SUMMER 2012

BULLETIN

TECHNICAL JOURNAL OF THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

TRANSITION IN TRAINING

NBBI BULLETIN
TECHNICAL JOURNAL OF THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

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The National Board of Boiler and Pressure Vessel Inspectors was organized for the purpose of promoting greater safety by securing concerted action and maintaining uniformity in the construction, installation, inspection, and repair of boilers and other pressure vessels and their appurtenances, thereby ensuring acceptance and interchangeability among jurisdictional authorities empowered to ensure adherence to code construction and repair of boilers and pressure vessels.

The National Board *BULLETIN* is published three times a year by The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229-1183, 614.888.8320, *nationalboard.org*. Postage paid at Columbus, Ohio.

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 ISSN 0894-9611. CPN 4004-5415.

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DEPARTMENTS

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Be Careful of What You Think You Know

BY DAVID A. DOUIN, EXECUTIVE DIRECTOR

The past 20 years at the National Board have seen a pattern of significant growth ranging from the recent physical enlargement of the lab and increased number of safety valve tests, to the considerable jump in **R** stamp certifications, to the ever-expanding volume of registrations.

As impressive as that may seem, there is another entity that has not only far exceeded growth expectations, but outpaced the need of every other National Board program: training. And that is the reason for this *BULLETIN's* cover feature.

The article beginning on page 20 details not only the modest early beginnings of National Board training, it chronicles the growth that has made our program the pressure equipment industry's premier source of professional instruction. The accreditation we received last month by the International Association for Continuing Education and Training (IACET) as an Authorized Provider of training and educational programs underscores National Board's commitment to the importance of training preparation.

Those of you familiar with National Board's evolution over the past two decades know this did not occur by accident. Rather, it was fulfillment of a need. That need was compounded by its critical importance: public safety.

Before there was the Training and Conference Center and the Inspection Training Center here in Columbus, industry education was primarily a series of courses with no semblance of a career path. Classes were rudimentary by today's standards. And while they imparted information essential to the student, these instruction sessions – and the materials employed therewith – did little to encourage critical thinking.

As we all know today, critical thinking is an essential component of any instructional course – particularly advanced classes providing the student with a real return on his or her investment of time and financial resources. I like to think the National Board was far ahead of its time in realizing training involved more than simple repetition and memorization.

Since I assumed the position of executive director, it has been my priority to make National Board training the best possible. This has been accomplished by a major commitment of needed resources and the assembly of an outstanding team of instructors and support staff headed by Training Manager Kimberly Miller.

Whether it is accessing a growing menu of Web courses, or providing one an opportunity to observe, touch, and actually handle equipment critical to professional success, the National Board has constructed its curriculum around the student: providing not only a variety of options, but exclusive insight only a faculty each having over 20 years' experience can impart.

In addition to professional credentials uniquely qualifying the teaching staff, we have subjected our instructors to evaluation by education experts who work with our training personnel to improve communication delivery and better understand the individual needs of students. Staff meets regularly to refine material and harmonize lesson plans. No longer are students taking the same class receiving different information from different tutors. Each course represents the combined input of all instructors responsible for teaching a particular course.

Ironically, the one constant about training is change. Modification of codes, use of new materials, and application of accelerated technology present a series of challenges that often make courses from just a few years ago significantly outdated. That not only justifies continuing education, it makes periodic re-visitation of previously attended classes a vital necessity.

To address this changing dynamic, the National Board now alerts past students of course modifications that may have an appreciable impact on their professional responsibilities. This is yet another advantage of the National Board training system. And it is the latest example of why National Board training credentials are among the most respected in the pressure equipment community.

Quite simply, our focus has always been on turning out the most knowledgeable, best prepared professionals in the industry. And that is why we remind each of our students to be mindful of what they *think* they know.

From my perspective, the importance of training was perhaps best expressed by Benjamin Franklin who profoundly observed: "By failing to prepare, you are preparing to fail."

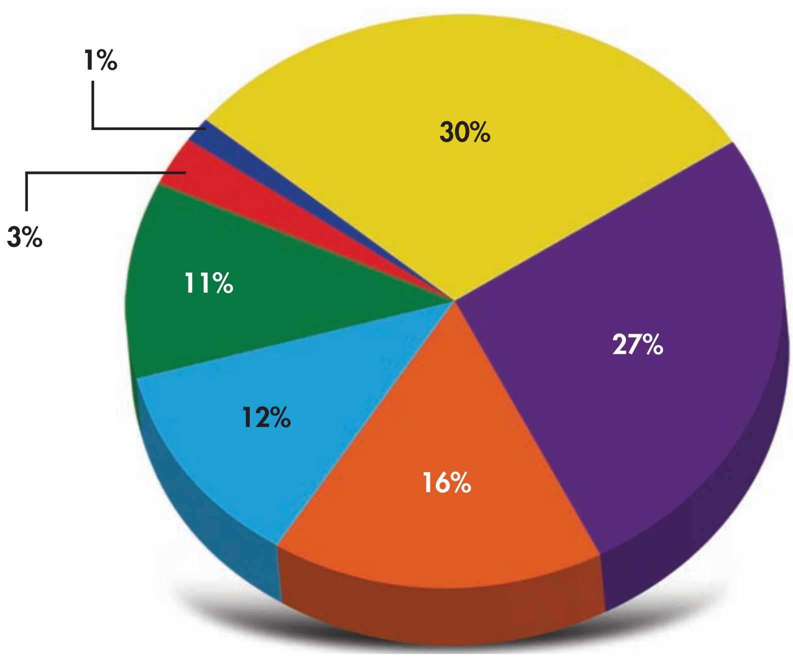
Think about it.

2011 Report of Violation Findings

The National Board Annual Violation Tracking Report identifies the number and type of boiler and pressure vessel inspection violations among participating member jurisdictions. The chart below details violation activity for the year 2011.

Annual Report 2011

Category	Number of Violations	Percent of Total Violations
Boiler Controls	18,722	30%
Boiler Piping and Other Systems	16,796	27%
Pressure-Relieving Devices for Boilers	10,207	16%
Pressure Vessels	7,551	12%
Boiler Components	6,949	11%
Boiler Manufacturing Data Report/Nameplate	1,875	3%
Repairs and Alterations	702	1%



Summary for 2011

Number of jurisdiction reports:	242
Total number of inspections:	610,400
Total number of violations:	62,802
Percent violations:	10%

The Violation Tracking Report indicates problem areas and trends related to boiler and pressure vessel operation, installation, maintenance, and repair. Additionally, it identifies problems prior to adverse conditions occurring. This report can also serve as an important source of documentation for jurisdictional officials, providing statistical data to support the continued funding of inspection programs.

A Professional's Opinion

Quick-Actuating Closures 27 Years Later: Maintenance and Operation Same Problem, Same Solution

By Roger F. Reedy, P.E. and Engineering Consultant

At the 54th National Board General Meeting in Salt Lake City, Utah, former National Board member M.L. Snow made a presentation addressing devastating accidents involving failed quick-actuating closures; the main causes of failure; and the importance of owners, management, and operating personnel to heed planned maintenance and precise operational procedures to prevent injury and loss of life:[1]

> *"Investigation shows that in most cases the failure of quick-actuating closures is caused by a combination of improper operation and poor maintenance. Training and supervision of operators is of utmost importance. Every operator should be adequately trained in the proper operation of an autoclave. He should be made fully aware of the potential for accidents involving these vessels and of the tremendous forces acting on the quick-opening doors. He should be made aware of and understand the importance of ensuring that the vessel is completely vented before attempting to open the door. He should understand the function of all operating controls and door interlocking devices and the danger of interfering with or bypassing any safety device. An operator who has not yet acquired sufficient knowledge and experience with autoclaves utilizing quick-opening doors should be closely supervised by a trained and experienced person."*

This message was written 27 years ago. Unfortunately, accidents involving quick-actuating closures still occur today.

I have performed or supervised the ASME Section VIII design calculations for quick-actuating and swing bolt closures for more than 50 pressure vessels. I have participated as an expert witness in lawsuits involving quick-actuating and other quick-opening closures. Based on my years of experience and forensic knowledge of the causes associated with the failures of quick-actuating and quick-opening closures, I am in complete agreement with the conclusions expressed by Mr. Snow.

Because too many people continue to be maimed or killed by quick-actuating closures – namely due to improper operation and/or poor maintenance – the intent of this article is to continue Mr. Snow's theme and to promote within the pressure industry a pro-active approach to solving this problem. The *ASME Boiler and Pressure Vessel Code*, Section VIII, rules for design of all quick-opening closures may require some slight clarification, but the real solution is to ensure owners and users fulfill their responsibilities when working with these closures.

BACKGROUND

The ASME code, paragraph UG-35, provides rules for design of quick-actuating closures. These rules were unchanged from 1966 to 1998. The 1998 Addendum consisted of a rewrite to clarify original intent. The change did not introduce any new requirements, but more definitions were provided, and a clarification was given to explain that redundancy is not required. In 2004, the rules were modified with no technical changes; however, a significant change was made with the addition of Appendix FF. Some of the details of the new Appendix are addressed below, but it is safe to say that Appendix FF is completely consistent with Mr. Snow's conclusions.

The terms "quick-actuating" and "quick-opening" must be defined in order to clarify ASME code requirements. According to the dictionary, "actuate" means to place in motion or action. A "quick-actuating closure" is a cover or door that is opened or closed with essentially a single motion. The single motion may be pushing a button or pulling a lever, or even partially rotating the cover or locking ring. A "quick-opening closure" is a cover or door that can be opened or closed more quickly than a standard bolted

FIGURE 1.

TYPICAL CAMLOCK CLOSURE

vessel contained grit material used for blast-cleaning storage tanks prior to painting. The manufacturer of the swing bolt closure identified it as a "camlock closure." Camlock closures are manufactured by several different suppliers and are used extensively in various applications involving pressure vessels and piping. Many thousands of camlock closures have been manufactured and operated over the past 25 years.

Figure 1 shows a typical camlock closure. Figure 2 illustrates a camlock closure assembly. Figure 3 identifies the various parts of the camlock closure assembly. In addition to the camlock closure assembly, the pressure vessel in this case was provided with a

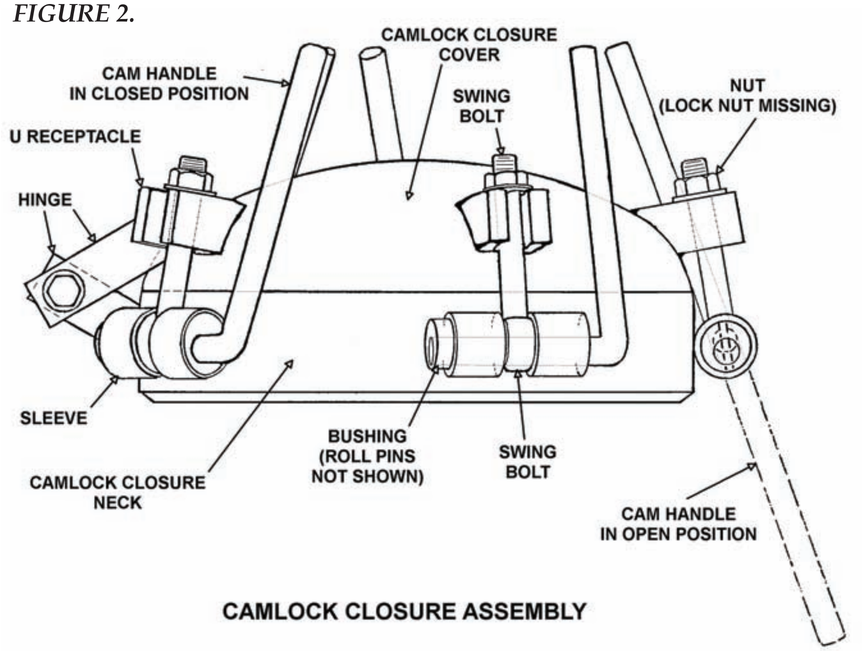
flange connection of the same size. A quick-actuating closure is quick-opening, but a quick-opening closure is not necessarily quick-actuating. An example of a quick-opening closure that is not quick-actuating is a swing bolt closure. Swing bolt closures are exempt from the rules of paragraph UG-35. The reason for the exemption is that each of the swing bolts must be removed individually. The swing bolts cannot all be released with one motion.

In an effort to illustrate the major theme of Mr. Snow's concerns, the following is an account of an accident that occurred on the East Coast of the US in May 2000.

A CASE IN POINT

A swing bolt closure, designed with a special cam action for tightening the bolts, was involved in an unfortunate accident that almost killed the operator. The pressure vessel with the swing bolt closure was mounted on a trailer so it could be moved from location to location. The pressure

FIGURE 2.



CAMLOCK CLOSURE ASSEMBLY

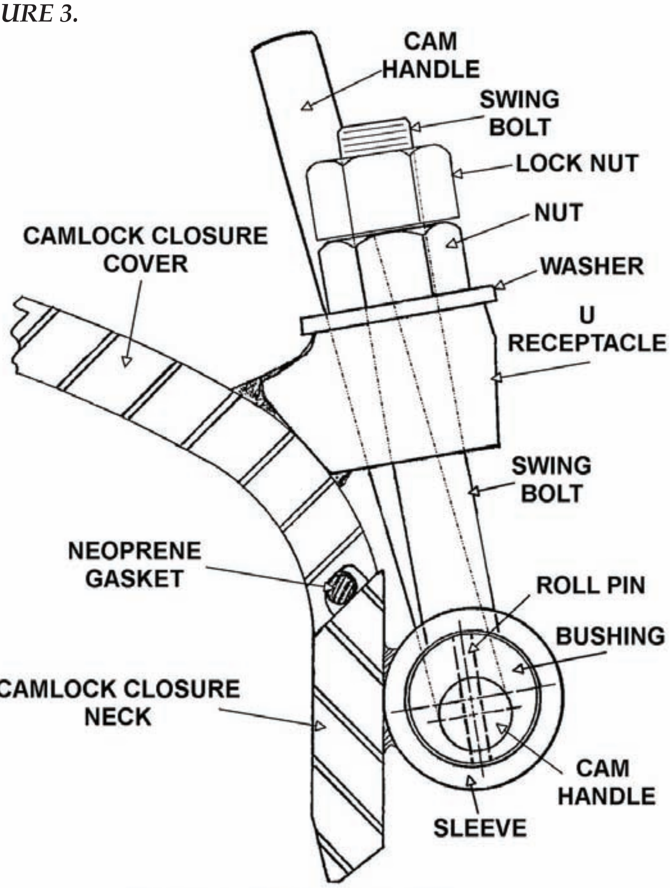
blowdown valve, to be used to ensure there was no pressure in the vessel when the closure was to be opened. The blowdown valve was a quarter-turn ball valve with a lever handle. When the lever handle of the valve is perpendicular to the pipe holding the valve, the valve is closed and there can be pressure in the vessel. When the lever is parallel with the pipe, the valve is open and there can be no pressure in the vessel. The operating procedure for the pressure vessel involved in the accident required the blowdown valve to be open prior to opening the closure.

Figure 2 shows the cam handles of the camlock closure in the closed position. In the closed position, the cam handle tightens and locks the swing bolt against the U-receptacle. When opened (the cam handle is in the down position), the swing bolt is automatically loosened and can be moved away from the cover. The operating procedure required all the cam handles to be in the open position (as shown in Figure 2) before moving any swing bolts away from the cover.

If the blowdown valve has not been opened and there is pressure in the vessel, one or two of the cam handles can be pulled to the open position by hand, but the force on the cover will not allow all the cam handles to be moved down. The swing bolts will still be in place but will allow leakage and prevent the cover from opening until the pressure is fully released.

The roll pins identified in Figure 3 are essential to allow the cam handles to perform their function. If the roll pins are broken, the cam handles will not move the swing bolts up and down as required. Lock nuts are essential to ensure proper bolt tension is maintained. When lock nuts are properly maintained, the closure can be easily opened and closed without using any tools.

FIGURE 3.



Although the operator had opened the closure many times previously, the closure had not been properly maintained by the owner, and the operator made a number of very serious mistakes. With regard to lack of maintenance, the following facts (all obvious to the operator) should be noted:

1) Four of the lock nuts required on the five swing bolts had been removed.
2) The roll pins on two of the cam handles were broken.
3) The camlock assembly was generally corroded.
4) The handle for pulling the cover open had been broken off prior to the accident.
5) The swing bolts had been hit many times in the past with a small sledgehammer.

Major mistakes made were:

1) The operator did not open the blowdown valve to release the pressure.
2) The operator did not move all the cam handles down before moving

any of the swing bolts away from the cover, as required. Also, two cam handles had broken roll pins.

3) The operator sometimes moved both the cam handles and the swing bolts with a small sledgehammer.

After forcing three swing bolts off the cover, the operator hammered the fourth swing bolt. The pressure force on the cover was enough to break the last restraints, thereby blowing the cover off the vessel. The cover hit the operator in the shoulder, knocked him off the top of the pressure vessel, and landed about 180 feet from the closure. The cover severed the man's arm and caused other severe damage throughout his body. The operator was never able to work again.

It was determined that the operator could not have been adequately trained and properly supervised at the time of the accident. This is exactly what Mr. Snow referred to when he stated:

> *"Investigation shows that in most cases the failure of quick-actuating closures is caused by a combination of improper operation and poor maintenance. Training and supervision of operators is of utmost importance."*

The manufacturer of the pressure vessel was sued, but the jury ruled that the pressure vessel manufacturer was not responsible for the accident.

Experience has shown that when operators force open quick-actuating or other types of closures, serious injuries result, whether the pressure in the vessel is a low-residual pressure or a high-operating pressure. In almost every case I have investigated, the operator violated procedures and used pry bars, come-alongs, or other improper equipment to force the closure open. These accidents generally are not caused by poor design, but by inadequate management.

APPENDIX FF AND STATES AND PROVINCES

In 2004, ASME Section VIII was revised to address the issue by adding a new Nonmandatory Appendix FF, "Guide for the Design and Operation of Quick-Actuating (Quick-Opening) Closures." The introduction states:

> *"This Appendix provides guidance in the form of recommendations for the installation, operation, and maintenance of quick-actuating closures. This guidance is primarily for the use of the owner and the user. The safety of the quick-actuating closure is the responsibility of the user. This includes the requirement for the user to provide training for all operating personnel, follow safety procedures, periodically inspect the closure, provide scheduled maintenance, and have all necessary repairs made in a timely fashion."*

The ASME code cannot impose requirements on the owner or user of pressure vessels. However, individual states and provinces can address the issue of responsibilities for owners and users of ASME pressure vessels. A great service would be performed if states and provinces required owners and users of quick-opening closures to implement programs for maintenance, inspection, and training of personnel. Without addressing the issue of the duties and responsibilities of owners and users, serious accidents will keep occurring.

The rules and provisions in the ASME code have proven to be adequate since 1966. Although more changes can be made to clarify the current requirements, the rules have provided for safe design and construction. Now we need help from the states and provinces.

CONCLUSION

States and provinces should take action to compel owners and users to follow the provisions of Appendix FF as a mandatory requirement. This action would go a long way to ensure owners and users properly install and maintain the necessary warning and safety devices. Mandating the use of Appendix FF should also ensure the owner or user has an adequate program for maintenance, inspection, training, and recordkeeping. Owners and users have a very serious obligation to protect their workers and others in the vicinity of this equipment.

This article represents views of the author only and does not necessarily reflect the opinion or policy of The National Board of Boiler and Pressure Vessel Inspectors or The American Society of Mechanical Engineers administration, staff, or membership, unless so acknowledged.

1 Mr. Snow's General Meeting presentation was subsequently published in the April 1986 National Board *BULLETIN*. The article, *Quick Actuating Closures*, can be accessed on the National Board website under "Technical Articles."

Pressures Associated with Pressure Vessel Design as Relating to ASME Section VIII, Division 1

BY FRANCIS BROWN, SENIOR STAFF ENGINEER

The determination of design pressure, maximum allowable working pressure (MAWP), and other pressures associated with pressure vessel design begins with the purchaser's stated operating pressure. The operating pressure (normal pressure) is the maximum expected pressure applied to the vessel during normal operation. In normal operation, the process or system produces only customary or expected pressures. Section VIII, Division 1, Appendix 3, of the *ASME Boiler & Pressure Vessel Code* (ASME code) defines operating pressure as "the pressure at the top of a vessel at which it normally operates." Pressure that exceeds vessel operating pressure is often called upset pressure.

Terms associated with pressure vessel design:

- Maximum allowable working pressure (MAWP)
- Design pressure
- Hydrostatic test pressure
- Operating pressure
- Normal pressure
- Upset pressure

Typically, the operating pressure is increased by 10% or more to arrive at the vessel basic design pressure to minimize or eliminate the activation of pressure relief devices during normal operation. This basic or minimum design pressure is the design pressure at the top of the vessel and may also be the MAWP of the vessel. Each vessel component has a design pressure that depends upon the fluid in the vessel and location of the component in the vessel.

ASME Section VIII, Division 1, Appendix 3, defines design pressure as "the pressure used in the design of a vessel component together with the coincident metal temperature, for the purpose of determining the minimum permissible thickness or physical characteristics of the different zones of the vessel. When applicable, static head shall be added to the vessel basic design pressure to determine the thickness of any specific zone of the vessel (see UG-21)."

Static head, or more correctly, static pressure, is pressure due to a column of liquid stated as the depth of liquid. ASME Section VIII, Division 1: UG-21, states, "Each element of a pressure vessel shall be designed for at least the most severe condition of coincident pressure (including coincident static head in the operating position) and temperature expected in normal operation." The operative words are "normal operation." Static head is added to the vessel design pressure only when the component will contain a liquid during normal operation. There is no static head in a vessel designed to contain a gas, such as an air receiver.

For illustration purposes, consider the design of a seven-foot I.D. vertical vessel with a 48-foot straight shell, 2:1 ellipsoidal heads, with an operating pressure of 150 psig at ambient temperature (Figure 1). The basic design pressure/MAWP of the vessel is obtained by increasing the operating pressure 10%, to 165 psi. This vessel will be designed to contain a gas such as air, or air over water (0.433 psi/ft), or air over carbon tetrachloride (0.688 psi/ft). The design pressures of each shell course and heads are determined from the basic/minimum design pressure of the vessel and the contents of the vessel. The vessel design pressure is increased by the static pressure only when the vessel contains a liquid during normal operation as illustrated in Table 1. The MAWP for the vessel is the lowest value of the component design pressures for any of the pressure boundary parts at the coincident temperature for that pressure.

Either a hydrostatic or a pneumatic pressure test is required for each vessel manufactured per the requirements of ASME Section VIII, Division 1. The hydrostatic test pressure is defined as 1.3 times the MAWP of the vessel without a stated maximum test pressure. Test loads, including coincident static head acting during the test, shall be considered in the design of the vessel [Section VIII, Division 1: UG-22(j)]. The code does not define how test loads, specifically hydrostatic test loads, are to be considered in the design of a vessel. The code only states the vessel is subject to rejection if the test pressure causes visible permanent distortion [ASME Section VIII, Division 1: UG-99(d)]. The design is considered to be satisfactory if the test pressure does not cause visible permanent distortion, and the vessel does not leak at MAWP.

If the stresses in the vessel components do not exceed the yield strength of the material during the hydrostatic test, there will be no permanent visible distortion and the vessel design is acceptable. Limiting the test pressure so the membrane stress in the component under consideration does not exceed 90% of material yield strength at test temperature is a method of considering the static head and other test loads during the hydrostatic test. For a cylindrical shell the pressure is: $P \leq \frac{0.9S_y t}{r}$ with ***r*** and ***t*** the radius and thickness respectively of a shell in the new condition, and S_y is the material yield strength at test temperature. The values of ***r*** and ***t*** in the new condition may be used for determining the maximum hydrostatic test pressure of new vessels. The corroded values of ***r*** and ***t*** shall be used for determining the maximum hydrostatic test pressure of inservice vessels.

For the example vessel, the minimum required thickness per ASME Section VIII, Division 1: UG-32(d) for the bottom head will be determined. The material used for this example is SA-516 grade 70 steel with a head efficiency of 1.0 at ambient temperature. The required thickness of the bottom head is shown in Table 2. The hydrostatic test pressure is considered in the component design by limiting the pressure so the primary stress does not exceed 90% of yield strength at test temperature. The primary membrane stress at the crown is: $S = \frac{Pa^2}{2bt}$ The yield strength is substituted for ***S*** and the equation solved for ***P:*** $P = \frac{2bt0.9S}{a^2}$ Where ***a*** is the semi-major axis, and ***b*** is the semi-minor axis of the semi-elliptical head. The test pressures are shown in Table 2.

In this simplified illustration, the design of the bottom head is complete. The minimum thickness for each case was determined for the operating condition, and an increase in bottom head thickness for hydrostatic test conditions is not required. The hydrostatic test pressure load on the bottom head was considered in the vessel design for the three cases and found to have no effect on the design.

In conclusion, vessel component design pressure is the pressure at the top of the vessel plus hydrostatic head when the vessel contains a liquid during normal operation. The code also requires the designer to consider the effects of the hydrostatic test pressure on vessel component design, but does not define an evaluation method nor acceptance criteria. An evaluation method and acceptance criteria were presented in this article based on membrane stress at 90% of material yield strength at test temperature.

Figure 1: Example Vessel

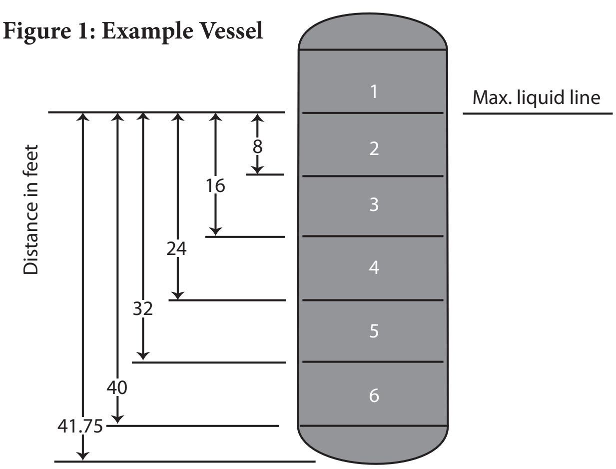


Table 1: Component Pressures

	Design Pressure[1], psi			Hydrostatic Test Pressures[2], psi (All Cases)
Zone	Air	Air/water	Air/CCl4	
Top head	165	165	165	214.5
	165	165	165	220
	165	168.5	170.5	224.5
	165	171.9	176	230
	165	175.4	181.5	233.5
	165	178.9	187	238
	165	182.3	192.5	242.5
Bottom head	165	183.1	193.8	243.5

[1] Pressures calculated at bottom of zone
[2] Water used for hydrostatic test

Table 2: Bottom Head Parameters

	Air	Air/Water	Air/CCl4
Design Pressure	165 psi	183.1 psi	193.8 psi
Min. Thickness	0.347 in	0.385 in	0.407 in
Test Pressure Top of Vessel	214.5 psi	214.5 psi	214.5 psi
Test Pressure[2] Bottom of Vessel	243.5 psi	243.5 psi	243.5 psi
Max. Test Pressure[3]	283 psi	314 psi	331 psi

[3] Based on the calculated minimum thickness of the head

81st General Meeting Highlights

Nashville 2012

"Safety Professionals: Devoting Our Lives to Protecting Yours" was the theme of this year's National Board/ASME 81st General Meeting, May 14-18 in Nashville, Tennessee.

Astronaut Gene Cernan launched the Monday morning session with opening remarks about his 20-year career as a naval aviator, which included three missions to space and the distinction of "Last Man on the Moon." Following Captain Cernan's remarks, a panel of industry experts discussed topics ranging from past and present tragedies (R. Miles Toler spoke on the 1937 New London, Texas, school gas explosion, and Kenneth Balkey shared an update on the March 2011 Fukushima Daiichi nuclear power plant incident), to evolving issues with solar boilers (Don Cook and Tim Zoltowski), establishing a federal inspection agency (John Swezy Jr.), and National Board testing data (presented by Joseph Ball). Look for narrative accounts of the lectures on the National Board website in the near future.

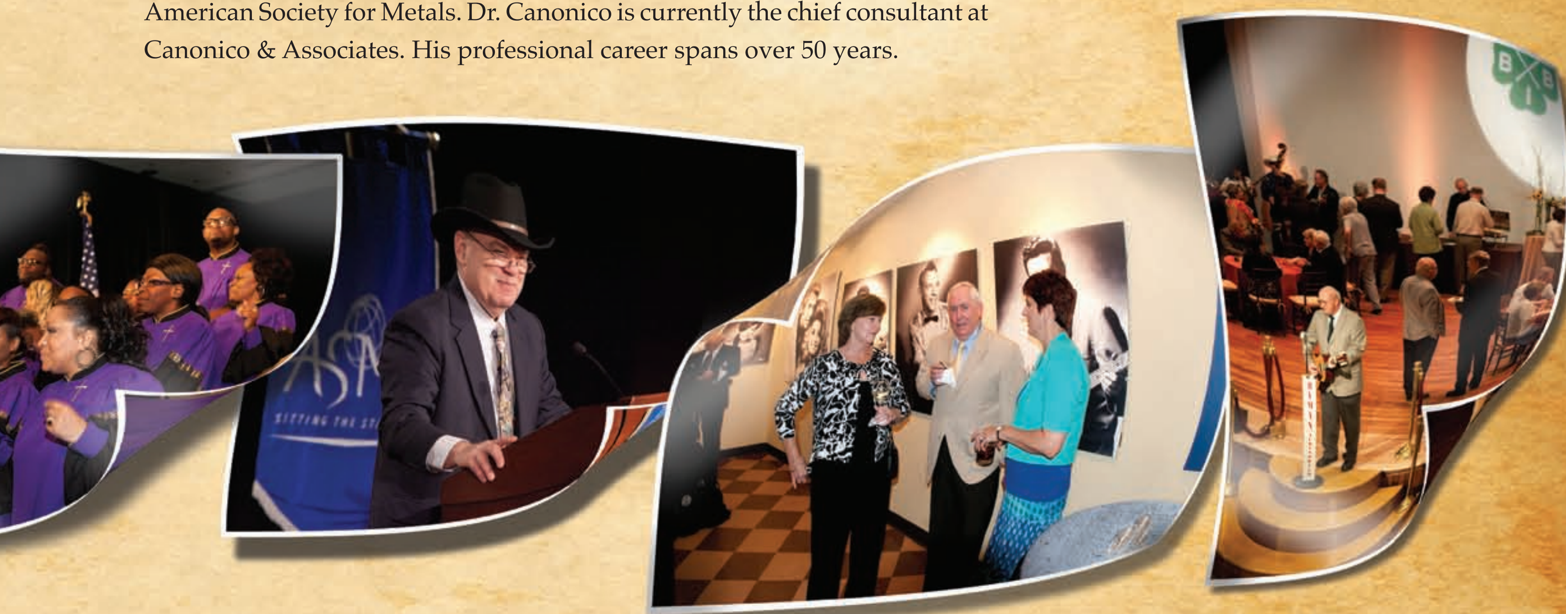
Guests on this year's outings experienced the best of middle Tennessee's southern charm and renowned landmarks. On Monday, guests visited the lush, rolling countryside on a custom tour of Nashville celebrity homes, including the estates of Alan Jackson and Martina McBride. Tuesday's tour featured Nashville's famous downtown attractions with a final stop at Carnton Plantation in Franklin – the setting of Robert Hick's *New York Times* bestseller, *The Widow of the South* – complete with lunch and a lecture by the author. On Wednesday guests went behind the scenes at the Grand Ole Opry House and then traveled to Fontanel Mansion for a picnic and tour of the 27,000 square-foot log home formerly owned by Barbara Mandrell. The week concluded with the Wednesday Evening Banquet and an entertaining twist – the stunts and comedy of the award-winning juggling duo, Raspyni Brothers.

Canonico Named 2012 Safety Medal Recipient

Dr. Domenic Canonico was presented with the 2012 National Board Safety Medal award at the 81st National Board/ASME General Meeting in Nashville, Tennessee.

Dr. Canonico is recognized as a key promoter of boiler and pressure vessel safety for his outstanding service and contribution to the industry. He has been a member of the *National Board Inspection Code* Main Committee representing general interest since 2001, and was chairman of the *ASME Boiler and Pressure Vessel Code* Main Committee for nine years. He is a fellow with three major technical societies: ASME International, American Welding Institute, and the American Society for Metals. Dr. Canonico is currently the chief consultant at Canonico & Associates. His professional career spans over 50 years.

David Douin presents the 2012 Safety Medal Award



Hynes Elected National Board Honorary Member

Mr. Ken Hynes was presented with a plaque at the 81st National Board/ASME General Meeting to commemorate his status as honorary member. He was selected for this honor at the October 2011 Members' Meeting in Columbus, Ohio. Mr. Hynes was chief inspector for the Province of Prince Edward Island from 1993 to 2011. He retired in June 2011.

Ken Hynes

Board of Trustees Election Results

Two National Board members were re-elected to the Board of Trustees after members cast their votes at the 81st General Meeting in Nashville, Tennessee, on Tuesday, May 15.

Terms were up for Gary Scribner, member at large, and Don Jenkins, second vice chair.

Both men were re-elected and will serve another three-year term on the Board of Trustees. Mr. Scribner now holds the second vice chair position, and Mr. Jenkins holds the member at large position.

Gary Scribner

Don Jenkins


GRAND OLE OPRY
GRINDERS
GRAND OLE OPRY


RYMAN

"To Stamp or not to Stamp?" That is the Question!

By Mark Masters, HSB Global Standards

Over the past two decades, global sourcing of pressure equipment for use in the oil, gas, and other continuous process industries has increased exponentially. At the same time, pressure equipment manufacturers and their customers have seen a proliferation of codes and standards meant to ensure pressure equipment, once fabricated, can be operated safely and reliably. *The American Society of Mechanical Engineers Boiler and Pressure Vessel Code* (ASME B&PVC) is by far the most widely adopted standard and, in fact, serves as the basis for many local standards.

Notwithstanding the widespread use of the ASME B&PVC, misconceptions remain as to how compliance with the ASME code is achieved and, further, the value of formal ASME certification versus a general requirement by the purchaser that equipment be built and designed "in accordance with ASME." This article presents a brief history of the ASME code and describes the certification process. It also refutes some common misconceptions related to costs of certification. Finally, it provides a case study illustrating the unique value of ASME certification.

HISTORY

The first ASME boiler code was published nearly 100 years ago, in 1914. Since that time, the code has been expanded to include rules for the design, fabrication, and testing of a wide range of pressure equipment; including nuclear steam generators, heat exchangers, and other unfired pressure equipment. Evolution of the standard has been dramatic, incorporating new fabrication methods and technologies (the change from riveted to welded construction, for example). That evolution has been aided by ASME's unique approach to codes and standards development and oversight, headed up by code committees comprising volunteers representing manufacturers, regulators, and owners/users of pressure equipment.

THE ASME CERTIFICATION PROCESS

Briefly summarized, the ASME B&PVC certification process (i.e., obtaining a *Certificate of Authorization* and Code Certification Mark) requires first that the manufacturer prepare a written description of its quality control system (QCS). As an example, in ASME Section VII, Div. 1, the QCS must address the following elements, at a minimum:

- Authority and responsibility
- Organization
- Drawing/design calculations/specification development and control(s)
- Material control
- Examination and inspection program
- Correction of nonconformities
- Welding
- Nondestructive examination
- Heat treatment
- Calibration of measurement and test equipment
- Records retention
- Interaction with the authorized inspector (AI) or ASME designee

Beyond a written description of its QCS, the manufacturer must also undergo a formal review of the QCS, (known as a joint review) and physically demonstrate its ability to implement that system. An actual vessel, product, or sample (mock-up) may be used for the demonstration, though in all cases the demonstration must completely represent each of the quality program elements described in the QCS.

The joint review of the manufacturer's quality program is performed by an audit team comprising a team leader representing ASME and representatives of the manufacturer's authorized inspection agency (AIA). If, in the team's judgment, the program (as written and implemented) meets the ASME B&PVC requirements, it makes recommendation to the ASME Committee on BPV Conformity Assessment that the manufacturer be issued an ASME *Certificate of Authorization.* Once a certificate is issued, it is typically valid for three years, at which point the manufacturer applies to renew the certificate following the same audit process to ensure the QCS continues to meet current code requirements.

Certification by the manufacturer is evidenced by application of the ASME Code Certification Mark to the product nameplate and by the manufacturer's data report

(MDR), certified by the manufacturer and signed also by the authorized inspector representing the accredited AIA. ***Both the certification mark and the data report are required for certification***. This last point is particularly important given that some pressure equipment buyers specify equipment built and/or designed in accordance with ASME, but ***don't*** require certification (i.e., stamping and data report). This poses the question, What's the difference between equipment that is certified and equipment that isn't?

THIRD-PARTY VERIFICATION

First, though quality is addressed by the ASME B&PVC, it is a safety standard rather than a quality one. Owing to the risks to people and property that are inherent with pressurized equipment, the ASME B&PVC requires a qualified and objective third party verify that code requirements have been met. This third party is the authorized inspector in the employ of the manufacturer's contracted AIA. Both the AI and AIA must demonstrate proficiency in measuring compliance with the code, and this proficiency must be maintained to the satisfaction of the qualifying entities. The AIA also holds a *Certificate of Accreditation* and must undergo a review or audit process similar to the manufacturer.

Some specific duties of the authorized inspector may include:

- Acceptance of any revisions to the written description of the manufacturer's QCS.
- Verification of calculations, drawings, and specifications. (Note: the inspector verifies that these exist. It's the manufacturer's responsibility to ensure they are accurate, correct, and meet the code requirements.)
- Acceptance of personnel qualifications for NDE and welding/brazing.
- Acceptance of welding/brazing and NDE procedure qualifications.
- Monitoring the QCS including calibration, material control, inspection, testing, etc.
- Performing a final internal and external inspection of the finished product.
- Witnessing the final pressure test of the product certified.
- Verifying accuracy of the equipment description for the Manufacturer's Data Report.
- Signing the certified MDR (the AI must also provide his/her unique identification).

WHY CERTIFY?

The ASME code is clear and specific regarding requirements for equipment certified in accordance with the standard. In contrast, there is no clear definition of what is intended when equipment is specified as "fabricated or constructed in accordance with the ASME code." Based on our experience, that equipment generally exhibits one or more of the following traits:

- No third-party inspection by authorized inspector(s).
- ASME code may be used for design, but fabrication requirements are not verified.
- ASME code may be used for only some of the fabrication activities.
- Manufacturer has not demonstrated implementation of an ASME-compliant QCS.
- Inferior materials may be substituted for those required by the ASME B&PVC.
- Procedures/personnel used for NDE and/or welding may not be qualified to the requirements of the ASME code.

Several arguments may be used to justify specification of pressure equipment "in accordance with the ASME code" but with no requirement for certification. Some of the most common are refuted next.

"The code's inspection requirements add unnecessary cost."

The use of third-party inspectors for verification of critical pressure equipment is a given, so inspection costs are unavoidable. The key is to ensure that value is delivered for the cost incurred. With the ASME code, value is increased by requiring the involvement of an authorized inspector. The AIA's responsibility for the AI's performance adds accountability. Finally, AI expertise specific to the ASME code can often significantly reduce overall inspection time and cost.

"It's difficult to find local certified manufacturers."

ASME provides a list of accredited and authorized manufacturers on its website (asme.org). The list is growing rapidly with nearly all growth coming from outside North America. South America, in particular, has seen a dramatic increase in the number of ASME Certificate Holders. By omitting inspection or stamping from the purchase order, buyers actually encourage manufacturers investing in ASME certification to abandon their certificates and maintenance of an ASME-certified quality control system.

"Materials required by the ASME code aren't available locally."

While the ASME code has specific and detailed requirements of the materials used for construction, it does allow certified manufacturers to re-certify material to an ASME code specification, providing that the minimum chemical and mechanical properties of the code are met. Those materials specified by the ASME code have been proven in service, and substitution of materials with inferior properties can also have serious implications with respect to joining, fitness for service, and useful life of pressure equipment assets.

"There's no real difference between equipment that is stamped and equipment that isn't."

There are significant differences between stamped and non-stamped equipment. Differences include:

- Ongoing third-party verification that current code requirements are met and that the manufacturer is controlling its processes. This is critical to countering the potential impact of employee turnover and continued evolution of the ASME code.
- The design of welded joints and qualification of welding procedures and personnel are verified when stamping is required. Weld quality is frequently sacrificed when stamping is waived.
- Records retained by code requirements (MDR's, drawings, calculations, final test reports, etc.) are indispensable for future asset repair, alteration, or sale.
- The security of knowing that your vessel complies with the ASME code.

CASE STUDY

The ASME code's unique value is illustrated by a recently completed power project. Details follow:

- Product: Two ASME-certified heat recovery steam generators (HRSG) for installation at the 500MW Astoria II power plant in Queens, New York.
- The HRSGs were designed by a Canadian certificate holder, with components (piping spools, heat recovery panels, drums, etc.) manufactured and provided as code "parts" by certificate holders in Indonesia, Malaysia, and the United States.
- Materials were sourced globally, including from Vietnam, the US, and other locations.
- Assembly and final testing and certification of the HRSGs was performed in Mexico by an Ecuadoran certificate holder, with the HRSGs then transported by barge to Queens, New York, for installation at the plant.

Some advantages of using the ASME code and ASME Certificate Holders throughout the project were:

- Optimized cost by sourcing globally, with no degradation to quality as ASME requirements are consistent independent of the work location.
- Facilitated the positive identification and suitability for use of materials employed in the HRSG fabrication. Also represents advantages for future welded repairs or alterations.
- Minimized time/travel costs and communication barriers by using local authorized inspectors with consistent qualification requirements for each.
- Eliminated redundant and costly product inspection and document review through the acceptance of ASME data reports for components and the completed assembly.
- Facilitated compliance with local regulations at the installation site (ASME certification is required for most states in the US and provinces in Canada and accepted in most countries in lieu of other and frequently ill-defined requirements).
- Uniform application of code rules.
- Physical, independent verification throughout the entire process.

Returning to the question implied by the title of this article, why insist on stamping when specifying that pressure equipment meet the ASME code requirements? It comes down to the nature of the standard itself. The ASME B&PVC is comprehensive; addressing design, material selection and control, testing, personnel and procedure qualification, certification, and third-party verification that all of these key elements have been controlled and implemented in a systematic and repeatable manner. The code stamp signals to equipment stakeholders (buyers, owner/users, insurers, and regulators) that those benefits described above can be fully realized.

National Board Inspection Training Center Equipment Update

By John Hoh, Senior Staff Engineer

Following an article in the summer 2011 *BULLETIN* about acquiring equipment for the Inspection Training Center, the National Board gained several more items for use as training aids. It is gratifying to know the industry is so willing to help – thank you!

The Inspection Training Center has a unique collection of boilers, pressure vessels, and related equipment. The National Board intends to keep adding to this collection to provide more examples for use during training classes.

Foreground left and right: Air separator and U-tube heat exchanger donated by ITT Corp. Background: Cut-away deaerator donated by Ware, Inc.

As the old saying goes, "a picture is worth a thousand words." Having this equipment on hand far exceeds that comparison. A perfect example is the Inservice Commission Course (**IC**), which is designed to help people just starting their careers as inservice inspectors. During the two-week course, students have almost unlimited opportunities to examine the equipment and ask questions of the National Board staff. In fact, there are times during the lectures when an instructor will take students to the inspection room

Cut-away firetube boiler donated by Ware, Inc.

Three process (SMAW, GMAW, GTAW) welder donated by Thermadyne Industries, Inc.

to help illustrate what they have been discussing. PowerPoint slides, books, and verbal descriptions are great, but nothing compares with seeing the real thing.

The National Board has been extremely fortunate to receive generous donations of equipment from the industry. These companies gain the advantage of their equipment being displayed in a training facility which attracts students from around the world. This could be described as a partnership in training, with public safety being the beneficiary. The National Board welcomes the participation of more companies who wish to donate boilers, pressure vessels, and related equipment. Companies should consider this as a way to showcase their products in addition to the training benefits they can provide. Donated items are affixed with a plate acknowledging the donor.

The National Board would like to obtain the following items:

1. ASME Section IV coil-type hot water boiler.
2. ASME Section IV cast aluminum boiler.
3. ASME Section IV copper fin-tube boiler.
4. ASME Section I electric boilers (electrode type and immersion resistance element type).
5. Vertical firetube boiler.
6. Line valves – cut-away displays would be welcome (check, ball, gate, outside screw and yoke, steam service stop/check).
7. Autoclave with a wedge/ring door closure (such as those used in the tire industry).

Those interested in donating equipment should contact John Hoh at jhoh@nationalboard.org. The National Board will make the necessary arrangements for shipping donated items to the Inspection Training Center.

Contributions or gifts to the National Board are not deductible as charitable contributions for federal income tax purposes.

The National Board thanks the following companies who have made donations to the Inspection Training Center in the past year.

- Consolidated Sterilizer Systems
- Diamond Ground Products, Inc.
- Elbi of America, Inc.
- Fluid Handling LLC, Xylem Inc. (formerly ITT Corp.)
- RENTECH Boiler Systems, Inc.
- State of Ohio Department of Commerce, Division of Industrial Compliance and Labor
- The Lincoln Electric Company
- Thermadyne Industries, Inc.
- Ware, Inc.

Inspection Training Center Valve Test Equipment

Designed for Training

BY JOSEPH F. BALL, P.E., DIRECTOR, PRESSURE RELIEF DEPARTMENT

As part of the National Board's continuing commitment to providing a hands-on training experience, two pressure relief valve (PRV) test stands have been designed and installed in the National Board's Inspection Training Center (ITC). This equipment serves as real world examples students will see in industry and is used to demonstrate valve operation and setting techniques.

The test stands were developed to improve teaching aids used in the National Board Pressure Relief Valve Repair (**VR**) seminar. They will also be used as demonstration items for other National Board classes. The **VR** seminar covers a wide range of topics associated with the National Board's **VR** program. The National Board **VR** program certifies organizations performing pressure relief valve repair. The **VR** seminar includes relevant *ASME Boiler and Pressure Vessel Code* and *National Board Inspection Code* requirements, pressure relief valve theory of operation, valve application, repair techniques and documentation, trouble shooting, and program administrative requirements. The course is oriented toward those who are responsible for organizing valve repair programs, valve repair technicians, quality personnel, or pressure relief valve users and inspectors wishing to obtain more knowledge about the operation, use, and repair of these important safety devices.

When the **VR** seminar is held in Columbus, students get a tour of the National Board Testing Laboratory. Testing demonstrations are included in the tour. However, the test lab equipment (which is designed for performance and flow capacity testing), is somewhat different from equipment found in a repair shop environment where capacity tests are not conducted. Some valve setting demonstrations are also performed on a small air tank (which is still used for "on-the-road" seminars), but this tank is also not typical of a repair shop. When the ITC was designed, one training improvement planned was the inclusion of PRV test stands that could be used to demonstrate PRV function and setting techniques. These test stands would also offer working equipment layouts which illustrate practices that could be useful for the repair industry.

AIR TEST SYSTEM

The test equipment includes two test stands: one for testing air/gas service valves, and one for water valves. Since the stands will not actually be used for repair, the design pressures were chosen at a relatively low pressure of 250 psig. Other than that, the equipment arrangements could be copied to a repair shop environment.

The first element included is that both ITC test stands have a full area block valve between the test vessel and the valve being tested. The test lab does not use a block valve on its test stands so that the flow characteristics of the PRV will not be affected. Block valves are common in repair shops and allow the pressure to be saved between tests. This saves energy needed to create the pressure, and time, both of which are vital to the repair shop's bottom line.

However, the block valve is also an important operational safety element, which is emphasized during training. Part of the repair process includes making adjustments to the PRV, which involves a technician putting tools and their hands inside the valve to fine-tune its performance. If care is not taken when


WATER TEST SYSTEM

the valve is under pressure while these adjustments are made, the valve can actuate. Rather than release all pressure between adjustments, the block valve between the pressure vessel and the valve under test is closed, and the space under the PRV is vented. To ensure the block valve does not affect the PRV performance, a full port ball valve was chosen to ensure very little drop in pressure. A bypass valve is supplied to help with opening the ball valve while the test tank is under pressure. A bleed valve and a small pressure gage are included above the ball valve to ensure there is no pressure present when the ball valve is closed.

The block valve also allows water PRVs to be changed between tests without the technician taking an unwanted shower!

Both test stands include ample volume which ensures that the valve will fully actuate and demonstrate the typical "popping" characteristic. Test stands without sufficient volume do not demonstrate complete valve performance because there is not enough volume to hold the valve open through a complete test cycle. An experienced technician can hear the difference when a valve is getting a sharp, clear opening, if there is enough volume under the valve.

The water test stand is a "J-tube" arrangement. The test valve is installed on the low side of the J and pressurized air is supplied to the high side. This arrangement allows the test pressure to be supplied at a constant rate slow enough to allow the pressure gages to be read accurately. Test stands utilizing a pump typically show pressure pulsations, which makes an accurate set pressure very difficult to read. Volume is sufficient to allow the pressure to be increased above the set pressure to see where the valve actually starts to go into full lift. This ensures the valve will achieve its required capacity before the code-specified overpressure, which is what the customer is relying on for protection of their equipment.

Materials of construction were chosen to be compatible with the test fluid. The air pressure vessel is made of carbon steel materials appropriate for the service pressure and temperature.

The pressure vessel for the water test stand was specified and built with stainless steel. All operating valves and drain and supply lines are stainless steel, brass, or copper. Although stainless steel is initially more expensive, corrosion due to using city water is avoided. In a repair shop, rust particles can be drawn into the valve under test, causing the valve to fail its seat leakage test. Any time a valve has to be taken apart to correct a leakage problem, the shop's costs and productivity are adversely affected.

While providing examples relevant to the valve repair industry, the test stands are also used as examples of process vessels in other National Board training courses and seminars. Both vessels were built and stamped to the requirements of ASME Section VIII, and registered with the National Board. The documentation and data reports for any pressure vessel supplied to the National Board are reviewed multiple times to provide accurate examples of implementation of design and construction rules being studied by inspectors in courses such as the New Construction Commission and Authorized Inspector (**A**) course.

When the pressure vessels were installed, a goal was to illustrate correct examples of the most important appurtenance on any pressure vessel – the overpressure protection equipment. Both vessels use National Board capacity certified and ASME Section VIII code-stamped pressure relief valves. They were sized based upon the expected possible overpressure scenario, and the installation illustrates recommended piping practices. These include supporting the discharge pipe independently of the valve and ensuring that the discharge is directed to a safe location. Students being trained for inservice inspection have a good example of some of the points to look for during PRV inspections.

The addition of the PRV test stands to the other equipment featured in the ITC is another example of the efforts being taken by the National Board to provide physical examples and demonstrations and to ensure that training provided to boiler and pressure vessel professionals is the best that it can be. ✤

NATIONAL BOA

RD TRAINING

A Powerful Advantage

With new status as accredited Authorized Provider now in place, the National Board training program delivers 'best in class' instruction to professionals seeking continuing education in the pressure equipment industry. Here, a behind-the-scenes look at the processes and people who make it possible.

*From **A** class students:*

"Diverse area of knowledge. Excellent instructor. Made subject matter interesting."

"Excellent – able to answer all questions. Used examples to make subject matter more memorable."

It doesn't seem too long ago when students attending National Board training shared two small classrooms (and the restrooms and kitchen) with National Board staff on the second floor of the headquarters building in Columbus, Ohio. It was the mid-1970s and the training program was just getting its start.

Fast forward to 2012. You could say there have been a few changes.

While there are no longer two classrooms set aside at the main office for training, there *are* two fully-equipped training facilities and a crew of experienced staff who provide the most comprehensive pressure equipment training in the world.

And there's more.

National Board training has since expanded beyond Columbus into an international program with over 1,500 students each year coming to either the Columbus campus or attending remote classes in places such as China, Canada, Germany, Bahrain, South Africa, and even online.

A work-in-progress spanning many decades, the Training Department today is reaching the peak of its sophistication as a training institute. Not only do the campus facilities provide a unique learning environment for students, but Department staff have taken a new, comprehensive approach in how they develop, execute, and evaluate the curriculum.

Their efforts have produced great benefits for the men and women who enroll in the program.

Students now have a varied menu of classroom and online courses to choose from, with more in development. Classroom instructors each have over 20 years of professional industry experience. Students interact in demonstrations and workshops as part of classroom training, and all coursework is continually updated to reflect the latest codes and standards and inspection practices.

And yet, there is one more new advantage now afforded National Board students – continuing education units (CEUs) for all eligible coursework.

How? The National Board training program has recently attained formal status with the International Association for Continuing Education and Training (IACET) as an Authorized Provider of training and educational programs – a significant achievement that officially marks National Board training as a competitive, comprehensive, and quality program recognized worldwide. The accreditation allows the National Board to issue CEUs.

EXPANSION, THEN AND NOW

From the humble start of its training program, the National Board was committed to providing quality training by qualified instructors. In fact, the very first training sessions were conducted at The Ohio State University. The program continued to grow throughout the 1970s and 1980s, but a new era of National Board training began in 1998 with the completion of the 15,000-square-foot, two-story National Board Training and Conference Center.

The new facility, built adjacent to the headquarters building, solidified the organization's pledge to provide quality training for years to come. That commitment was reinforced in 2007 with the construction of a second building, the Inspection Training Center, which today contains numerous pieces of equipment inspectors will encounter in the field (see page 17) to provide students with hands-on instruction, which was not available before.

"Although the National Board has always had a good training program, it's evolved and grown to meet the needs of students and a changing industry, and to stay ahead of a competitive market," says Kimberly Miller, manager of training. Miller joined the Training Department in 2008 and has been instrumental in managing a busy season of growth over the past four years.

Miller explains: "With support of National Board leadership, we were given more resources to put toward our training efforts, such as more full-time staff dedicated to training. More staff has enabled us to make advancements throughout the program." For instance, a new document management system was created to put all training materials through a series of checks and reviews for accuracy before they are approved and published for use in the classroom. Likewise, the Department has taken a new approach in how it develops examination questions. An assigned committee, comprising an average of four engineers, reviews each exam question for technical and grammatical accuracy, and for relevance to the body of knowledge. Before an assembled examination is administered, there is another review by a second committee for final approval. These processes were put in place to maintain the quality control of examination questions.

And there have been other enhancements. "We've developed and incorporated instructional methods that go beyond traditional classroom lectures," says Miller, citing hands-on workshops and group presentations geared toward students who learn by participation. "We've also included more graphic elements into curriculum materials, such as photography, illustrations, charts/graphs, and video clips," she adds. Additionally, Miller hired staff educated in curriculum development and e-learning to bring dimension

*From **N** class student:*

"Got my money's worth. Sound information and good discussions."

Students get hands-on training in the Inspection Room.

to the highly technical content. "As a department we have made an effort to learn the principles of adult learning and how we can work together to integrate those methods more effectively into our courses," she says. "We provide facilitation training for our instructors, too."

And the Training Department took another expansive leap into cyberspace with the launch of an online training center in June 2010. Students from around the world can now take a National Board course from the convenience of home or office. Currently there are 11 online courses available, with more in development. By the end of 2012, up to 17 online courses will be offered. To date, the most popular online course is CSD-1, with NBIC Part 2, Inspection, and NBIC Part 3, Repair and Alterations, coming in a close second and third.

All of this is possible thanks to the people behind the program. "National Board training is a leader in the industry because we have a staff of highly experienced individuals within the boiler and pressure vessel field who each possess a wealth of knowledge," says Miller. The faculty includes former chief inspectors, former insurance company officials, design engineers, and licensed operators. "They are actively involved in codes and standards development and serve on many committee meetings worldwide. Our instructors' combined knowledge and accomplishments make for a world-class training experience."

MEET THE INSTRUCTORS

Go to nationalboard.org and click "Faculty Directory" under the "Training" tab to read the professional credentials and put faces to the names of National Board instructors.

And what's the natural progression for a world-class training experience? Worldwide accreditation.

IACET AUTHORIZED PROVIDER

With a new, comprehensive approach to curriculum development, a diverse line-up of classroom and online courses in place, and growing international enrollment, becoming an internationally accredited program was the inevitable next step for the Training Department.

AUTHORIZED IACET PROVIDER

"Delivering quality training to students has always been a priority for the National Board. Accreditation raises the bar," says Miller. "It means our program has undergone in-depth evaluation of training methodology, policies, processes, and staff to meet the requirements of the IACET standard, which is a proven model used to develop effective training programs."

Accreditation with IACET verifies that Authorized Providers – National Board now among the ranks – have met the rigorous IACET standard. It's important to note that the IACET standard is approved by the American National Standards Institute (ANSI), which means it meets ANSI's requirements for openness, balance, consensus, and due process.

The IACET breaks the accreditation process into five steps:

1) internal review and evaluation of the training program to the IACET standard;
2) submittal to IACET;
3) review of the program by the IACET commission;
4) site visit and audit by IACET representatives; and
5) recommendations and approval.

In mid-April, the Training Department successfully completed the process and was granted formal status of IACET Accredited Provider on May 1, 2012 – a feat that was over a year and a half in the making.

"Receiving notice of our accreditation was a very exciting moment for all of us who have worked hard to make it happen," says Miller. "It's a big achievement. Our program 'passed the test' of an internationally recognized standards organization, and as such, set a benchmark for pressure equipment training. All of our students will benefit from our status as an accredited provider of continuing education."

CEUS = A QUALITY TRAINING PROGRAM

Continuing education units (CEUs) measure, assess, and track the continuing education requirements that varying regulatory boards, agencies, and companies require in order for professionals to maintain the licenses or certifications necessary in their line of work. Use of the CEU system strengthens an industry's credibility and simultaneously sharpens an individual's professional development.

The IACET developed the CEU in 1970 to standardize a nationally accepted system that

FOR MORE INFORMATION

To see a list of organizations that accept IACET CEUs and to learn more about the Authorized Provider program, visit the IACET website at http://iacet.org.

Liquid penetrant examination workshop.

would measure continuing education and training for adult learners across all segments of industry. IACET's CEU is used by thousands of organizations, and only those that are approved through the Authorized Provider accreditation process are certified to issue IACET CEUs. One CEU equals ten contact hours of participation.

"CEUs indicate that a level of excellence has been met within a particular training program," says Miller. "When an organization is accredited with IACET, students can be assured their training, certification, or recertification is coming from a credible, quality program."

Everyone benefits from IACET accreditation. The return on investment for students: knowing the training is held to a higher standard, and the CEUs they receive will be recognized by other organizations accepting the IACET standard, such as licensing bodies, colleges, and credentialing organizations. The return on investment for the National Board: the ability to offer the industry quality, standardized training that is recognized as such by an accrediting body of higher education.

EXCELLENCE IN EDUCATION

The National Board training program has been on a fruitful journey that started many years ago with the organization's commitment to the highest quality safety standards in order to equip and instruct inspectors for the sake of public safety.

But if you know anything about the history and values of the National Board, that's old news.

"The National Board was established in 1919 and has a longstanding reputation for maintaining high safety standards. Our training program shares the same commitment to excellence," says Miller.

And with the recent status of accredited IACET Authorized Provider, National Board continues that legacy and is set to sail far into the future of boiler and pressure vessel safety training.

And that's good news for the entire industry. ✤

At-A-Glance
Current Roster of National Board Classroom and Online Courses

Visit the National Board website for complete program information, including course descriptions, tuition fees, enrollment, classroom dates and availability, and more.

INSTRUCTOR-LED CLASSROOM TRAINING
- Authorized Inspector Supervisor Course (**B/O**)
- Authorized Nuclear Inservice Inspector Course (**I**)
- Authorized Nuclear Inspector (Concrete) Course (**C**)
- Authorized Nuclear Inspector Course (**N**)
- Authorized Nuclear Inspector Supervisor Course (**NS**)
- Boiler and Pressure Vessel Repair Seminar (**RO**)
- Inservice Commission Course (**IC**)
- New Construction Commission and Authorized Inspector Course (**A**)
- Pressure Relief Valve Repair Seminar (**VR**)

ONLINE TRAINING COURSES
- ASME Code Reading Primer
- Basic Mathematics: Operations and Formulas
- Certified Individual: Cast Aluminum Boilers
- Certified Individual: Cast Iron Boilers
- Certified Individual: Electric Boilers
- Certified Individual: Reinforced Thermoset Plastic Corrosion-Resistant Equipment
- Certified Individual: Unfired Miniature Pressure Vessels
- Controls and Safety Devices for Automatically Fired Boilers
- National Board Inspection Code, Part 1, Installation
- National Board Inspection Code, Part 2, Inspection
- National Board Inspection Code, Part 3, Repairs and Alterations

Boiler External Piping (BEP)

Part 1 – Steam Piping

By Steve Kalmbach

An introductory overview article on boiler external piping appeared in the winter 2012 issue of the BULLETIN. This is the first of a three-part series on steam, feedwater, and blowoff piping.

Steam piping is used to connect the steam outlet on a boiler to the steam distribution system for delivery to the point of use. The supply and return piping for high-temperature hot water systems (HTHW) connect the boiler to the hot water distribution system. Although not typically encountered in normal service, there are installations that generate superheated steam. The ASME Section I and ASME B31.1 codes provide guidance and rules for the installation of piping for both steam and HTHW systems.

STEAM PIPING DESIGN RULES

Steam piping is subject to different design rules as compared to feedwater and blowoff piping systems. Unlike feedwater and blowoff piping, which is based on the maximum allowable working pressure (MAWP), the design pressure for steam piping shall not be less than the lowest set pressure for any safety valve. When designing a steam system using superheated steam, the final steam temperature at the superheater outlet shall be used. The steam pressure design can therefore be less than the MAWP of the boiler. The temperature of the superheated steam can have a big influence on the piping design (for example, the choice of materials used). The steam temperature must be taken into consideration when planning the steam piping system. The superheater outlet pressure is generally lower than the boiler operating pressure, and even though the piping may be suitable for the steam design pressure, the factor of the temperature at the outlet of the superheater header must be used. There is no specific design criterion dictating the design temperature margin above the superheated steam temperature – that is left to the engineer or designer of the equipment. This margin must be large enough to provide reliable and safe operation.

Sometimes when a boiler is outfitted with superheated steam, particularly in utility boiler service, there is reheat piping from the turbine to the boiler and back to the turbine. Interestingly, this piping is exempt from the boiler external piping (BEP) rules and requirements. BEP only covers the vent and drain connections on the cold and hot reheat headers, which are a part of the ASME Section I requirements. The rules for steam piping in BEP are found in ASME B31.1, 122.1.2, and 122.1.7(A), along with the additional rules provided in the ASME Section I, 2010 with the 2011 Addendum, in paragraphs PG-58 through PG-61. These rules, along with those provided in ASME B31.1, shall be applied concurrently.

FLANGE RULES

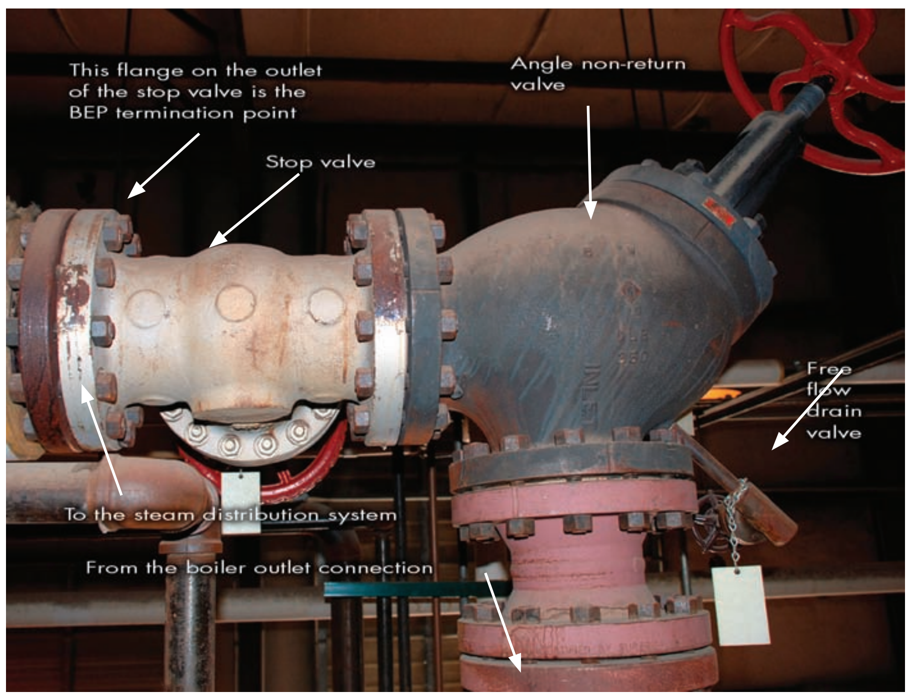
Since most steam connections tend to be large, there is a rule in ASME B31.1, 122.1.1(F) that will generally apply to most steam piping. This rule limits the use of a slip-on flange to a maximum size of 4″ nominal pipe size (NPS). Anything larger than 4″ NPS must be a weld neck flange. Note that this flange restriction is for size only, not class rating. All flanges that exceed 4″ NPS, irrespective of the class rating, must be of a weld neck style.

Another flange rule should be taken into consideration. ASME B31.1, paragraph 104.5.1, allows the use of slip-on flanges up to and including 24″ NPS. However, slip-on flanges in this paragraph are limited to pressure classes of 150 and 300. It would appear from this restriction that if the boiler outlet happened to be a 3″ NPS, a slip-on flange would only be permitted if it is a class 150 or 300. If a class 600 flange was needed, it would have to be a weld neck flange. ASME B31.1, paragraph 122.1.1, also lists additional prohibitions on flanges used in BEP, such as they may not be cut from plate. Socket weld flanges may also be used within their class and size limitations as listed in their standards. Standard flanges are manufactured to the ASME B16.5 and B16.34 standards. Flanges larger than the above standards are manufactured to B16.47 standards. As an alternative, ASME Section VIII, Division 1, Appendix 2 may also be used for flanges not listed in the previous standards. The restrictions for threaded and socket flanges can be found in ASME Section I, PG-39, PG-42, and ASME B31.1 paragraphs 110 through 118.

VALVE LIMITS AND REQUIREMENTS

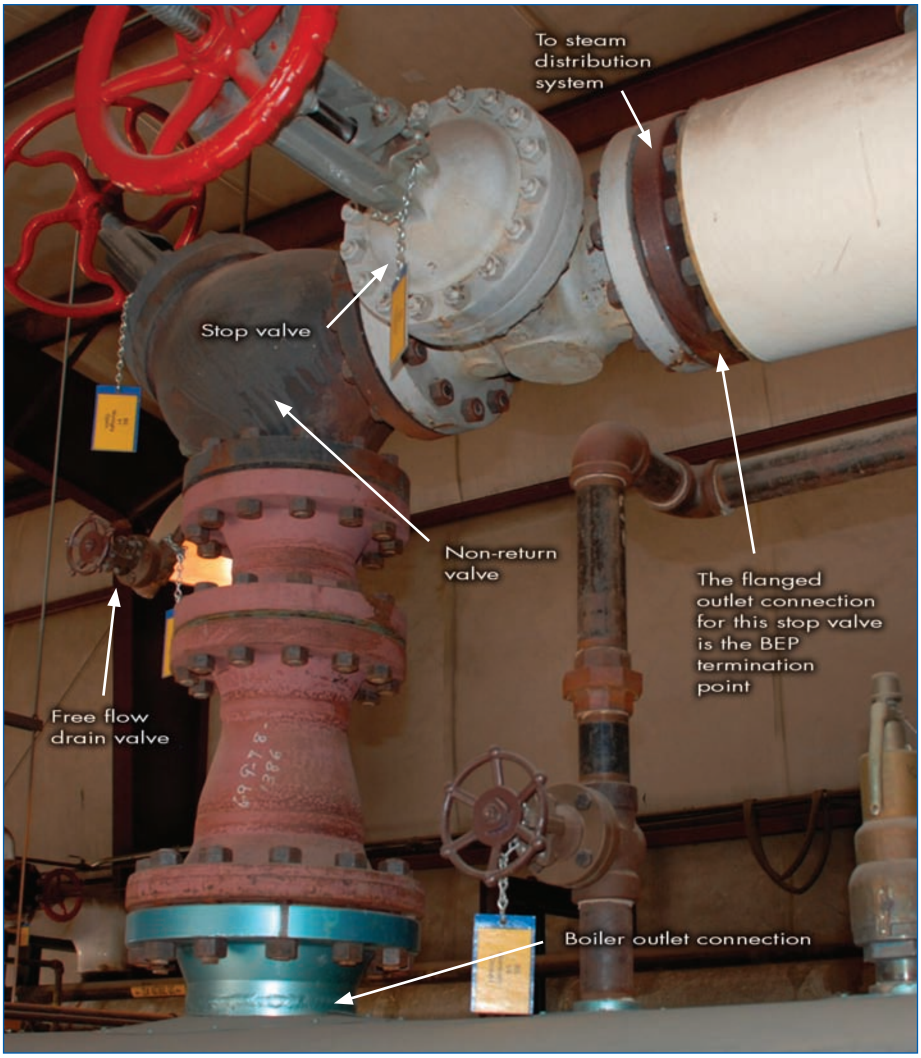
Valves used in steam service are also subject to limitations and specific requirements. The required number of steam valves and the limits of BEP are determined by two items. If the boiler has a manway and entry can be made into the pressure vessel, and if there is another source of steam (for example, from a common steam header with other boilers or extraction steam from a turbine or heat recovery steam generator), two steam valves are required and the BEP requirements extend to and include the required second valve.

This two-valve arrangement also requires the installation of a valved free blow drain between these valves. This drain valve cannot be hard-piped to any other connection, such as a blowoff tank or piping. As this is referred to as a drain valve it should be located at a point in the piping system that will allow any water contained between the two valves to be safely removed. If this valve is located such that it cannot safely perform its function, it will not be in code compliance. This three-valve requirement is for the inspector's protection. When performing a waterside inspection that involves entering a pressure vessel through a manway, the inspector can verify that the area is safe to enter by seeing that both valves are closed and the free-flowing drain is open. Inspectors can feel safe entering a boiler without the possibility of a hazardous condition from steam or hot water entering their workspace. Of course, any requirements for lock-out/tag-out and confined space entry must be followed.



One exception to this rule is when the boiler is a high-temperature hot water boiler. In most of these designs there is no drum or vessel to enter. Generally, these boilers are constructed with headers that do not have manways. In this case the BEP extends up to and only includes one valve. There is a code interpretation that addresses and answers this question. However, good engineering practice would still dictate the use of two valves with a drain valve for future servicing of this type of system.

The preferred valves for steam service are either a rising stem or an outside screw and yoke (OS&Y) valve, which gives a visual status of the valve position from a distance. The use of quarter-turn to open or close valves is prohibited for use within BEP unless they are installed with some sort of slow-opening mechanism that incorporates a visual indicator of the valve position. The use of a slow-opening mechanism limits the dynamic loading on the steam piping. Sometimes disk-style valves with resilient seats are used in this service and they are limited to 150 psi and 366°F service. There are many boilers designed for a MAWP of 150 psi and in some cases the outlet steam connection is a flanged class 150 outlet. When the boiler is supplied with a class 150 flange, be sure the installed steam valve meets code requirements. Class 125 and class 150 flanges are interchangeable and will mate to each other. It is possible to install a class 125 cast iron valve on a class 150 flange. A class 125 cast iron valve is rated for 150 psi at 350°F. However, at 150 psi the steam temperature is 366°F, which would make this class 125 valve not in compliance with the ASME B31.1 BEP requirements. Sometimes an installer will save some



money by buying the cast iron valve instead of the cast steel valve.

EXPANSION JOINTS

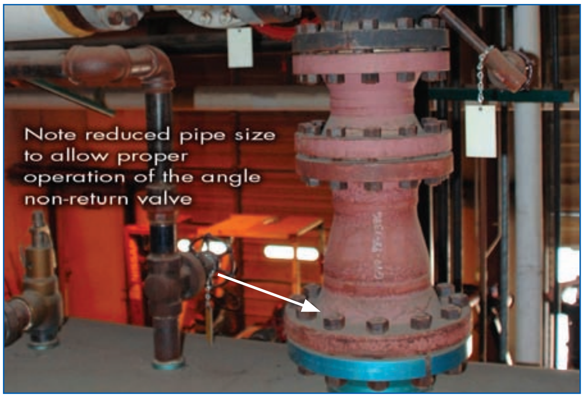
Another common question involves the use of expansion joints within BEP. This probably happens more with high-temperature hot water systems, as sometimes due to piping installation there is limited provision made for expansion. Generally with steam piping there are built-in piping changes to address the flexibility requirements. ASME B31.1 paragraph 101.7.2 states expansion joints of various designs may be used within their limitations. This paragraph also specifically prohibits certain types of expansion joints that can be used in BEP from the boiler outlet connection to the first required valve.

NON-RETURN VALVES

As mentioned above, certain installations require the use of two steam valves. Although in many installations one of the two valves is usually a non-return or stop-check style, the code does not mandate or require this style of valve to be installed. There simply has to be two stop valves on the steam piping. The construction of a non-return valve is such that the disc is free to move when the valve stem is fully open and can act to put a boiler online or take it offline depending on the steam pressure on the inlet of the valve. When the pressure on the inlet of the valve is greater than the header pressure, the valve opens and exports steam to the system. When the pressure is lower it closes and removes the boiler from service. For this valve to operate properly and open fully to prevent valve seat chatter, the velocity needs to be higher than what is normally found in steam piping systems.

Boiler designers generally try to limit steam system velocity to prevent operational or system operating problems. That is not the case with non-return valves. High velocity is needed to keep the valve disc off of the seat so no mechanical damage is done to the seat if it chatters. After using the sizing charts for non-return valves, it is not uncommon to see a valve one size or possibly even two sizes smaller than the boiler outlet connection. Very rarely is it necessary to install the same size non-return valve as the boiler outlet. Boiler manufacturers try to limit the velocity of the steam leaving the boiler to prevent water level problems and carryover. Non-return valves need the highest velocity possible to help the valve function properly. The proper application of the correct non-return valve size requires an evaluation of the system's design parameters, such as pressure, flow, and temperature. Non-return valve manufacturers should be consulted for assistance in sizing the correct valve for the application.

Use of a non-return valve is good engineering practice as it allows multiple boilers to go on- and offline automatically. If there happened to be a tube failure on an inservice boiler and the pressure dropped below the header pressure, the boiler would automatically be taken offline and possibly limit



potential damage. If a non-return valve is used, the code recommends that it be the first valve installed on the boiler. As this valve is subject to some damage from operation, installing it between the boiler and the required second valve allows it to be serviced without removing the steam system from service. Damage to the steam valve typically happens from an oversized valve that allows the disc to open a minimal amount to meet the steam demand and then may chatter as the valve opens and closes. A smaller valve that allows the disc to remain further off of the seat will give better service life to the valve.

In conclusion, piping for steam and high-temperature hot water boilers is subject to rules that have some minor differences than the rest of the BEP requirements. The major factor for piping design in some cases becomes the temperature of the steam, which influences the choice of material used. The requirements for the number and style of valves for steam piping are given along with guidance for sizing the valves properly.

The next installment in this series will be on the rules and requirements for installing boiler feedwater piping and valves. There are specific design rules and requirements for these systems which require close examination in order to be in code compliance.

Look for Steve Kalmbach's article, "Boiler External Piping (BEP), Part 2 – Feedwater Piping" in the fall issue of the *BULLETIN*.

Steve Kalmbach has been involved in the boiler repair, maintenance, and service industry for 40 years. His company, Kasco, has been in operation for 28 years and has a National Board ***R*** *Certificate of Authorization for repairs and alterations and an ASME Certificate of Authorization with* ***S*** *and* ***U*** *designators controlled by their office in Golden, Colorado.* ✤

2012 Technical Scholarship Recipient Named

Conor O'Brien of Redmond, Washington, has been awarded a $6,000 collegiate scholarship by The National Board of Boiler and Pressure Vessel Inspectors. He is pursuing a bachelor of science degree in chemical engineering at the University of Washington (UW). O'Brien is the son of National Board Commissioned Inspector Edward (Jake) O'Brien, a 30-year veteran inspector for FM Global.

Conor's academic achievements include being named on UW's Dean's List each quarter of his freshman year, UW's Annual Dean's List for the 2010-2011 academic year, 2010 National Advanced Placement (AP) Scholar, and 2009 AP Scholar with Distinction.

He has been actively involved in his hometown community and at UW. Throughout high school he was a regular volunteer with Habitat for Humanity. He was a founding member and executive director of development and outreach for a microfinancing fundraising organization that raised thousands of dollars to provide micro loans in Third World countries. In the Boy Scouts of America program he earned the rank of Eagle Scout and held several leadership positions within his troop. At UW he was admitted into a program called UW Leaders, a leadership development group with the goal of forming a strong sense of community and community service.

In addition to his regular classes, O'Brien is a volunteer research assistant in two labs at UW. The first project involves developing a hydrophilic water filter, which has potential application for boiler water quality. The second involves nanotechnology (organic semiconductors).

O'Brien plans to acquire a Ph.D. in physical chemistry and work in nanotechnology and electronics. Long term he would like to return to an institution to teach the next generation of students and to conduct research. September 1 marks the open submission period for the 2013 scholarship award. Visit nationalboard.org for details. ✤

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Member Retirements


Robert Whitman


Steve Donovan

DELAWARE INSPECTOR RETIRES

Robert Whitman retired as chief inspector for the state of Delaware on November 30, 2011. Mr. Whitman's career began in 1972 when he went to work for E. I. du Pont de Nemours and Company as an engineering specialist. After 32 years of service, he retired from DuPont and became a senior deputy boiler inspector for the state of Delaware in 2004. He was named chief inspector for the state on October 18, 2010. During his years with du Pont, Mr. Whitman was a National Board owner/user inspector, **VR** shop supervisor, and Level II UT and VT.

NORTHWEST TERRITORIES INSPECTOR RETIRES

Steve Donovan has retired from his position as chief boiler inspector with the Northwest Territories, Canada. Mr. Donovan has accumulated over 40 years of industry experience. He studied power engineering at St. John Institute of Technology and shortly thereafter went to work for the International Nickel Company of Canada. In 1975 he became a shift engineer for Maritime Electric Company at Prince Edward Island. The following year he became a boiler and pressure vessel inspector for the Prince Edward Island Department of Labour, a position he held for 14 years. In 1990 he and his family relocated to the Northwest Territories, where he took a position as a boiler inspector. He was promoted to chief inspector and joined the National Board in 1997. Mr. Donovan's unique inspection experiences in remote areas of the Northwest Territories were featured in the winter 2010 issue of the *BULLETIN*.

Davenport Remembered

Retired Pennsylvania member Jack Davenport passed away on May 28, 2012. He is survived by his wife Margaret, five daughters, a son, and 11 grandchildren.

Following a 25 year career in the US Navy, Mr. Davenport retired as a master chief petty officer in 1987 and assumed his first professional position as an on-site supervisor for Airco from 1987 to 1989. He joined Livingston HVAC in 1989 as an HVAC technician.

In 1995, Mr. Davenport went to work for the Commonwealth of Pennsylvania as a boiler inspector and became assistant director in 2004. He was named director in 2008 and joined the National Board that same year. In 2000 he became a National Board and ASME team leader. He held National Board Commission No. 11838 with **A** and **B** endorsements. He retired in 2011.

New National Board Members


John J. Esch

NEW DELAWARE MEMBER

John J. Esch has been accepted to National Board membership representing the state of Delaware. Mr. Esch served the US Coast Guard from 1976 to 1980. He was an operator/mechanic for A-Valey Engineers from 1981 to 1986. In 1986 he went to work for Barton Mechanical Contractors as a mechanic and consequently served as service manager from 1990 to 1992. He served as a boiler inspector for the Commonwealth of Pennsylvania from 1994 to 1997, and went on to work as an authorized inspector for Hartford Steam Boiler in 1997. In 1998 he became a deputy boiler inspector for the state of Delaware until assuming his current role as chief inspector.


Jamie D. Johnson

NEW MASSACHUSETTS MEMBER

Jamie D. Johnson has been elected to National Board membership representing the Commonwealth of Massachusetts. Mr. Johnson received certificates of steam engineering at Peterson School of Steam Engineering and the Technology Learning Center. His professional career began in 1989 as fireman and watch engineer at the New England Confectionery Company. From 1999 to 2010 he was employed with Advanced Energy Systems (Medical Area Total Energy Plant, MATEP) as operations manager. In 2010 he became district engineering inspector for the Commonwealth of Massachusetts Department of Public Safety before assuming his current role as chief of inspections-mechanical.


Bruce Fierheller

NEW MANITOBA MEMBER

Bruce Fierheller has been voted a National Board member representing Manitoba. Mr. Fierheller's career began in 1996 when he joined Manitoba's Mechanical and Engineering Branch first as a power engineer and then as a boiler inspector in 2007. He was appointed chief inspector with the Office of the Fire Commissioner for the province of Manitoba in April 2011. He is a representative for both Manitoba's Standardization of Power Engineer Examinations Committee (SOPEEC) and the Canadian Association of Chief Inspectors (ACI). He is chair of the Manitoba Gas and Oil Advisory Board and member of the Power Engineer advisory board.


Clayton C. Novak

NEW ILLINOIS MEMBER

Clayton C. Novak has been elected a to National Board member representing the state of Illinois. Mr. Novak worked as a quality control inspector for The Babcock & Wilcox Company in Ohio from 1978 to 1980. He became a manager of quality control and safety for Universal Lockport Corporation in Illinois from 1981 to 1983. In 1983 he began employment with the Nuclear Installation Services Company in West Virginia as a field quality assurance/quality control manager. In 1990 he became a boiler safety specialist for the state of Illinois until assuming his current role of chief.


Christopher S. Selinger

NEW SASKATCHEWAN MEMBER

Christopher S. Selinger has been accepted as a National Board member representing Saskatchewan. Mr. Selinger began his career as a regulatory boiler and pressure vessel design survey engineer for the Technical Safety Authority of Saskatchewan (TSASK) in 1999. He was promoted to design survey manager in 2005 and remained in that position until assuming the role of chief inspector in November of 2011. Mr. Selinger is a member of the Association of Professional Engineers and Geoscientists of Saskatchewan and the Canadian Standards Association.

KARL J. KRAFT

Chief Boiler Inspector, State of Maryland

BULLETIN Photograph by kevinweber.com

Consider this: the odds of a cow falling from a tree onto a person are one chance in 3,548,217,886.

Meet the one man who defied all odds: Karl Kraft.

He of dubious distinction, the Maryland chief boiler inspector is still amused by an event that placed him in rather unique statistical company back when, let's just say, he was one with the earth.

To hear him tell it, Karl's life growing up in Highlandtown in East Baltimore was without significant incident. When the Kraft family moved further outside of Baltimore to Rosedale in the mid-1950s, it was to take advantage of the postwar prosperity. His father, like his father before him, took a job with Bethlehem Steel.

Life was good. Karl's parents became active in the church. And Karl developed a healthy interest in the Boy Scouts.

As wholesome as his upbringing would suggest, there was a bit of rogue in the future Maryland official. "I had just turned 13 when I met the prettiest girl ever in Sunday school," he reveals with a grin. "She was 12 years old and stole my heart at first sight. I just had to tug on her ponytail to get her attention."

That tug commenced a 51-year relationship that would eventually see Peggy and Karl Kraft recently celebrate 44 years of marriage, the raising of four grown children, and the blessing of 12 grandchildren.

Karl demonstrated a passion for mechanical engineering early in life. His father a mechanical engineer, the young Baltimore native reveled in taking things apart. Like most boys possessing similar talents, reassembly proved somewhat more of a challenge.

Admitting to an early career bias toward engineering, Karl also felt the influence of strong religious beliefs that prompted him to consider the clergy.

His dilemma unresolved, the future National Board member decided to attend Wartburg College in Waverly, Iowa, a school with strong curricula in both theology and engineering.

It was during his freshman year that Karl developed yet another interest: chemistry. "A wonderful professor had me doing blood workups," the

Maryland inspector explains. "It was from those early experiences I really became fascinated with chemistry and the possibility of someday working in police forensics."

It wasn't long before the two years of separation proved too much for the Maryland official. Following his sophomore year he transferred to the University of Maryland and the school's chemistry program. His goal: marrying Peggy.

Karl returned home as Peggy was concluding pursuit of her nursing degree. But the Karl Kraft who left Rosedale, Maryland, two years hence was suddenly and without explanation not the Karl Kraft who would once again darken his parents' doorstep.

"It was quite the transformation," he acknowledged with a grin. "Not only did I return with a new perspective on theology and life, I was the physical embodiment of the era's hippie, or as some would call it, flower child." To complete his avatar, the unshaven and unshorn disciple of peace and love also returned with a new experience to adorn his fledgling résumé: managing a coffee house.

Following graduation with a B.S. in chemistry, Karl set his sights on the Baltimore police force and a career in forensics. But the realization he would soon be drafted for military service prompted him to get the jump on conscription. Joining the army and spending seven years in the infantry, Karl attended officer's candidate school before achieving the rank of second lieutenant.

Discharged from the army, Karl subsequently accepted a job as sanitarian for the Baltimore City Health Department. "Working for the air pollution section, it was my first exposure to getting out and doing field inspections around the city," he nods.

Three years passed before the Baltimore native secured a position at Bethlehem Steel. Hired as a technical assistant, he found himself fast-tracked to engineer in the fuel and steam department.

As part of company reorganization, the last 15 years of Karl's nearly 30-year career with Bethlehem were spent as a staff engineer working on environmental issues. "It was in 1992 when I overheard an older engineer talking to an insurance inspector about 'registering pressure vessels.' Upon the older gentlemen's retirement, I took over coordinating jurisdictional inspections and quality control associated with the company's **R** stamp program. To improve the company's relationship with the state, I faithfully attended state boiler board meetings. I also became active with the *ASME Boiler and Pressure Vessel Code* weeks and attending National Board General Meetings.

During this time Karl became familiar with a person who would eventually become his mentor and friend: the late Myron Diehl.

In 2003, Bethlehem Steel, once the second-largest producer of steel in America, was dissolved following bankruptcy. Before losing his job in April of that year, Karl took it upon himself to pass the National Board Commission examination.

While looking for employment opportunities in the manufacturing sector, the future National Board member learned of an opening for a Maryland deputy boiler inspector. Within months of going on unemployment compensation, Karl was now a state employee. More incredibly, in February of 2004, he applied for and was named chief inspector.

Today, Karl oversees a staff of 11 deputy positions, between 30 and 40 special inspectors, and a clerical staff of four. During his tenure, the army veteran has been able to achieve a number of department improvements, including a reduction in the number of overdue inspections from a high of nearly 20,000 to about 2,000 today.

Karl credits Maryland Commissioner of Labor and Industry Ron DeJuliis for many of his boiler department's accomplishments. "The commissioner's leadership in increasing salaries and adding positions has been critical to our success," he proclaims.

The chief inspector attempts to spend as much time with family as his schedule allows. And when not reveling in family activities, he and Peggy continue work on what they call their 30-year dream house.

"We bought a small farm back in the '70s with the intention of making it comfortable for our entire family," Karl relates. "Well, that was more than 30 years ago and we still haven't finished it. And now the kids are all grown and moved out."

But the farm still holds memories of when the Krafts took a page out of *Mother Earth News* and decided to grow and butcher all of their own food. And it worked out pretty well. Mostly.

"A neighbor had a cow with a broken leg and rather than just destroy it, I thought it was ideal for butchering," Karl recollects with a laugh. "We hoisted the dead animal upside down on a large tree branch with rope attached to its hind legs." The tree branch held. The rope did not.

Had the young engineer known then what he knows now, he might have avoided positioning himself directly under the nearly 1,000-pound bovine. Fortunately, Peggy was at home to help rescue her husband.

And his dignity. ♣

LAST VOYAGE OF THE *SULTANA*

North America's Deadliest Accident

The following chapter passages were excerpted from the forthcoming book, *B L O W B A C K*, releasing later this year. Written by National Board Director of Public Affairs Paul Brennan, *B L O W B A C K* is an absorbing collection of stories and essays about pressure equipment mishaps ranging from hot water heaters, to massive train boilers, to beer kegs and everything in between – making the point that everyone comes within close proximity of pressure equipment danger every day.

Paul D. Brennan
Author of B L O W B A C K

It would be imprudent to discuss the dangers of pressure equipment without acknowledging the deadliest accident ever recorded in North America.

A boiler explosion aboard the steamship *Sultana* occurred at 2 a.m., April 27, 1865, on the flooded Mississippi River just north of Memphis. It resulted in the deaths of an estimated 1,800 passengers. With a carrying capacity of 376, the *Sultana* was en route to Cairo, Illinois, with 2,300 passengers, many of whom were Union soldiers returning from Confederate prisoner confinement and the ravages of the just-concluded Civil War.

In 1892, *Sultana* survivor Chester D. Berry published a stirring and graphic account of the accident. *Loss of the Sultana and Reminiscences* was a product of Berry's efforts to contact other survivors and catalog their first hand experiences. Included are facts, records, and personal accounts – many of which illustrate a moving portrait of man's enduring will to survive.

Herewith an extraordinary look – directly from an exceptionally rare publication – at select passages featuring the haunting words of the emaciated Union prisoners who survived:

THE ATROCITIES OF PRISON LIFE

The food they gave us was corn cobs, all ground up and made into mush, and there wasn't near enough of that to keep the boys alive any length of time. Those that lived had to speculate by trading their brass buttons, boots, etc., with the guards. There were from 100 to 150 boys dying every day. A large wagon, drawn by four mules, was used in drawing out the dead. They were laid in as we pile cord wood and taken to the burying ground, generally putting 50 in a grave, and returning would bring mush in the same wagon, where worms that came from the dead could be seen crawling all over it; but we were starving, therefore we fought for it like hungry hogs. **– Joseph Stevens**

On the 30th of November, 1864, at the memorable Battle of Franklin, Tennessee, I was again taken prisoner and this time took a trip to Andersonville, that indescribable den of suffering, sorrow, and death.

I will give some death rates that I gathered from official records as follows: Of 12,400 persons taken to the hospital, 76% died.

In May 1864, of 18,454 prisoners, 701 died; 23 per day.

In June 1864, of 26,364 prisoners, 1,202 died; 40 per day.

In July 1864, of 31,678 prisoners, 1,742 died; 56 per day.

In August 1864, of 31,693 prisoners, 3,076 died; 99 per day.

On the 23rd of August, 1864, was the greatest mortality; 127 died, one for every 11 minutes. You will allow me to say that I call that treatment wholesale murder and that of the most cruel kind known to history. **– Samuel H. Raudebaugh**

BOARDING THE *SULTANA* IN MEMPHIS

We were . . . ordered to fall into line and march aboard the steamer "Sultana." When going on board my attention was attracted by the noise and work at the boilers going on at that time. We were marched to the hurricane deck and informed that this was to be our place of abode, but I thought different.

I went below and looked at the boilers, which were not very favorable to my mind. I went back to the boys, told them that we had better look for some other place and that I thought that there was danger; and if the boat should blow up and we were on that deck we would go higher than a kite. **– Wm. Boor**

Last known photo of Sultana taken in Memphis, TN, two days prior to the catastrophe.

THE EXPLOSION

Myself and two comrades bunked together, just back of the left wheel house, on the middle deck. The first sensation I experienced was that of falling down through space, as probably many of you have felt when you had an attack of nightmare. I soon realized that it was no nightmare for we were immersed in the icy water of the river. **– Jotham W. Maes**

As I stopped to take a hurried glance around me I heard someone near me exclaim, "For God's sake someone help me get this man out." I turned and saw a lieutenant of a Kentucky regiment. He was a very large man and was called "Big Kentuck." He had found a man that was held fast by both feet, a large piece of the wreck having fallen across them. I took hold and helped the lieutenant but we could not release him and he was soon roasted by the intense heat. **– M. C. White**

There were so many people in the water you could almost walk over their heads. I got a shutter about three feet square, and at this time I found Joe Moss. He begged me to let him have the shutter as he could not swim. I threw it into the river and told him to follow it, which he did; I never saw him again. **– Ben C. Davis**

WATER RESCUE

Owing to the necessity of constant motion, without rest to any part of the body, being reduced to a mere skeleton through being confined in rebel prisons was in my favor, as I could never have survived that awful disaster had I weighed as much as I did before my prison experience. My weight now was 80 pounds. When I was captured I weighed 175 pounds. **– Epenetus W. McIntosh**

We were going along fairly well when a drowning man seized my left leg. I tried to kick him loose but failing I let go the raft and tried to force him off but could not, and was obliged to drag that dead weight until we reached Memphis. We were helped out of the water just above the wharf by citizens, and the last I can recollect was they were trying to pry the dead man's grip loose from my leg. **– M. H. Sprinkle**

RETURNING HOME

After being at the hospital a few days, and not being injured, I made my escape, determining to reach home as soon as possible. The first boat that came along was the "St. Patrick," a handsome steamer plying between Cincinnati and Memphis. Like a burnt child dreading the fire, I dreaded getting on a steamboat for fear of another explosion. Adopting what I supposed was the safest plan, I crawled into the yawl hanging over the stern of the boat (as all sidewheel packets have) and never left my quarters until I arrived at the wharf at Evansville. It rained most all the way up, but I stuck it through. Every time the boat would escape steam or blow the whistle I prepared to jump, supposing an explosion was about to take place. **– *Wm.* A. McFarland**

Potential Dangers of Carbonated Beverage Systems

By Gary Scribner, National Board Member

Recent incidents involving high concentrations of carbon dioxide (CO_2) gases caused by improperly installed and poorly maintained carbonated beverage systems led to over a dozen hospitalizations in Pooler, Georgia, and Phoenix, Arizona, and identified the acute need to raise awareness of potential safety concerns related to these systems.

Currently, there are over 1,250,000 beverage systems that are filled on-site in the United States alone. Carbon dioxide liquid has an expansion rate of approximately 555%. Its vapor is 1 ½ times heavier than air and displaces oxygen. The dangers associated with CO_2 exposure are based on the concentration percentage and amount of time a person is exposed.

The Occupational Safety and Health Administration's (OSHA) permissible exposure limit for an eight-hour time weighted average is only 0.5%. A 3% concentration results in deeper breathing, reduced hearing, headaches, increased heart rate, and has a short-term exposure limit of 15 minutes. Concentrations of 10% and greater lead to unconsciousness in under a minute, and death if no actions are taken.

TRANSPORTED CYLINDERS

Liquid carbon dioxide (CO_2) was developed in the early 1900s specifically for making carbonated beverages. Historically, cylinders are filled with liquid CO_2 at the distributors' facilities and transported to businesses for use in carbonated beverage dispensing machines. This method still exists today and utilizes cylinders ranging from 10 to 100 pounds of liquid CO_2. The cylinders are classified by the actual weight of liquid CO_2 used to fill them.

These distribution systems have a good safety record since the cylinders are filled off-site and are designed for a much higher working pressure than the ones at which they normally operate. Problems associated with this process typically result from improper handling and storage of the cylinders, as well as lack of employee knowledge about the potential dangers of CO_2 systems. These cylinders fall within Department of Transportation (DOT) regulations since they are transported via roads and highways. Other than DOT regulations, few regulations exist for this type of process.

Photo courtesy of Chart Industries, Inc.

CYLINDERS FILLED ON LOCATION

Approximately 20 years ago the carbonated beverage industry developed a system to fill cylinders on-site at businesses that use carbonated dispensing machines, giving CO_2 distributors/suppliers the capability to service more customers less often by filling the larger storage vessels using tank trucks. Today, almost every gasoline station, convenience store, bar, and restaurant has a carbonated beverage system. Cylinders used in this system contain a much larger volume of liquid CO_2 and can range from 200 pounds to 750 pounds of liquid CO_2. The size of the storage cylinders is based on both the volume of beverages served at the location and the delivery frequency of the distributor/supplier.

Cylinders which are not transported are not DOT-regulated or -certified cylinders, and are designed for a working pressure from 300 psi to 350 psi and are double-walled. The inner vessel is the storage area while the outer area has a coil and is under a vacuum to facilitate the change of state from liquid to gas.

Most systems using these tanks utilize a fill box that is installed on the outside of the building. It should be noted that in some instances the owner of the building will not permit a fill box to be installed. In these cases, the distributor /

supplier either disconnects the piping from the CO_2 cylinder or brings the fill hose inside the business to fill the cylinder. If a fill box exists, the box is fitted with a fill connection and a vent or relief connection, both of which must be properly piped out of the storage cylinder.

The internal pressure of these CO_2 cylinders varies based on the amount of liquid, ambient temperature, the vacuum in the outer vessel, and the volume of CO_2 changing state at that time. Cylinders may reach the maximum working pressure when being filled or immediately after high-usage times resulting in the excess pressure being vented through the safety relief circuit of the system. This creates the highest potential for risk of CO_2 to be released from the cylinder. Most cylinder manufacturers are very explicit regarding the installation instructions for these systems and require the vent or relief circuits to be piped to a fill box installed at a safe point of discharge outside the building. Additionally, the location of the vent or fill box should not be below grade or in any enclosed area outside the building. Several incidents involving injury and even death have occurred when the vent circuit was not in a free air flow area outside the building.

These systems are seldom regulated by local jurisdictions. Lack of knowledge of how the systems function, lack of proper detection equipment, and change in environment between the time of incident and an investigation have led to the lack of reporting and/or misreporting of incidents and near misses.

The following are incidents directly related to carbonated beverage system malfunctions due to: improper installation and/or maintenance, renovation to rooms or areas where the systems were installed without an engineering evaluation of the effect on the systems, and/or lack of knowledge about the dangers of CO_2 gas:

- September 2011 – Ten people hospitalized, including two firefighters, and one fatality at a fast food restaurant in Pooler, Georgia.
- June 2011 – Evacuation of a fast food restaurant in Dorchester, United Kingdom.
- May 2011 – Three hospitalized, including two firefighters, at a fast food restaurant in Phoenix, Arizona.
- May 2010 – Evacuation of a movie theater in Des Moines, Iowa.
- July 2008 – Two hospitalized from an incident in a bar in Benson, Nebraska.
- April 2008 – One fatality in a hotel in Victoria, Australia.
- August 2007 – Fatality of a waiter at a restaurant in Coronado, California (DOT cylinder).
- January 2005 – Two fatalities, employee and delivery driver, outside a fast food restaurant in Sanford, Florida.
- March 1998 – Two hospitalized and two treated at the scene at a fast food restaurant in the US. Location unknown.
- 1996 – Fatality of a delivery driver outside a restaurant in Cincinnati, Ohio.

Some jurisdictions do require inspection of beverage systems that are filled on-site. Initial inspections revealed a violation rate of over 25% related to the safety/vent circuit installation statewide, with some isolated communities having close to a 100% violation rate.

Local considerations should be given as a means to detect carbon dioxide in businesses or places of public assembly that utilize bulk CO_2 systems, and can include:

- Prohibiting CO_2 systems of any type from being installed below grade.
- Prohibiting the filling of storage tanks inside a business and/or disconnecting any system piping to facilitate filling.
- Mandating posted signage warning employees, customers, and first responders of the utilization of CO_2 and the potential risk and symptoms associated with carbon dioxide exposure.

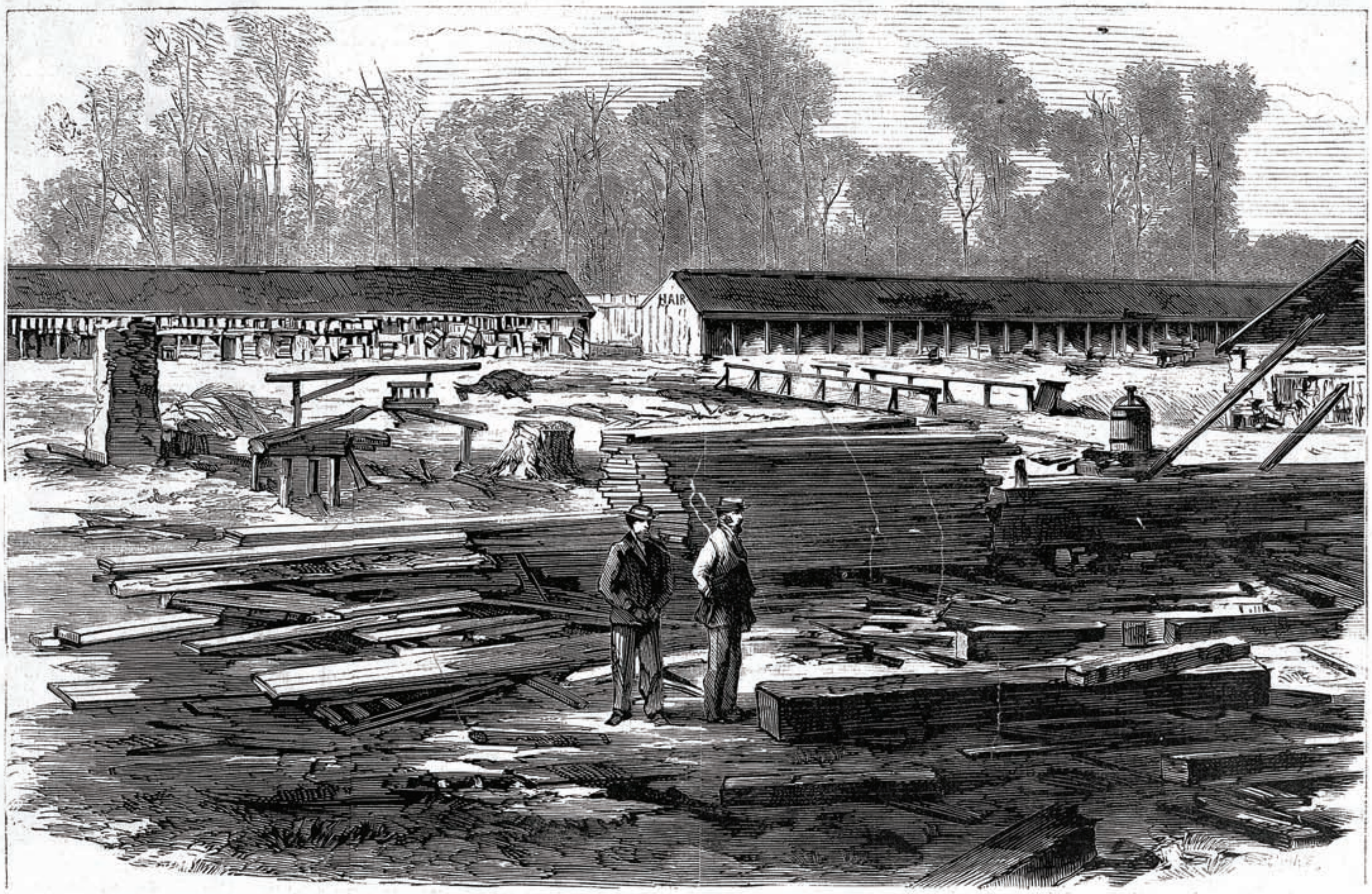
Additional consideration should be given to CO_2 awareness training for emergency responders, businesses, and places of public assembly utilizing CO_2, as well as obtaining CO_2 detection equipment for first responders.

The public and jurisdictional authorities should be aware that carbon dioxide exists and has many uses within industry, especially the food industry. The OSHA incident reporting system has 20 pages of incidents and fatalities involving CO_2 exposure. Additionally, carbon dioxide systems (almost identical to the carbonated beverage systems) have recently been discovered being utilized with large swimming pools to control pH and is now being used as a refrigerant in what are advertised as "green systems."

Awareness and inspection of carbonated beverage systems is the key to ensuring the safety of emergency responders and the public.

For further information regarding CO_2 systems, please contact the chief boiler inspector of your jurisdiction.

For a video presentation of a CO_2 *incident, visit: www.youtube.com/watch?v=eY__H-CMvw0* ✤



SCENE OF THE TERRIBLE BOILER EXPLOSION AT THE STATE FAIR, INDIANAPOLIS, INDIANA.

Sawmill Competition Ends in Tragedy

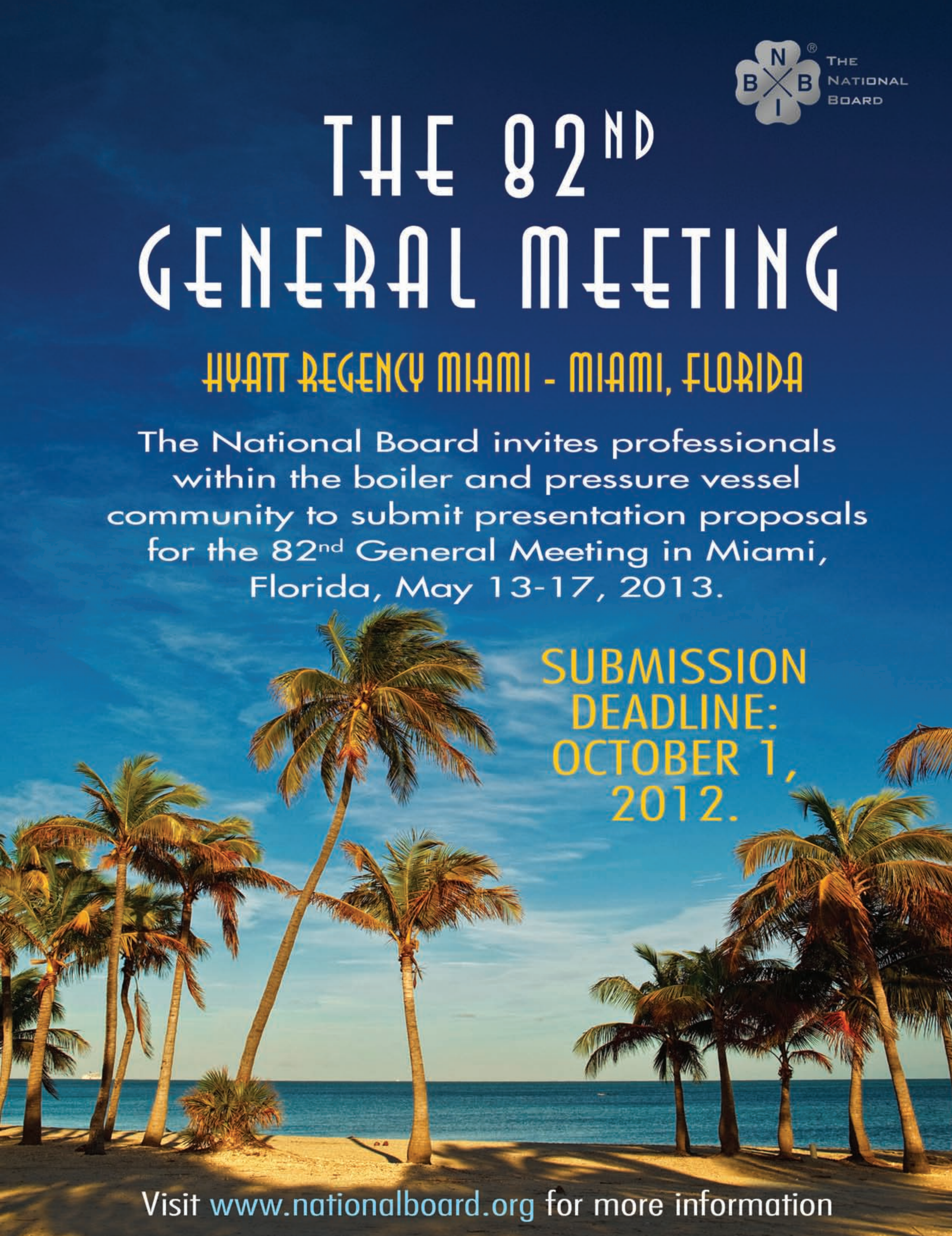
A sizable crowd gathered around a sawmill competition at about 1 pm at the Indianapolis, Indiana State Fair on the first of October, 1869. Portable sawmills attached to steam boilers chopped through lumber in an outstanding display of steam, strength, and ingenuity. Bystanders watched as E.T. Sinker & Company's sawmill cut 513 feet of lumber and easily won the competition. According to the October 2, 1869, issue of the *Indianapolis Journal*, every part of the engine was "strained to the utmost tension" as it sawed vigorously for nearly 10 minutes. When the competition ended, the Sinker mill was permitted to rest and the boiler's fires quelled.

At 3 pm, Sinker's foreman decided to cut the remaining logs and went about the task after Mr. Sinker himself checked the boiler's gages. When the pit beneath the saw filled with sawdust, the job was paused so workers could clean it out. While the machine was still, it erupted.

Reported the *Indianapolis Journal*: "At a moment of undisturbed quiet, while the hum of the machinery was hushed . . . a noise like the explosion of a park of artillery saluted the ear, and a concussion of the earth as of an earthquake sent a thrill of fear to the heart. A volume of steam, a blinding cloud of dust and smoke, the air filled with debris of timber, of pieces of iron, of shreds of clothing, parts of human beings, of groans and shrieks, men falling hither and thither."

The *Journal* detailed gruesome accounts of maimed and unidentifiable victims, shocked and terrorized survivors, and property damage. Mr. Sinker, who survived the explosion, said he had noticed nothing out of the ordinary. "He cannot tell what was the cause of the accident yesterday, as his trial of the water gage showed plenty of water in the boiler, and he saw no intimations of danger," reported the *Journal*. But the article also pointed out that Sinker's reading of the gage "might have fooled him by the bubbling of the water, as it sometimes does."

The *New York Times* reported on October 7, 1869, that the coroner's jury rendered a verdict: the boiler explosion was caused "by carelessness and culpable mismanagement on the part of the engineer in charge," who died in the explosion along with over 25 other people. More than 50 others were wounded in the disastrous event.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