10 Things to Know About Industrial Steam Plants

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Make sure an unexpected accident is not waiting the next time someone opens a valve or puts a steam line into service.

This article seeks to provide methods for screening high pressure (below 300 psig) piping systems, that may normally be encountered in industrial steam plants, to identify safety issues related to the design and/or installation of pipe, valves, flanges, and components used in these systems. The following is not an all-inclusive guide to safe practices, but instead attempts to give some insight for understanding and conducting a simple screening of a steam piping system.

This review of what is installed is important for every steam plant operator to help make sure that an unexpected accident is not waiting the next time someone opens a valve or puts a steam line into service.

STEAM PIPING RATINGS OF BOILER SYSTEMS

In most states and jurisdictions, steam piping is classified as high pressure piping when it exceeds 15 PSIG. The main construction code used to define high pressure piping issues and requirements for construction and installation is published by the American Society of Mechanical Engineers Section I (Power Boiler) and ASME code B31.1 (Pressure Piping) codes. You can obtain copies of these code sections at www.asme.org or by calling (800) THE-ASME.

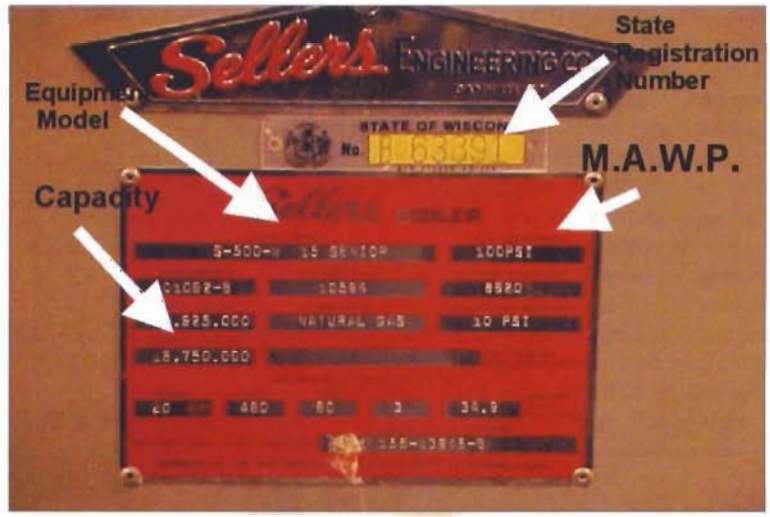
WHAT IS MAWP?

The piping, valves, and components of any high pressure piping system have to be rated for the MAWP, or the Maximum Allowable Working Pressure, of the boiler. ASME requires a nameplate be affixed to the boiler with this information on it. The piping attached to the steam discharge flange must also be built to withstand the MAWP that the boiler can generate. In multiple boiler installations, the design rules typically apply to all piping through the second stop valve from the discharge flange of the boiler and are governed by ASME Code Section I and B31.1. After the discharge of the second valve, the piping must be rated as required by the applicable jurisdiction. This may be the MAWP of the boiler or at least the setpoint of the highest safety relief valve protecting the system. There are also specific rules for stamping or identifying the piping which falls within the code boundary jurisdiction of the boiler. Typically the S/N (serial number), Certified By and Pressure will be stamped or a nameplate banded to the pipe indicating this information.

SOME PIPING BASICS

It is very important that you understand what you are looking at and the consequences of being wrong when it comes to evaluating piping systems.

Let's start with the pipe itself. Most pipe you will ever encounter starts its life at a steel mill in sheet form. In many cases, the mill rolls the sheet



into tubes and welds it. There are different piping designations, an example is ASTM A 53B, ASME SA 53 B. ASTM means American Society of Testing Materials, (www.astm.org), SA 53 B, is the designation for plain black steel pipe mostly used in the industry. Piping also comes in different schedules (or wall thicknesses). The schedule or thickness would be schedule 40 or 80. The wall thickness for typical 6" schedule 40 increases from 0.280" to 0.432" for schedule 80. Schedule 40 is what's commonly called for in B31.1 for pressure piping in service conditions that apply to this article. B31.1 and ASME code, Section I, have calculations that the designers would use to determine the safe working pressure of the piping based on its type, thickness and minimum diameter. Schedule 80 is called out as good practice for most condensate systems since they are a severe duty as compared to steam. Condensate is likely to contain carbonic and or other mild acids. This tends to erode condensate piping over time. Making this kind of piping thicker from the start builds in a factor of safety.

JOINTS AND JOINING METHODS

Pipe gets assembled to other pipe, fittings, and flanges by either welding or threading. There are specific code requirements that describe when it is permissible to thread or when welding must be used. Within the welding world, you also need to be aware of several other possibilities. Flanges and fittings come as either slip on or weld neck. Slip on fittings are just that, slipped onto the end of the pipe. The flange is then welded up around the contact points on the inside and outside of the pipe and the flange. Slip on flanges are not considered as strong a joint as weld neck or butt welded connections. In the case of a butt welded or weld neck flange the two pieces, flange and pipe, are prepped and then welded together with full penetration through the weld construction (a welder carefully lays a bead and builds up layers around the entire surface of the gap between the two pieces). Socket welding is a term used to describe when a slip on fitting, usually used for small diameters, is inserted into the fitting until it bottoms out. Then the pipe is pulled back from the bottom and welded to the fitting. Failure to pull the pipe back can cause welds to fail from stresses.

FLANGES AND THEIR RATINGS

You also need to be aware of flange pressure ratings. The ratings and certification information are usually stamped on the circumference of the flange. A 150 LB flange indicates a pressure temperature rating. This is not the MAWP of the flange, but a designation which allows a certain pressure use based upon the installation and temperature to be encountered. Pressure /Temperature ratings can be found in ASTM A 105 B 16.5 specification tables (www.astm.org).

FLANGE MATERIALS

Flange materials can also be tricky. You always want to make sure you are using carbon steel flanges with the proper rating, A 105 B 16.5 is a typical carbon steel flange used in pressure piping applications. Cast iron flanges are too brittle and could break in this kind of application.

FASTENER ISSUES, WHEN A BOLT IS NOT JUST A BOLT

Fasteners could be another problem area. Fasteners should be rated to at least a grade 8. This means they have a tensile strength that could withstand the force that must be applied for the proper assembly of the components. There is also a standard marking system for fasteners. When you look at a bolt head you should be able to see markings that identify its grade or rating. Be aware that cheap fasteners can mean forgeries that can cost someone their life. You can find out more about fasteners and ratings by going to the National Fastener Distributor Association's website at www.nfda-fastener.org. Also, be aware of threaded rods and studs. Studs are not simply some supply house off the shelf threaded rod cut to size. Studs should be marked with a stamping in the end that indicates they are a special grade and type of material that is of sufficient tensile strength. They might have a marking like "AB or HV" stamped into the end.

VALVE AND FITTINGS RATINGS

Valves and fittings should have their pressure rating cast into them or marked as required by the applicable material specification. Many pipe fittings are marked with a manufacturer's logo or insignia, size, and schedule rating (example 6" SA 234 Gr WPB or 1" 3000M A105 B 16.5 with the logo). The pressure rating must be at least equal to the design MAWP. Again ASME/ASTM SA/A 234 or SA/A 105 B 16.5 give the specific requirements for these fittings. Valves will also be marked with their pressure rating along with the type of service permitted to be used. The ASME

codes specify which types of valves and fittings are permitted to be used and their proper service applications in pressure piping applications.

WELDING CONSIDERATIONS

Welding on pipe, fittings, flanges, and pressure vessels must only be done by someone with the proper credentials. Welding on pressure piping must be performed following qualified welding procedure specifications. It is the responsibility of the installer to have welding procedure specifications that are certified to meet the applicable ASME code construction;(refer to ASME code Section I and B 31.1 and ASME Code Section IX for welding procedure specifications). The National Board Inspection code which is required for repairs of pressure equipment also includes AWS (American Welding Society, www.aws.org) standard welding procedures. Every detail of AWS standard welding procedures must be followed when welding or the weld can be deemed to not be a qualified weld and in jeopardy of having to be removed.

QUALIFIED PEOPLE

Welders must also be qualified to the requirements of ASME code Section IX. Once qualified and certified, the welder

Bolt Grade Markings and Strength

Head Markings	Grade or Class	Material	Nominal Size Range (Inches)	Mechanical Properties		
				Proof Load (psi)	Minimum Yield Strength (psi)	Minimum Tensile Strength (psi)
American						
 No Markings	Grade 2	Low or Medium Carbon Steel	1/4 thru 3/4	55,000	57,000	74,000
			Over 3/4 thru 1-1/2	33,000	36,000	60,000
 3 Radial Lines	Grade 5	Medium Carbon Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
			Over 1 thru 1-1/2	74,000	81,000	105,000
 6 Radial Lines	Grade 8	Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 1-1/2	120,000	130,000	150,000
Stainless markings vary. Most stainless is non-magnetic	18-8 Stainless	Steel alloy with 17-19% Chromium and 8-13% Nickel	1/4 thru 5/8		80,000 – 90,000	100,000 – 125,000
			3/4 thru 1		45,000 – 70,000	45,000 – 70,000
			Above 1			80,000 – 90,000
Metric						
 8.8	Class 8.8	Medium Carbon Steel, Quenched and Tempered	All Sizes thru 1-1/2	85,000	92,000	120,000
 10.9	Class 10.9	Alloy Steel, Quenched and Tempered	All Sizes thru 1-1/2	120,000	130,000	150,000
Stainless markings vary. Most stainless is non-magnetic	A-2 Stainless	Steel alloy with 17-19% Chromium and 8-13% Nickel	1/4 thru 5/8		80,000 – 90,000	100,000 – 125,000
			3/4 thru 1		45,000 – 70,000	100,000
			Above 1			80,000 – 90,000

Tensile Strength: The maximum load in tension (pulling apart) which a material can withstand before breaking or fracturing.
Yield Strength: The maximum load at which a material exhibits a specific permanent deformation
Proof Load: An axial tensile load which the product must withstand without evidence of any permanent set.

can only weld within the variables listed on their welder's performance qualification record. The welder must also weld within the process at least once every six months or the qualification expires. Records must be kept to prove that the welder had welded at least once every six months. Welders will mark their welds with stamping to identify which person welded which joint. This stamping could be there on your system but possibly obscured with insulation.

Along with the ASME required stamping, the National Boards registration numbers might also be found. The National Board of Boiler and Pressure Vessel Inspectors is located in Columbus, Ohio. They maintain a database of all registered pressure items. You can call them with the National Board number, original manufacturer and year built as indicated on a nameplate, and they can tell you lots about what you have and the original design. They can be reached at www.nationalboard.org. This is very important when inspecting, repairing or replacing items. The proper repair or replacement should ensure the same safety integrity as when the boiler, pressure piping or pressure equipment was originally constructed (if not better).

There it is. Ten simple rules that might keep you or someone else alive. Trust me, you do not want to be around a piece of piping or a flange that lets go. We are talking the immediate removal of flesh, displacement of oxygen, and burns over so much of your body that it will be over in a painful matter of hours. This stuff is nothing to play with so make sure the job is being done right, use professionals, and know what you are getting. Also, take a little time to use the information above and know more about what you already have.

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