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 \( (35,500 \text{ psi}) \)

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**

\[ S = S_{MTS} \text{ (60,200 psi)} \]

and

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

**Maximum Allowable Operating Pressure (MAOP)**

\[ S = S_{SMYS} \text{ (35,500 psi)} \text{ reduced by a design factor, for example 0.72,} \]

and

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

**Mill Hydrostatic Test Pressure**

\[ S = S_{SMYS} \text{ (35,500 psi)} \text{ reduced by a factor depending on OD and grade (0.60 for 8-5/8" OD Grade B)} \]

and

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

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:

\[ t = \frac{PD}{2S} = \frac{[2,000] \times 8.625}{2 \times 35,500} = 0.243 \text{ wall} \]

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.