U. S. Steel Material Standards

U. S. Steel material standards are specifications not covered by a society, association or other specifying body. The following includes the material standards used most frequently for tubular applications.

USS M1020	Plain End ERW Pipe for Water Well Applications
USS M1021	Plain End ERW Pipe for Use in Structural Applications
USS M1024	Seamless Mechanical Tubing in Sizes from NPS 2 thru 26
USS M1029	Plain End Seamless Pipe for Use in General Purpose Applications
USS M1400	Constructional Alloy Steel Seamless Mechanical Tubing – Grades USS "T-1" Type A and USS "T-1" Type B
USS M1407	ERW Pipe NPS 8 thru 12 for Lift Devices
USS M1430	Seamless Steel Slurry Pipe - Grade USS 430
USS M1431	Seamless Slurry Pipe to be Heat Treated. Primarily for Mechanical Joining
USS M1470	Seamless Steel Pipe for Fabrication into Ordinary Welding Fittings
USS M1471	Seamless Steel Pipe for Fabrication into High-Strength Welding Fittings
USS M1475	Seamless Steel Pipe for Manufacture of Cold-Formed Fittings
USS M2430	ERW Pipe Intended for Transportation of Solids in Slurry Form

Pressure Determinations

Barlow's Formula is commonly used to determine the following:
- Internal Pressure at Minimum Yield
- Ultimate Burst Pressure
- Maximum Allowable Operating Pressure, and
- Mill Hydrostatic Test Pressure

This formula is expressed as $P = \frac{2St}{D}$, where:

P = pressure, psig
t = nominal wall thickness, inches
D = outside diameter, inches
S = allowable stress, psi

To illustrate, assume a seamless piping system 8-5/8" OD x 0.375" wall specified to API 5L Grade B which has a specified minimum yield strength (SMYS) of 35,500 psi and a specified minimum tensile strength (SMTS) of 60,200 psi.

Internal Pressure at Minimum Yield

S=SMYS (35,500 psi)

and

$$P = \frac{2St}{D} = \frac{2\ (35{,}500)\ (0.375)}{8.625} = 3{,}087 \text{ or } 3{,}090 \text{ psig (rounded to nearest 10 psig)}$$

Ultimate Burst Pressure at Minimum Tensile

S = SMTS (60,200 psi)

and

$$P = \frac{2St}{D} = \frac{2\ (60{,}200)\ (0.375)}{8.625} = 5{,}234.7 \text{ psig or } 5{,}230 \text{ psig (rounded to nearest 10 psig)}$$

Maximum Allowable Operating Pressure (MAOP)

S=SMYS (35,500 psi) reduced by a design factor, for example 0.72,

and

$$P = \frac{2St}{D} = \frac{2\ (35{,}500 \times 0.72)\ (0.375)}{8.625} = 2{,}222.6 \text{ psig or } 2{,}220 \text{ psig (rounded to nearest 10 psig)}$$

Mill Hydrostatic Test Pressure

S=SMYS (35,500 psi) reduced by a factor depending on OD and grade (0.60 for 8-5/8″ OD Grade B)

and

$$P = \frac{2St}{D} = \frac{2\ (35{,}500 \times 0.60)\ (0.375)}{8.625} = 1{,}852.2 \text{ psig or } 1{,}850 \text{ psig (rounded to nearest 10 psig)}$$

Some safety codes and regulatory agencies also assign a longitudinal joint factor to account for weld efficiency. The more common are 0.85 for ERW pipe and 0.60 for CW pipe. Seamless pipe enjoys a joint factor of 1.00. This means that some designers consider ERW pipe as 85 percent as efficient as seamless pipe and CW pipe only 60 percent as efficient for the same application. Therefore, for a given application, ERW pipe would require a heavier wall than seamless pipe, and CW pipe, in turn, would require a heavier wall than ERW pipe.

Distributors who stock pipe in a combination of seamless, ERW, and CW must exercise extreme care to see that pipe with joint efficiency factors of 0.85 or 0.60 is not used on jobs which require pipe with a joint factor of 1.00.

Wall Thickness

Barlow's Formula is also useful in determining the wall thickness required for a piping system. To illustrate, assume a piping system has been designed with the following criteria:

1. A working pressure of 2,000 psig (P)
2. The pipe to be used is 8-5/8″ OD (D) specified to API 5L Grade B (SMYS = 35,500 psi)

Rearranging Barlow's Formula to solve for wall thickness gives:

$$t = \frac{PD}{2S} = \frac{(2{,}000)\ (8.625)}{2\ (35{,}500)} = 0.243 \text{ wall}$$

Wall thickness does not affect the outside diameter; only the inside diameter is affected. For example, the outside diameter of a one-inch extra-strong piece of pipe compared with a one-inch standard weight piece of pipe is identical; however, the inside diameter of the extra-strong is smaller than the inside diameter of the standard weight because the wall thickness is greater in the extra-strong pipe.