PIPING NEWS

A Newsletter published by W. M. Huitt Co.
for designers and engineers involved with process piping

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Written and/or Edited by W. M. (Bill) Huitt

CHEMICAL SAFETY BOARD

The US Chemical Safety and Hazard Investigation Board, known more pointedly and distinctly as the Chemical Safety Board, is "…an independent federal agency charged with investigating industrial chemical accidents." In doing so they publish narratives and videos on their findings.

The narratives along with the videos paint a vivid picture of what caused an accident, how it developed, and what the end result was. I frequently use their findings in my piping design courses to lay at the feet of those who take the various piping training courses.

Such industrial autopsies shed a great deal of light on how these accidents evolved to become the catastrophe that they become. Knowing the cause for such accidents helps the designer and engineer get a clearer picture of how these accidents often evolve from some small insignificant oversight or neglect. It opens the eyes during HAZOPS reviews to better recognize mistakes, oversights, or a poor installation for the potential they are to evolve into a catastrophic event.

It is with that in mind that we present the latest report from the CSB as an update on the fire and explosion that occurred on October 16 of this year, as follows:

CSB Factual Update on the Massive Explosion and Fire at the PES Refinery in Philadelphia, PA

Philadelphia, PA, October 16, 2019 – Today, the US Chemical Safety Board (CSB) released a factual update into the June 21, 2019, explosion and fire at the Philadelphia Energy Solutions (PES) Refinery in Philadelphia. The factual update notes that a pipe elbow, which had corroded to about half the thickness of a credit card, appears to have ruptured in the refinery's alkylation unit, releasing process fluid that included over 5,000 pounds of hydrofluoric acid, or HF. The leaking process fluid formed a large ground-hugging vapor cloud. Two minutes later, the cloud ignited, causing a massive fire and explosions.

Interim Executive Dr. Kristen Kulinowski said, "Since 2015, the CSB has investigated three major incidents at refineries that utilize HF for alkylation. Incidents in Superior, WI, and Torrance, CA, fortunately did not result in an HF release. That was not the case here in Philadelphia. Though the main tank holding HF was not breached, HF was a component of the process fluid released from the alkylation unit. We are lucky there were no serious injuries or fatalities."

While the CSB's investigation is still ongoing, the factual update notes important details of the incident collected through interviewing witnesses gathering evidence, and ultimately, piecing together the events that led to the explosion:

- The piping was susceptible to corrosion from the hydrofluoric acid that was in the process fluid. The elbow that ruptured corroded faster than the rest of the piping in this part of the process.

- While pipe thickness in this section of the unit was periodically measured to monitor corrosion rates, the thickness of the elbow that failed had not been monitored for corrosion. The piece of piping that failed had a high nickel and copper content. Various industry publications have found that carbon steel with a higher percentage of nickel and copper corrodes at a faster rate than carbon steel with a lower percentage when used in a process with hydrofluoric acid.

- A secondary event at the PES refinery occurred when the V-1 Treater Feed Surge Drum ruptured, which launched a fragment of the vessel weighing 38,000 pounds across the Schuylkill River. Two other large fragments landed within the PES Refinery.

CSB Supervisory Investigator Lauren Grim said, "Corrosion is not a new issue for the CSB. In its prior investigation of a 2012 Chevron Refinery fire we determined that corrosion caused the rupture of a piping component. Similarly, the 2009 Silver Eagle refinery fire was also caused by the failure of piping that had thinned due to corrosion."

Animation of the event can be viewed at:
https://www.youtube.com/watch?v=J4wKjGHvs_4&feature=youtu.be

During the news conference Interim Executive Kulinowski noted that moving forward the CSB is examining the need for more robust reviews of corrosion mechanisms as well as looking more closely at the use of HF in the refining process.

The CSB is an independent, non-regulatory federal agency whose mission is to drive chemical safety change through independent investigations to protect people and the environment. The agency's board members are appointed by the President and confirmed by the Senate.

CSB investigations look into all aspects of chemical incidents, including physical causes such as equipment failure as well as inadequacies in regulations, industry standards, and safety management systems. For more information, contact public@csb.gov.■

ASME B31.3 and BPE MEETINGS

The ASME B31.3 Process Piping Committee meets two times each year and the BPE Committee meets three time each year. This year their Meetings, which are open to the public, will be held as follows:

B31.3 Process Piping Committee Meetings

Spring 2020

April 06 2020 08:30 AM - April 08 2020 05:00 PM, Monday - Wednesday

Venue & Location:

Royal Sonesta New Orleans
https://www.reservationcounter.com/hotels/show/6123778/royal-sonesta-new-orleans-new-orleans-la/
300 Bourbon Street
New Orleans LA, United States

Fall 2020

September 14 2020 08:30 AM - September 16 2020 05:00 PM, Monday – Wednesday

Venue & Location:

Hilton Long Beach
https://www3.hilton.com/en/hotels/california/hilton-long-beach-LGBLHHF/index.html?SEO_id=GMB-HI-LGBLHHF
701 W. Ocean Blvd
Long Beach, California, USA

Bioprocessing Equipment (BPE) Committee Meetings

Winter 2020

January 13, 2020 08:00 AM to January 16, 2020 12:00 PM, Monday - Thursday

Venue & Location:

Caribe' Hilton
https://www.caribehilton.com/
1 San Geronimo Street
San Juan, Puerto Rico 00901

Spring 2020
May 18, 2020 08:00 AM to May 21, 2020 12:00 PM, Monday - Thursday

Venue & Location:

Royal Sonesta New Orleans
https://www.sonesta.com/
300 Bourbon Street
New Orleans LA, United States

Fall 2020

September 21, 2020 08:00 AM to September 24, 202 12:00 PM, Monday – Thursday

Venue & Location

Hotel Bonaventure Montreal
http://hotelbonaventure.com
900 Rue de la Gauchetiere Quest
Montreal, Saskatchewan, CAN

STEAM SYSTEM DESIGN – THE BASICS PLANT WIDE DISTRIBUTION

In order to determine an appropriate pressure for steam generation and how much of that steam will need to be generated, some, actually a lot of preliminary work will have to be done. In doing that work, one of the first steps will be to determine the usage rate, in Btu's, for all of the users. Process and mechanical engineering should have this information

Through the exercise of determining the rate of steam each of the users will require, at the steam pressure they will require it, that usage can then be converted to Btu/hr of the latent heat of evaporation for each user.

In doing this you will be able to add up all of the Btu/hr of the latent heat of evaporation, at the various steam pressures, to arrive at a total Btu/hr for all users.

Assuming that the highest pressure steam service needed is 300 PSIG saturated steam we will need to design a system that will deliver the 300 psig throughout the distribution system. Allowing for pressure loss through friction and radiant heat loss we will have to generate pressure at an amount that will compensate for that loss in pressure. But that is not the only consideration we have to give thought to.

In determining the pressure at which we want to generate steam there are two key factors to consider, which are:

1. In a large facility, where steam distribution headers can run upwards of 1000 plus feet in any one direction, friction loss and radiant heat loss, with their resultant pressure drop, has to be taken into consideration.
2. The second factor lies in determining the most cost effective way in which to get quality steam to all of the users.

By elevating the steam pressure at the boilers above what is demanded at the use points we accomplish three things:

1. The higher pressure of the distribution system provides ample pressure above 300 psig to accommodate any pressure drop in the steam.
2. Higher pressure steam can provide more Btu/volume mass than lower pressure steam.
3. The ability to move more Btu/volume mass through a smaller pipe size is achieved.

This is where we get into philosophical reasoning on behalf of the owner or the engineering firm representing the owner. This implies that there are deep rooted and standardized approaches an owner or engineer will take based on proven methods used over a period of time. When it comes to determining at what pressure steam should be generated at there are two basic methods at making that determination:

1. Determine the combined pressure drop of radiant heat loss and head loss due to friction then increase the pressure from the highest pressure needed plus 20% of the calculated pressure loss rounded off to the next higher 25 psi increment.
2. Increase steam generation pressure to the pressure limit of the ASME B16.5 flange rating needed for the highest pressure

As an example of utilizing the limits of a system's pressure rating, the highest steam pressure currently needed for our theoretical plant is 300 psig at 420ºF. This puts the piping system within the ASME B16.5 Class 300 carbon steel flange rating range. As a side note, this also means that all components (valves, strainers, flow meters, etc.) will also have to meet or exceed that same pressure rating. The pressure rating of a piping system is based on the lowest rated joint or component within that system.

How much then, of an increase in pressure can we achieve while remaining within that same Class 300 flange rating without exceeding the limits of that rating? If we are to stay within the limits of the Class 300 flange pressure range we can increase the steam pressure up to 600 psig at 489ºF.

At this point we can do one of two things:

1. Run the pressure drop calculations to determine the worst case pressure drop through the distribution piping then bump up the pressure, as described above to compensate for that loss in pressure
2. Or we can decide to generate 600, 500, 400, etc. psig saturated steam through the main distribution system.

In going with choice #2, and having elected to have steam generated at 600 psig, we have just increased the steam distribution pressure to a more efficient pressure for distribution. This checks off all four of the points made above, which are:

- Generate steam at a higher pressure than the users require in order to provide the needed steam pressure at the points of use.
- Distribute steam in the most cost efficient manner.
- Design a system that can meet future demands which may require higher pressures than currently needed.
- Reduce distribution pipe size by using a more efficient high pressure steam distribution system.

In order to do this we will need to calculate the total plant wide energy demand based on the Btu's of the latent heat of evaporation. These are the Btu's contained in the steam, not in the liquid phase of saturated steam. And this value will vary, depending on the steam pressure. As an example, Table 1 shows the breakdown of the Btu values at six different steam pressures.

TABLE 1 – STEAM AND ITS RELATED VALUES

Pressure (psig)	Temperature (ºF)	Heat of the Liquid (Btu/lb)	Latent Heat of Evaporation (Btu/lb)	Total Heat of Steam (Btu/lb)	Specific Volume (ft^3/lb)	
					Water	Steam
50	298	267.3	911.7	1179.0	0.01743	6.6826
120	350	321.8	870.5	1192.3	0.01799	3.3392
150	366	338.7	856.9	1195.6	0.01819	2.7515
200	388	362.1	837.2	1199.3	0.01847	2.1332
300	420	397.3	805.9	1203.2	0.01894	1.4954
600	489	474.7	728.7	1203.4	0.02019	0.7509

In the October 2019 issue of this Newsletter we defined the terms used in the column headings of Table 1. Notice that the Btu/lb value under "latent heat of evaporation" diminishes as the pressure increases. Also notice that the ft^3/lb of space required for steam, shown in the last column, is lessened with the increase in pressure. The indication being that while the Btu/lb are being reduced by pressure the steam itself will require less space and will allow more steam to be carried by smaller diameter pipe. The end result being that more Btu/lb of steam can be provided through smaller pipe than lower pressure steam. Making the higher pressure steam a more efficient way of moving steam throughout a plant.

TABLE 2 – STEAM LOADS AT PRESSURE				
Steam Pressure (psig)	Normal Loads (lb/hr)	Peak Loads (lb/hr)	Latent Heat of Evaporation (Btu/hr)	
			Normal Loads	Peak Loads
MP 300	150,000	300,000	120,885,000	241,770,000
LP 50	80,000	200,000	72,936,000	182,340,000
		Total Latent Heat of Evaporation	193,821,000	402,950,000
HP 600*	265982	552971		
Note: *There are no 600 psig steam users. The steam load for the 600 psig steam is the amount needed to supply the medium and low pressure systems.				

The first step in the process of sizing steam pipelines is to determine the total amount of 600 psig steam we will have to generate and distribute throughout the plant. In doing this we will need to determine the total amount of Btu/hr using the common denominator value, which in this case is the latent heat of evaporation.

Doing this requires obtaining the lbs/hr usage rate of steam for each user at the steam pressure they are specified to use. As an example, if one of the users requires 120 PSIG steam at a rate of 300 lb/hr the latent heat of evaporation (Btu) demand would be calculated as shown in eq. 8:

300lb/hr x 870.5 BTU/lb (latent heat of evaporation at 120 psig) = eq. 8
261,150 BTU/hr (latent heat of evaporation)

By converting the lb/hr of steam at its various pressures into the common Btu form of latent heat of evaporation of all users we can then determine the total peak lb/hr of 600 psig steam that will be needed in order to generate enough steam for plant wide use. The peak load in regions which are effected by large seasonal temperature swings will have their peak load in their winter months in supplying additional steam for heating and heat protection against the colder temperatures. So rather than get too deep into the weeds of parsing the steam usage for all of the many users, we will use hypothetical lb/hr rates for each of our steam pressures.

The steam distribution pressures used in our hypothetical plant will include:

- HP steam at 600 psig
- MP steam at 300 psig
- LP steam at 50 psig

Steam usage loads are given in Table 2. What this Table provides is the calculated normal use loads and peak use loads for the various steam pressures. The table shows the converted lb/hr steam loads of the low pressure and medium pressure as latent heat of evaporation. This, in turn, shows the lb/hr rate of 600 psig steam as calculated from the latent heat of evaporation values.

This was done by converting all steam loads of both LP and MP steam to latent heat of evaporation Btu's. That value is then used to convert the steam loads from Btu's into lb/hr of 600 psig steam that will be required to meet those demands.

Using the peak loads as an example, it shows a 300,000 lb/hr rate for 300 psig steam. In referring to Table 1, 300 psig saturated steam contains 805.9 Btu/lb of latent heat of evaporation. By multiplying 300,000 lb/hr of 300 psig steam times the 805.9 Btu/lb, as shown in eq. 9, we have a Btu work load of 241,770,000 Btru/hr.

300,000 lb/hr x 805.9 Btu/lb = 241,770,000 Btru/hr   eq. 9

The 50 psig steam has a demand load of 200,000 lb/hr. By calculating in the same manner as before we will use the 911.7 Btu/lb latent heat of evaporation for the 50 psig steam, as indicated in Table 1 and multiply 200,000 lb/hr by 911.7, as shown in eq. 10, we have a Btu work load of 182,340,000 Btu/hr for the 50 psig steam.

200,000 lb/hr x 911.7 Btu/lb = 182,340,000 Btru/hr   eq. 10

Adding up the two Btu values of 241,770,000 Btru/hr + 182,340,000 Btu/hr gives us a total demand of 402,950,000 Btu/hr. By dividing that value by 728.7 Btu/lb of the latent heat of evaporation for the 600 psig steam, as shown in eq. 11, we get 552,971 lb/hr of 600 psig required to supply the peak load demand for all steam users.

402,950,000 Btu/hr ÷ 728.7 Btu/lb = 552,971 lb/hr of 600 psig steam   eq. 11

END OF EXCERPT

What you just read, along with the first installment published in the October issue, Volume 1 Issue 7, of the Newsletter is an excerpt from the upcoming book titled, “Process Piping Design and Engineering Start to Finish – From interpreting Flow Diagrams to Turnover.” The book is expected to be published by June 2020.

With regard to the two-part excerpt on steam, which is one small segment of the book, it goes on to explain and demonstrate pipeline sizing, steam trap sizing and selection, HRSG (Heat Recovery Steam Generation), do’s and don’ts of steam system design, and much more on the subject of steam system design.

In addition to covering a wide range of design and construction elements in the art of piping design and engineering, the book will also cover code compliance and interpretation. The very foundation for designing and constructing a safe and efficient process plant facility

More about this book will be described in future Newsletters, including additional excerpts. It will be a good addition to any library on piping design.■

THE ASME ICEBERG

It’s general knowledge that the largest portion of an iceberg, between 80 to 90%, lies out of sight below the waterline. Which, at the surface, and to folks not familiar with the physical aspects of an iceberg, leaves little impression. As in, “Is that all there is?”

The iceberg analogy is my feeble effort to describe the ASME juggernaut to some small degree. A degree to which we all, as volunteers and others simply familiar with its presence, are aware of only a very small part of the ASME organization.

The ASME organization is divided into four Sectors that includes:

- Standards and Certification
    - “…responsible for the activities of the Society relating to codes and standards, including related conformity assessment pro-grams.”
- Technical Events and Content
    - “…responsible for planning, developing and delivering new technical content in the form of new products, services, net-working opportunities, confer-ences, events and delivery mechanisms across ASME’s market segments.”
- Public Affairs and Outreach
    - “…responsible for the coor-dinated outreach to industry, government, education, and the public. It is responsible for initiatives that address diversity

and humanitarian programs."

- Student and Early Career Development
    - "…responsible for meeting the needs and providing a voice for students and early career engineers."

- Board on Pressure Technology Codes and Standards,
- Board on Safety Codes and Standards,
- Board on Conformity Assessment,
- Energy and Environmental Standards Advisory Board,
- Board on Codes and Standards Operations,
- Board on Strategic Initiatives, and the
- Board on Hearings and Appeals.

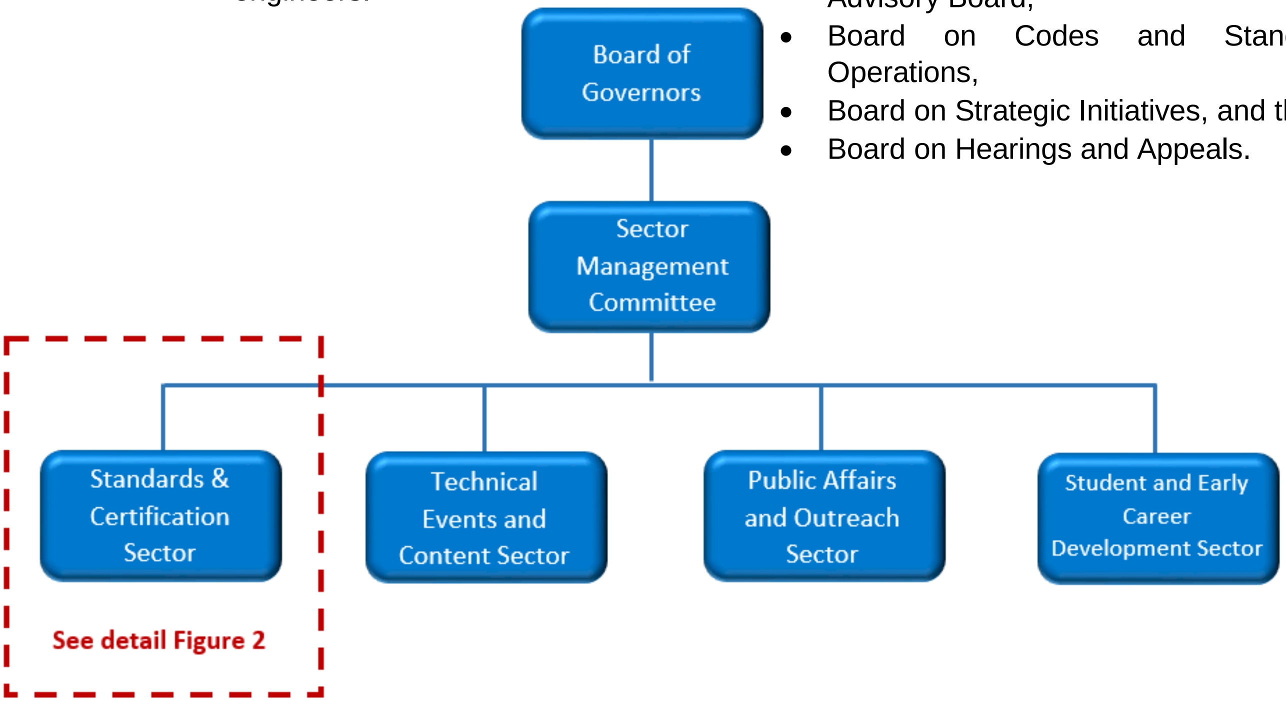


Fig. 1 – Structure of the ASME Upper Ranks

Referring to Fig. 1, ASME is organized into the four main Sectors, as bulleted above, that report to the Board of Governors (BOG). Within each of the named Sectors fall various Boards. Under the various Boards are various Committees, as you will see. It is way too much to unpack the entire organization structure of ASME in this brief article, but we will follow the organizational path down one arm of the "Standards and Certification Sector.

To begin with, each Sector is led by a Council. In the case of the Standards and Certification Sector it is managed by the Council on Standards and Certification (CSC). The Standard and Certification Sector is made up of the following Boards:

- Board on Standardization and Testing,
- Board on Nuclear Codes and Standards,

The CSC is made up of a Senior Vice President who serves as Chair, two Vice Chairs, not more than twelve members-at large, and Chairs for each of the following Boards:

- Standardization and Testing,
- Nuclear Codes and Standards,
- Pressure Technology Codes and Standards,
- Safety Codes and Standards,
- Conformity Assessment,
- Hearings and Appeals, and
- the Energy and Environmental Standards Advisory Board

In Fig. 2 each of the aforementioned boards under the CSC are indicated, plus a couple more. And the one we will take a look at is the Board on Pressure Technology Codes and Standards with the yellow backdrop.

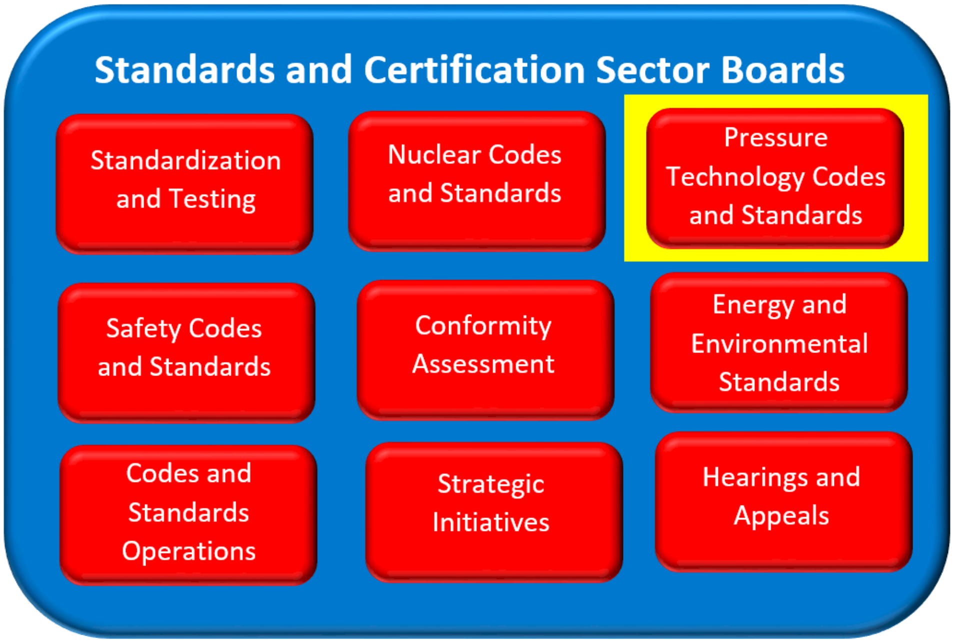


Fig. 2 – Boards Within the Standards and Certification Sector

Under the Board on Pressure Technology Codes and Standards are 23 Committees and Groups, as follows:

- ASME/API Joint Committee on Fitness for Service
- B16 Standardization of Valves, Flanges, Fittings, and Gaskets Standards Committee
- B31 Code for Pressure Piping Standards Committee
- Bioprocessing Equipment Standards Committee (BPE)
- BPTCS Research Evaluation Group (BREG)
- BPTCS Task Group on Risk-based Design and Inspection
- BPTCS/BNCS Special Committee on Use of Additive Manufacturing for Pressure Retaining Equipment
- BPV Committee on Fiber- Reinforced Plastic Pressure Vessels (X)
- BPV Committee on Heating Boilers (IV)
- BPV Committee on Materials (II)
- BPV Committee on Nondestructive Examination (BPV V)
- BPV Committee on Overpressure Protection (XIII)
- BPV Committee on Power Boilers (I)
- BPV Committee on Pressure Vessels (VIII)
- BPV Committee on Transport Tanks (XII)
- BPV Committee on Welding, Brazing and Fusing (IX)
- Committee on Turbine Water Damage Prevention (TWDP)
- Nonmetallic Pressure Piping Systems Standards Committee (NPPS)
- Pressure Technology Post Construction Committee
- Pressure Vessels for Human Occupancy (PVHO)
- Reinforced Thermoset Plastic Corrosion Resistant Equipment Main Committee (RTP)
- Structures for Bulk Solids (SBS)
- Technical Oversight Management Committee (TOMC)

That little ensemble list of Committees and groups is the cast of characters that fall under the umbrella of the Board on Pressure Technology Codes and Standards (BPTCS). These are what the industry refers to as Standards Developers. And this is just one of nine Boards from one Sector, and there are four Sectors.

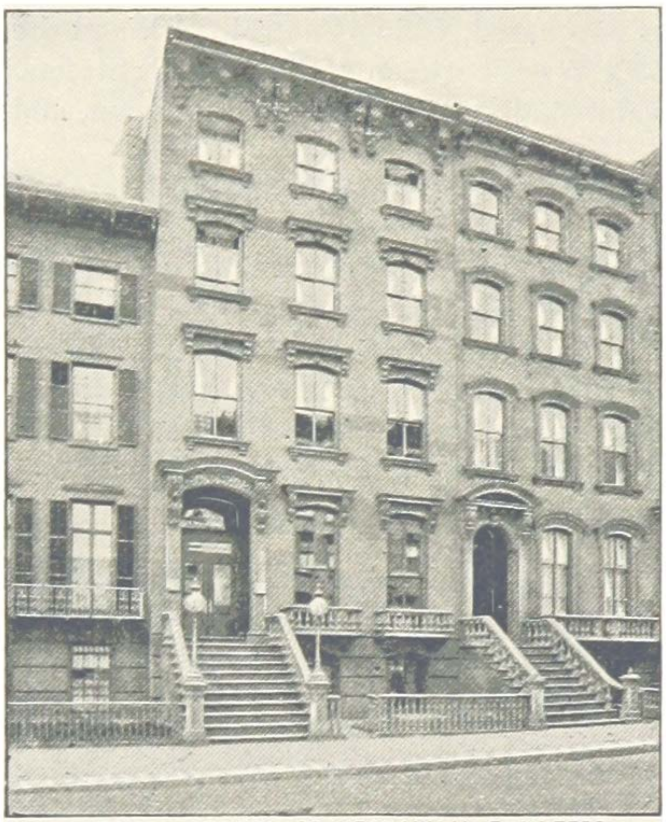
Many of us who work on one or more committees under the BPTCS get so involved in the work we are doing on this or that committee that we sometimes fail to see the bigger picture; the world view if you will.

With the help of more than 110,000 volunteers throughout 150 countries plus ASME staff there are currently more than 600 codes and standards in print. Codes and Standards covering many things from fasteners, plumbing fixtures, elevators, pipelines, power plant systems, valves, piping components, pressure vessels, and so much more.

And this does not take into account the white papers, books, and magazine articles being published by ASME on an almost relentless hamster wheel like frenzy.

Then there is the education wing of the organization that promotes student awareness and support. Not to mention the ongoing training courses for continuing education.

And much of this is done to feed the problem solving thirst of engineers and others with a similar nature. A nature in which problem solving is red meat. Putting a problem in front of an engineer is like placing a 3 pound raw Porterhouse steak in front of a wild dog.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
12 WEST 31ST STREET.

Fig. 3 – ASME Headquarters Late 1800's

Being involved in such activities not only feeds that hunger to solve problems it also nourishes that part of us that wants to create, give back, be a part of something that is bigger than ourselves. To help make the world a safer place to work and live in.

Is juggernaut the right word to describe the ASME organization? I'm not sure what one word describes it better. And does an iceberg describe an organization in which we, at any one time, only see a very small part of a much larger mass that lies just below the waterline, like the ASME organization.

In its 139 year existence the ASME organization has far and away exceeded anything its founders could have possibly anticipated back in 1880. ■

A BIT OF TRIVIA

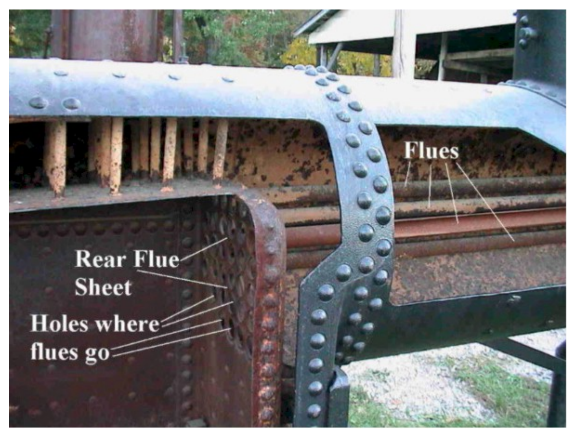


Fig. 4 – Rivets Used in Fabrication

Rivets were used in the fabrication of pressure vessels up until the early 1900's when the art of welding became better understood and developed for industrial use. The advent of welded joints, publication of the first boiler code in 1915, and the founding of the American Welding Society (AWS) all coalesced to reduce the number of boiler explosions dramatically.■

QUESTION OR COMMENTS

If you would like us to address a specific topic or simply answer a question, related or unrelated to the content of this Newsletter, please contact us at: staff@wmhuittco.com. In the subject line of the email please enter "Newsletter Question/Comment."

If you no longer wish to receive this Newsletter please contact us at: staff@wmhuittco.com. In the subject line of the email please enter "Cancel Newsletter." We do respect your right to privacy.

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