - | - | 1.250 | 10.25 | 82.516 | 45.16 | 3.34 | 2.683 | 154 | 35.77 | 755.378 | 118.5 | 4.09 |
| | 160 | - | - | 1.312 | 10.126 | 80.531 | 47.145 | 3.34 | 2.651 | 160 | 34.91 | 781.126 | 122.5 | 4.07 |
| | - | - | 5S | 0.156 | 13.688 | 147.153 | 6.785 | 3.67 | 3.584 | 23.1 | 63.8 | 162.564 | 23.22 | 4.89 |
| | - | - | 10S | 0.188 | 13.624 | 145.78 | 8.158 | 3.67 | 3.567 | 27.7 | 63.2 | 194.566 | 27.8 | 4.88 |
| - | - | - | 0.210 | 13.58 | 144.84 | 9.098 | 3.67 | 3.555 | 30.9 | 62.79 | 216.308 | 30.9 | 4.88 | |
| - | - | - | 0.219 | 13.562 | 144.457 | 9.481 | 3.67 | 3.551 | 32.2 | 62.63 | 225.142 | 32.16 | 4.87 | |
| 10 | - | - | 0.250 | 13.5 | 143.139 | 10.799 | 3.67 | 3.534 | 36.7 | 62.06 | 255.3 | 36.47 | 4.86 | |
| - | - | - | 0.281 | 13.438 | 141.827 | 12.111 | 3.67 | 3.518 | 41.2 | 61.49 | 285.047 | 40.72 | 4.85 | |
| 20 | - | - | 0.312 | 13.376 | 140.521 | 13.417 | 3.67 | 3.502 | 45.6 | 60.92 | 314.384 | 44.91 | 4.84 | |
| - | - | - | 0.344 | 13.312 | 139.18 | 14.758 | 3.67 | 3.485 | 50.2 | 60.34 | 344.242 | 49.18 | 4.83 | |
| 30 | Std | - | 0.375 | 13.25 | 137.886 | 16.052 | 3.67 | 3.469 | 54.6 | 59.78 | 372.76 | 53.25 | 4.82 | |
| 40 | - | - | 0.437 | 13.126 | 135.318 | 18.62 | 3.67 | 3.436 | 63.3 | 58.67 | 428.607 | 61.23 | 4.8 | |
| - | - | - | 0.469 | 13.062 | 134.001 | 19.937 | 3.67 | 3.42 | 67.8 | 58.09 | 456.819 | 65.26 | 4.79 | |
| - | XS | - | 0.500 | 13 | 132.732 | 21.206 | 3.67 | 3.403 | 72.1 | 57.54 | 483.756 | 69.11 | 4.78 | |
| 60 | - | - | 0.593 | 12.814 | 128.961 | 24.977 | 3.67 | 3.355 | 84.9 | 55.91 | 562.287 | 80.33 | 4.74 | |
| - | - | - | 0.625 | 12.75 | 127.676 | 26.262 | 3.67 | 3.338 | 89.3 | 55.35 | 588.53 | 84.08 | 4.73 | |
| 80 | - | - | 0.750 | 12.5 | 122.718 | 31.22 | 3.67 | 3.272 | 106 | 53.2 | 687.318 | 98.19 | 4.69 | |
| 100 | - | - | 0.937 | 12.126 | 115.485 | 38.453 | 3.67 | 3.175 | 131 | 50.07 | 824.436 | 117.8 | 4.63 | |
| 120 | - | - | 1.093 | 11.814 | 109.618 | 44.32 | 3.67 | 3.093 | 151 | 47.52 | 929.521 | 132.8 | 4.58 | |
| 140 | - | - | 1.250 | 11.5 | 103.869 | 50.069 | 3.67 | 3.011 | 170 | 45.03 | 1027.2 | 146.7 | 4.53 | |
| 160 | - | - | 1.406 | 11.188 | 98.309 | 55.629 | 3.67 | 2.929 | 189 | 42.62 | 1116.65 | 159.5 | 4.48 | |
| - | - | 5S | 0.165 | 15.67 | 192.854 | 8.208 | 4.19 | 4.102 | 27.9 | 83.61 | 257.303 | 32.16 | 5.6 | |
| - | - | 10S | 0.188 | 15.624 | 191.723 | 9.339 | 4.19 | 4.09 | 31.7 | 83.12 | 291.904 | 36.49 | 5.59 | |
| 10 | - | - | 0.250 | 15.5 | 188.692 | 12.37 | 4.19 | 4.058 | 42.1 | 81.81 | 383.664 | 47.96 | 5.57 | |
| 20 | - | - | 0.312 | 15.376 | 185.685 | 15.377 | 4.19 | 4.025 | 52.3 | 80.5 | 473.248 | 59.16 | 5.55 | |
| 30 | Std | - | 0.375 | 15.25 | 182.654 | 18.408 | 4.19 | 3.992 | 62.6 | 79.19 | 562.084 | 70.26 | 5.53 | |
| 40 | - | - | 0.500 | 15 | 176.715 | 24.347 | 4.19 | 3.927 | 82.8 | 76.61 | 731.942 | 91.49 | 5.48 | |
| 60 | - | - | 0.656 | 14.688 | 169.44 | 31.622 | 4.19 | 3.845 | 108 | 73.46 | 932.336 | 116.5 | 5.43 | |
| 80 | - | - | 0.843 | 14.314 | 160.921 | 40.141 | 4.19 | 3.747 | 136 | 69.77 | 1156.29 | 144.5 | 5.37 | |
| 100 | - | - | 1.031 | 13.938 | 152.578 | 48.484 | 4.19 | 3.649 | 165 | 66.15 | 1364.43 | 170.6 | 5.3 | |
| 120 | - | - | 1.218 | 13.564 | 144.499 | 56.563 | 4.19 | 3.551 | 192 | 62.65 | 1555.41 | 194.4 | 5.24 | |
| 140 | - | - | 1.437 | 13.126 | 135.318 | 65.744 | 4.19 | 3.436 | 224 | 58.67 | 1759.86 | 220 | 5.17 | |
| 160 | - | - | 1.593 | 12.814 | 128.961 | 72.101 | 4.19 | 3.355 | 245 | 55.91 | 1893.54 | 236.7 | 5.12 | |



Properties of Pipe

| Nom. Pipe Size, O.D. Inches | Number Schedule | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration ⁴ In. |
|-----------------------------|-----------------|-----|-------|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | a | b | c | | | | | | | | | | | |
| 18 18.0000 | - | - | 5S | 0.165 | 17.67 | 245.224 | 9.245 | 4.71 | 4.626 | 31.4 | 106.3 | 367.621 | 40.85 | 6.31 |
| | - | - | 10S | 0.188 | 17.624 | 243.949 | 10.52 | 4.71 | 4.614 | 35.8 | 105.8 | 417.258 | 46.36 | 6.3 |
| | - | - | - | 0.250 | 17.5 | 240.528 | 13.941 | 4.71 | 4.581 | 47.4 | 104.3 | 549.138 | 61.02 | 6.28 |
| | 20 | - | - | 0.312 | 17.376 | 237.132 | 17.337 | 4.71 | 4.549 | 58.9 | 102.8 | 678.244 | 75.36 | 6.25 |
| | - | Std | - | 0.375 | 17.25 | 233.705 | 20.764 | 4.71 | 4.516 | 70.6 | 101.3 | 806.631 | 89.63 | 6.23 |
| | 30 | - | - | 0.437 | 17.126 | 230.357 | 24.112 | 4.71 | 4.484 | 82 | 99.87 | 930.264 | 103.4 | 6.21 |
| | - | XS | - | 0.500 | 17.0 | 226.98 | 27.489 | 4.71 | 4.451 | 93.5 | 98.4 | 1053.17 | 117 | 6.19 |
| | 40 | - | - | 0.562 | 16.876 | 223.681 | 30.788 | 4.71 | 4.418 | 105 | 96.97 | 1171.49 | 130.2 | 6.17 |
| | 60 | - | - | 0.750 | 16.5 | 213.825 | 40.644 | 4.71 | 4.32 | 138 | 92.7 | 1514.64 | 168.3 | 6.1 |
| | 80 | - | - | 0.937 | 16.126 | 204.241 | 50.228 | 4.71 | 4.222 | 171 | 88.55 | 1833.47 | 203.7 | 6.04 |
| | 100 | - | - | 1.156 | 15.688 | 193.297 | 61.172 | 4.71 | 4.107 | 208 | 83.8 | 2179.69 | 242.2 | 5.97 |
| | 120 | - | - | 1.375 | 15.25 | 182.654 | 71.815 | 4.71 | 3.992 | 244 | 79.19 | 2498.09 | 277.6 | 5.9 |
| | 140 | - | - | 1.562 | 14.876 | 173.805 | 80.664 | 4.71 | 3.895 | 274 | 75.35 | 2749.11 | 305.5 | 5.84 |
| | 160 | - | - | 1.781 | 14.438 | 163.721 | 90.748 | 4.71 | 3.78 | 309 | 70.98 | 3019.96 | 335.6 | 5.77 |
| | - | - | 5S | 0.188 | 19.624 | 302.458 | 11.701 | 5.24 | 5.138 | 39.8 | 131.1 | 574.172 | 57.42 | 7 |
| | - | - | 10S | 0.218 | 19.564 | 300.611 | 13.548 | 5.24 | 5.122 | 46.1 | 130.3 | 662.796 | 66.28 | 6.99 |
| 10 | - | - | 0.250 | 19.5 | 298.648 | 15.512 | 5.24 | 5.105 | 52.7 | 129.5 | 756.434 | 75.64 | 6.98 | |
| 20 | Std | - | 0.375 | 19.25 | 291.039 | 23.12 | 5.24 | 5.04 | 78.6 | 126.2 | 1113.47 | 111.3 | 6.94 | |
| 30 | XS | - | 0.500 | 19.0 | 283.529 | 30.631 | 5.24 | 4.974 | 104 | 122.9 | 1456.86 | 145.7 | 6.9 | |
| 40 | - | - | 0.593 | 18.814 | 278.005 | 36.155 | 5.24 | 4.925 | 123 | 120.5 | 1703.71 | 170.4 | 6.86 | |
| 60 | - | - | 0.812 | 18.376 | 265.211 | 48.948 | 5.24 | 4.811 | 166 | 115 | 2256.74 | 225.7 | 6.79 | |
| - | - | - | 0.875 | 18.25 | 261.587 | 52.573 | 5.24 | 4.778 | 179 | 113.4 | 2408.69 | 240.9 | 6.77 | |
| 80 | - | - | 1.031 | 17.938 | 252.719 | 61.440 | 5.24 | 4.696 | 209 | 109.6 | 2771.62 | 277.2 | 6.72 | |
| 100 | - | - | 1.281 | 17.438 | 238.827 | 75.332 | 5.24 | 4.565 | 256 | 103.5 | 3315.02 | 331.5 | 6.63 | |
| 120 | - | - | 1.500 | 17.0 | 226.98 | 87.179 | 5.24 | 4.451 | 296 | 98.4 | 3754.15 | 375.4 | 6.56 | |
| 140 | - | - | 1.750 | 16.5 | 213.825 | 100.335 | 5.24 | 4.32 | 341 | 92.7 | 4215.62 | 421.6 | 6.48 | |
| 160 | - | - | 1.968 | 16.064 | 202.674 | 111.486 | 5.24 | 4.206 | 379 | 87.87 | 4585.21 | 458.5 | 6.41 | |
| - | - | SS | 0.188 | 21.624 | 367.25 | 12.883 | 5.76 | 5.661 | 43.8 | 159.2 | 766.19 | 69.65 | 7.71 | |
| - | - | 10S | 0.218 | 21.564 | 365.215 | 14.918 | 5.76 | 5.645 | 50.7 | 158.3 | 884.816 | 80.44 | 7.7 | |
| 10 | - | - | 0.250 | 21.500 | 363.05 | 17.082 | 5.76 | 5.629 | 58.1 | 157.4 | 1010.26 | 91.84 | 7.69 | |
| 20 | Std | - | 0.375 | 21.250 | 354.656 | 25.476 | 5.76 | 5.563 | 86.6 | 153.8 | 1489.67 | 135.4 | 7.65 | |
| 30 | XS | - | 0.500 | 21.000 | 346.361 | 33.772 | 5.76 | 5.498 | 115 | 150.2 | 1952.45 | 177.5 | 7.6 | |
| - | - | - | 0.625 | 20.75 | 338.163 | 41.970 | 5.76 | 5.432 | 143 | 146.6 | 2399 | 218.1 | 7.56 | |
| 60 | - | - | 0.750 | 20.5 | 330.064 | 50.069 | 5.76 | 5.367 | 170 | 143.1 | 2829.69 | 257.2 | 7.52 | |
| 80 | - | - | 0.875 | 20.25 | 322.062 | 58.07 | 5.76 | 5.301 | 197 | 139.6 | 3244.91 | 295 | 7.48 | |
| 100 | - | - | 1.125 | 19.75 | 306.354 | 73.778 | 5.76 | 5.171 | 251 | 132.8 | 4030.43 | 366.4 | 7.39 | |
| 120 | - | - | 1.375 | 19.25 | 291.039 | 89.094 | 5.76 | 5.04 | 303 | 126.2 | 4758.5 | 432.6 | 7.31 | |
| 140 | - | - | 1.625 | 18.75 | 276.117 | 104.016 | 5.76 | 4.909 | 354 | 119.7 | 5432 | 493.8 | 7.23 | |
| 160 | - | - | 1.875 | 18.25 | 261.587 | 118.546 | 5.76 | 4.778 | 403 | 113.4 | 6053.72 | 550.3 | 7.15 | |
| 160 | - | - | 2.125 | 17.75 | 247.45 | 132.683 | 5.76 | 4.647 | 451 | 107.3 | 6626.39 | 602.4 | 7.07 | |



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Properties of Pipe

| Nom. Pipe Size, O.D. Inches | Number Schedule | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration ⁴ In. |
|-----------------------------|-----------------|-----|-------|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | a | b | c | | | | | | | | | | | |
| 24 24.0000 | 10 | - | - | 0.250 | 23.5 | 433.736 | 18.653 | 6.28 | 6.152 | 63.4 | 188 | 1315.34 | 109.6 | 8.4 |
| | 20 | Std | - | 0.375 | 23.25 | 424.557 | 27.833 | 6.28 | 6.087 | 94.6 | 184.1 | 1942.3 | 161.9 | 8.35 |
| | - | XS | - | 0.500 | 23 | 415.476 | 36.914 | 6.28 | 6.021 | 125 | 180.1 | 2549.35 | 212.4 | 8.31 |
| | 30 | - | - | 0.562 | 22.876 | 411.008 | 41.382 | 6.28 | 5.989 | 141 | 178.2 | 2843.2 | 236.9 | 8.29 |
| | - | - | - | 0.625 | 22.75 | 406.493 | 45.897 | 6.28 | 5.956 | 156 | 176.2 | 3136.93 | 261.4 | 8.27 |
| | 40 | - | - | 0.687 | 22.626 | 402.073 | 50.316 | 6.28 | 5.923 | 171 | 174.3 | 3421.28 | 285.1 | 8.25 |
| | - | - | - | 0.750 | 22.5 | 397.608 | 54.782 | 6.28 | 5.89 | 186 | 172.4 | 3705.46 | 308.8 | 8.22 |
| | - | - | 5S | 0.218 | 23.564 | 436.102 | 16.288 | 6.28 | 6.169 | 55.4 | 189.1 | 1151.59 | 95.97 | 8.41 |
| | - | - | - | 0.875 | 22.25 | 388.821 | 63.568 | 6.28 | 5.825 | 216 | 168.6 | 4255.34 | 354.6 | 8.18 |
| | 60 | - | - | 0.968 | 22.064 | 382.348 | 70.042 | 6.28 | 5.776 | 238 | 165.8 | 4652.61 | 387.7 | 8.15 |
| | 80 | - | - | 1.218 | 21.564 | 365.215 | 87.174 | 6.28 | 5.645 | 296 | 158.3 | 5671.82 | 472.7 | 8.07 |
| | 100 | - | - | 1.531 | 20.938 | 344.318 | 108.071 | 6.28 | 5.482 | 367 | 149.3 | 6851.69 | 571 | 7.96 |
| | 120 | - | - | 1.812 | 20.376 | 326.083 | 126.307 | 6.28 | 5.334 | 429 | 141.4 | 7824.55 | 652 | 7.87 |
| | 140 | - | - | 2.062 | 19.876 | 310.276 | 142.114 | 6.28 | 5.204 | 483 | 134.5 | 8625.01 | 718.8 | 7.79 |
| | 160 | - | - | 2.343 | 19.314 | 292.978 | 159.412 | 6.28 | 5.056 | 542 | 127 | 9455.42 | 788 | 7.7 |
| | - | - | - | 0.250 | 25.5 | 510.705 | 20.224 | 6.81 | 6.676 | 68.8 | 221.4 | 1676.38 | 129 | 9.1 |
| 26 26.0000 | 10 | - | - | 0.312 | 25.376 | 505.75 | 25.179 | 6.81 | 6.643 | 85.6 | 219.3 | 2077.16 | 159.8 | 9.08 |
| | - | Std | - | 0.375 | 25.25 | 500.74 | 30.189 | 6.81 | 6.61 | 103 | 217.1 | 2478.42 | 190.6 | 9.06 |
| | 20 | XS | - | 0.500 | 25 | 490.874 | 40.055 | 6.81 | 6.545 | 136 | 212.8 | 3257 | 250.5 | 9.02 |
| | - | - | - | 0.625 | 24.75 | 481.105 | 49.824 | 6.81 | 6.48 | 169 | 208.6 | 4012.56 | 308.7 | 8.97 |
| | - | - | - | 0.75 | 24.5 | 471.435 | 59.494 | 6.81 | 6.414 | 202 | 204.4 | 4745.57 | 365 | 8.93 |
| | - | - | - | 0.875 | 24.25 | 461.863 | 69.066 | 6.81 | 6.349 | 235 | 200.2 | 5456.48 | 419.7 | 8.89 |
| | - | - | - | 1.000 | 24 | 452.389 | 78.54 | 6.81 | 6.283 | 267 | 196.1 | 6145.74 | 472.7 | 8.85 |
| | - | - | - | 1.125 | 23.75 | 443.014 | 87.916 | 6.81 | 6.218 | 299 | 192.1 | 6813.8 | 524.1 | 8.8 |
| | - | - | - | 0.25 | 27.5 | 593.957 | 21.795 | 7.33 | 7.199 | 74.1 | 257.5 | 2098.09 | 149.9 | 9.81 |
| | 10 | Std | - | 0.312 | 27.376 | 588.613 | 27.139 | 7.33 | 7.167 | 92.3 | 255.2 | 2601.02 | 185.8 | 9.79 |
| - | XS | - | 0.375 | 27.25 | 583.207 | 32.545 | 7.33 | 7.134 | 111 | 252.8 | 3105.12 | 221.8 | 9.77 | |
| 28 28.0000 | 20 | - | - | 0.500 | 27.000 | 572.555 | 43.197 | 7.33 | 7.069 | 147 | 248.2 | 4084.81 | 291.8 | 9.72 |
| | 30 | - | - | 0.625 | 26.75 | 562.001 | 53.751 | 7.33 | 7.003 | 183 | 243.6 | 5037.66 | 359.8 | 9.68 |
| | - | - | - | 0.750 | 26.5 | 551.546 | 64.206 | 7.33 | 6.938 | 218 | 239.1 | 5964.16 | 426 | 9.64 |
| | - | - | - | 0.875 | 26.25 | 541.188 | 74.564 | 7.33 | 6.872 | 253 | 234.6 | 6864.82 | 490.3 | 9.6 |
| | - | - | - | 1.000 | 26 | 530.929 | 84.823 | 7.33 | 6.807 | 288 | 230.2 | 7740.1 | 552.9 | 9.55 |
| | - | - | - | 1.125 | 25.75 | 520.768 | 94.984 | 7.33 | 6.741 | 323 | 225.8 | 8590.49 | 613.6 | 9.51 |
| | - | - | 5S | 0.250 | 29.5 | 683.493 | 23.366 | 7.85 | 7.723 | 79.4 | 296.3 | 2585.18 | 172.3 | 10.52 |
| | 10 | - | 10S | 0.312 | 29.376 | 677.759 | 29.099 | 7.85 | 7.691 | 98.9 | 293.8 | 3206.31 | 213.8 | 10.5 |
| | - | Std | - | 0.375 | 29.25 | 671.957 | 34.901 | 7.85 | 7.658 | 119 | 291.3 | 3829.44 | 255.3 | 10.47 |
| | 20 | XS | - | 0.500 | 29 | 660.52 | 46.338 | 7.85 | 7.592 | 158 | 286.4 | 5042.21 | 336.1 | 10.43 |
| 30 30.0000 | 30 | - | - | 0.625 | 28.75 | 649.181 | 57.678 | 7.85 | 7.527 | 196 | 281.4 | 6224.01 | 414.9 | 10.39 |
| | 40 | - | - | 0.750 | 28.5 | 637.94 | 68.919 | 7.85 | 7.461 | 234 | 276.6 | 7375.38 | 491.7 | 10.34 |
| | - | - | - | 0.875 | 28.25 | 626.797 | 80.062 | 7.85 | 7.396 | 272 | 271.7 | 8496.84 | 566.5 | 10.3 |
| | - | - | - | 1.000 | 28 | 615.752 | 91.106 | 7.85 | 7.33 | 310 | 267 | 9588.93 | 639.3 | 10.26 |
| | - | - | - | 1.125 | 27.75 | 604.806 | 102.053 | 7.85 | 7.265 | 347 | 262.2 | 10652.1 | 710.1 | 10.22 |
| | - | - | - | 0.250 | 29.5 | 683.493 | 23.366 | 7.85 | 7.723 | 79.4 | 296.3 | 2585.18 | 172.3 | 10.52 |
| | 10 | - | - | 0.312 | 31.376 | 773.188 | 31.06 | 8.38 | 8.214 | 106 | 335.2 | 3898.89 | 243.7 | 11.2 |
| | - | - | - | 0.375 | 31.25 | 766.99 | 37.257 | 8.38 | 8.181 | 127 | 332.5 | 4658.48 | 291.2 | 11.18 |
| | 20 | Std | - | 0.500 | 31 | 754.768 | 49.48 | 8.38 | 8.116 | 168 | 327.2 | 6138.62 | 383.7 | 11.14 |
| | 30 | XS | - | 0.625 | 30.75 | 742.643 | 61.605 | 8.38 | 8.05 | 209 | 322 | 7583.39 | 474 | 11.09 |
| 32 32.0000 | 40 | - | - | 0.688 | 30.624 | 736.569 | 67.678 | 8.38 | 8.017 | 230 | 319.3 | 8298.32 | 518.6 | 11.07 |
| | - | - | - | 0.750 | 30.5 | 730.617 | 73.631 | 8.38 | 7.985 | 250 | 316.8 | 8993.35 | 562.1 | 11.05 |
| | - | - | - | 0.875 | 30.25 | 718.688 | 85.559 | 8.38 | 7.919 | 291 | 311.6 | 10369.1 | 648.1 | 11.01 |
| | - | - | - | 1.000 | 30 | 706.858 | 97.389 | 8.38 | 7.854 | 331 | 306.5 | 11711.1 | 731.9 | 10.97 |
| | - | - | - | 1.125 | 29.75 | 695.126 | 109.121 | 8.38 | 7.789 | 371 | 301.4 | 13020 | 813.7 | 10.92 |

Properties of Pipe

| Nom. Pipe Size, O.D. Inches | Number Schedule | | | Wall Thickness Inch | Inside Diameter Inch | Inside Area Sq. In. | Metal Area Sq. In. | Outside Surface Sq. Ft./ Ft. | Inside Surface Sq. Ft./ Ft. | Weight per Foot Lbs. † | Weight of Water per Foot Lbs. | Moment of Inertia In. ⁴ | Section Modulus In. ³ | Radius Gyration ⁴ In. | |
|-----------------------------|-----------------|-----|----|---------------------|----------------------|---------------------|--------------------|------------------------------|-----------------------------|------------------------|-------------------------------|------------------------------------|----------------------------------|----------------------------------|-------|
| | a | b | c | | | | | | | | | | | | |
| 34 34.0000 | - | - | - | 0.250 | 33.500 | 881.413 | 26.507 | 8.90 | 8.770 | 90.1 | 382.1 | 3774.38 | 222.0 | 11.93 | |
| | 10 | - | - | 0.312 | 33.376 | 874.9 | 33.02 | 8.90 | 8.738 | 112 | 379.3 | 4684.65 | 275.6 | 11.91 | |
| | - | Std | - | 0.375 | 33.250 | 868.307 | 39.614 | 8.90 | 8.705 | 135 | 376.4 | 5599.28 | 329.4 | 11.89 | |
| | 20 | XS | - | 0.500 | 33.000 | 855.288 | 52.632 | 8.90 | 8.639 | 179 | 370.8 | 7384.89 | 434.4 | 11.85 | |
| | 30 | - | - | 0.625 | 32.750 | 842.389 | 65.532 | 8.90 | 8.574 | 223 | 365.2 | 9127.59 | 536.9 | 11.8 | |
| | 40 | - | - | 0.688 | 32.624 | 835.919 | 72.001 | 8.90 | 8.541 | 245 | 362.4 | 995.61 | 587.7 | 11.78 | |
| | - | - | - | 0.750 | 32.500 | 829.577 | 78.343 | 8.90 | 8.508 | 266 | 359.7 | 10832.2 | 637.2 | 11.76 | |
| | - | - | - | 0.875 | 32.250 | 816.863 | 91.057 | 8.90 | 8.443 | 310 | 354.1 | 12497.9 | 735.2 | 11.72 | |
| | - | - | - | 1.000 | 32.000 | 804.248 | 103.673 | 8.90 | 8.378 | 352 | 348.7 | 14125.4 | 830.9 | 11.67 | |
| | - | - | - | 1.125 | 31.750 | 791.73 | 116.190 | 8.90 | 8.312 | 395 | 343.2 | 15715.1 | 924.4 | 11.63 | |
| | 36 36.0000 | - | - | - | 0.250 | 35.500 | 989.798 | 28.078 | 9.42 | 9.294 | 95.5 | 429.1 | 4485.9 | 249.2 | 12.64 |
| | | 10 | - | - | 0.312 | 35.376 | 982.895 | 34.981 | 9.42 | 9.261 | 119 | 426.1 | 5569.48 | 309.4 | 12.62 |
| - | | Std | - | 0.375 | 35.250 | 975.906 | 41.970 | 9.42 | 9.228 | 143 | 423.1 | 6658.92 | 369.9 | 12.6 | |
| 20 | | XS | - | 0.500 | 35.000 | 962.113 | 55.763 | 9.42 | 9.163 | 190 | 417.1 | 8786.2 | 488.1 | 12.55 | |
| 30 | | - | - | 0.625 | 34.750 | 948.417 | 69.459 | 9.42 | 9.098 | 236 | 411.2 | 10868.4 | 603.8 | 12.51 | |
| 40 | | - | - | 0.75 | 34.500 | 934.82 | 83.056 | 9.42 | 9.032 | 282 | 405.3 | 12906.1 | 717.0 | 12.47 | |
| - | | - | - | 0.875 | 34.250 | 921.321 | 96.555 | 9.42 | 8.967 | 328 | 399.4 | 14900.0 | 827.8 | 12.42 | |
| - | | - | - | 1.000 | 34.000 | 907.92 | 109.956 | 9.42 | 8.901 | 374 | 393.6 | 16850.7 | 936.2 | 12.38 | |
| - | | - | - | 1.125 | 33.750 | 894.618 | 123.258 | 9.42 | 8.836 | 419 | 387.9 | 18758.9 | 1042.2 | 12.34 | |
| - | | - | - | 0.25 | 41.500 | 1352.652 | 32.790 | 11.00 | 10.86 | 111 | 586.4 | 71447.1 | 340.2 | 14.76 | |
| - | | Std | - | 0.375 | 41.250 | 1336.404 | 49.038 | 11.00 | 10.80 | 167 | 579.4 | 10621.6 | 505.8 | 14.72 | |
| 42 42.0000 | | 20 | XS | - | 0.500 | 41.000 | 1320.254 | 65.188 | 11.00 | 10.73 | 222 | 572.4 | 14035.8 | 668.4 | 14.67 |
| | 30 | - | - | 0.625 | 40.750 | 1304.203 | 81.24 | 11.00 | 10.67 | 276 | 565.4 | 17388.1 | 828.0 | 14.63 | |
| | 40 | - | - | 0.75 | 40.500 | 1288.249 | 97.193 | 11.00 | 10.6 | 330 | 558.5 | 20679.3 | 984.7 | 14.59 | |
| | - | - | - | 1.000 | 40.000 | 1256.637 | 128.805 | 11.00 | 10.47 | 438 | 544.8 | 27081.3 | 1289.6 | 14.5 | |
| | - | - | - | 1.250 | 39.500 | 1225.417 | 160.025 | 11.00 | 10.34 | 544 | 531.3 | 33247.7 | 1583.2 | 14.41 | |
| | - | - | - | 1.500 | 39.000 | 1194.591 | 190.852 | 11.00 | 10.21 | 649 | 517.9 | 39184.3 | 1865.9 | 14.33 | |



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