BULLETIN

SUMMER 2003 • VOLUME 58 • NUMBER 2

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 assuring acceptance and interchangeability among jurisdictional authorities empowered to assure 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.

ON THE COVER:
The aftereffects of a deadly boiler explosion in Brockton, Massachusetts, which left 58 dead, and had a far-reaching impact on the people of Massachusetts. *To find out more, turn to page 20.*

Cover Story

Features

Departments

It's That Time . . .

BY DONALD E. TANNER, EXECUTIVE DIRECTOR

For the past ten years, the somber tone of this Executive Director's Message has been an exercise in the art of repetition. Like baseball, it happened every spring.

While there are many in our industry who have resigned themselves to the annual imparting of bad news regarding the Incident Report, there are recent signs indicating that maybe — just maybe — our message of safety is finally beginning to resonate.

Simply stated: the 2002 Incident Report represents the lowest annual number of deaths, injuries and accidents since we established this survey in 1991. And while these statistics suggest a reason to be guardedly optimistic, it must be implicitly stated that *even one death* or *just one injury* is one too many.

In 2002, there were 5 deaths, 22 injuries, and 1,663 accidents. Comparatively speaking, there were 12 deaths, 84 injuries and 2,219 accidents in 2001. That translates to a 58 percent decline in deaths, a 74 percent drop in injuries, and a 25 percent reduction in incidents.

Another sign that the message of safety may be getting through can be seen in the injury-per-accident ratio, or the odds of being injured during an incident. Last year, injuries occurred at a rate of 1 for every 76 incidents. This is in stark contrast to 2001 when the ratio sunk to a frightening 1 injury for every 26 incidents — one of the most dangerous years of recent record.

Yet another positive sign in the 2002 report involves an appreciable decrease in the number and percentage of unknown or undetermined accidents. This category is of particular importance to our industry because identifying and isolating problems are key components to helping preclude accidents of a similar nature. Exceeding 7 percent in 2001, last year's percentage dropped to less than 4 percent.

An additional point that merits attention involves a significant reduction in the collective number of **Low-Water Condition** and **Operator Error or Poor Maintenance** incidents. Once again the leading cause of accidents at 592, low-water condition incidents declined by 32 percent over 2001. The second leading cause of accidents, operator error, recorded a comparative drop of 24 percent.

Finally, a figure that reinforces our cautious optimism: the 2002 Incident Report reveals a reduction in the number of deaths caused by human error (i.e., **Low-Water Condition**, **Improper Installation**, **Improper Repair**, and **Operator Error or Poor Maintenance**). Collectively, these categories (which totaled 1,828 in 2001 and 1,305 in 2002) declined 29 percent. However, human error still played a disturbing role in causing 3 of the 5 recorded fatalities last year.

While there is some cause for encouragement, one must temper his or her enthusiasm for the data presented above by taking into account last year's survey participation. While the number of responses from jurisdictional authorities *increased* by 6 percent, the responses from authorized inspection agencies *decreased* by 27 percent when compared to 2001. The overall response rate, however, remained constant, dropping insignificantly from 64 to 63 percent.

Before jumping to conclusions as to what this information foretells, I think it is important to understand that — as with any statistics — consistency is the true measure of our success, or lack thereof. In this regard, we must await another spring to determine whether indeed a positive trend exists.

While I have repeatedly indicated on these pages that happenstance has no place in our industry, there will always be the few who will justify the modest improvement in this annual Incident Report as an anomaly — or even more curiously — luck.

I grudgingly admit: they may have a point. Particularly if one optimistically believes, as did baseball great Branch Rickey, that "Luck is the residue of design."

It's an intriguing thought. ❖

2002 Incident Report

OBJECT EXPERIENCING INCIDENT	ACCIDENTS	INJURIES	DEATHS
POWER BOILERS			
Safety Valve	8	0	0
Low-Water Condition	137	1	0
Limit Controls	4	1	0
Improper Installation	5	0	0
Improper Repair	14	0	0
Faulty Design or Fabrication	6	3	0
Operator Error or Poor Maintenance	90	6	2
Burner Failure	16	3	1
Unknown / Under Investigation	2	0	0
SUBTOTALS	282	14	3
HEATING BOILERS: STEAM			
Safety Valve	2	0	0
Low-Water Condition	359	0	0
Limit Controls	17	0	0
Improper Installation	5	0	0
Improper Repair	2	0	0
Faulty Design or Fabrication	54	0	0
Operator Error or Poor Maintenance	262	0	0
Burner Failure	16	1	0
Unknown / Under Investigation	16	0	0
SUBTOTALS	733	1	0
HEATING BOILERS: WATER (includes hot-water supply)			
Safety Relief Valve	7	0	0
Low-Water Condition	96	0	0
Limit Controls	23	0	0
Improper Installation	11	0	0
Improper Repair	2	0	0
Faulty Design or Fabrication	60	0	0
Operator Error or Poor Maintenance	215	0	0
Burner Failure	28	1	0
Unknown / Under Investigation	30	0	0
SUBTOTALS	472	1	0
UNFIRED PRESSURE VESSELS			
Safety Valve	19	2	0
Limit Controls	8	0	0
Improper Installation	4	0	1
Improper Repair	1	0	0
Faulty Design or Fabrication	24	2	1
Operator Error or Poor Maintenance	102	1	0
Unknown / Under Investigation	18	1	0
SUBTOTALS	176	6	2
TOTALS	1,663	22	5

This report was compiled from data submitted by National Board jurisdictional authorities and authorized inspection agencies (insurance companies) as of December 31, 2002. It also includes materials submitted from several insurance companies that insure boilers but do not provide inspection services.

Please note: deaths and injuries are industry-related. They include, but are not limited to, owners and operators of boilers and pressure vessels.

This survey notes an 80-percent response rate from National Board jurisdictional authorities and a 30-percent response rate from authorized inspection agencies. The total number of surveys mailed was 89, with a 63-percent response rate overall. ❖

Developing Inservice Codes and Standards

BY CHUCK WITHERS, SENIOR STAFF ENGINEER

Responding to Technology

In today's technological world, as advances are continually made in materials and equipment, codes and standards must advance as well. That's why the NB-23, *National Board Inspection Code*, is sometimes referred to as a "living document," continually evolving to match the pace of change in technological and material advances. At the same time, any good code or standard must maintain the traditional focus on safety as the number one priority. A code or standard that properly addresses a user's needs will provide great benefits not only in terms of safety, but also in terms of cost-effectiveness and usefulness.

After all, as age and replacement costs of pressure equipment increase, good inservice codes for inspecting, evaluating, repairing and re-designing pressure equipment are needed for continued safe operation. NB-23, the *National Board Inspection Code* (NBIC), is one of many codes developed to address safety issues for inspection and repairs to pressure-retaining items.

Pressure equipment does not last forever and will fail (sometimes catastrophically) if not inspected and maintained properly. Design, materials and fabrication methods are considered in determining the life expectancy of the equipment. Availability of new materials, improved manufacturing techniques, and technological advances allow for expanding operating pressures and temperatures, and also may allow for extension of life if equipment is operated within design parameters.

Code Versus Standard — Legal Requirement Versus Reference

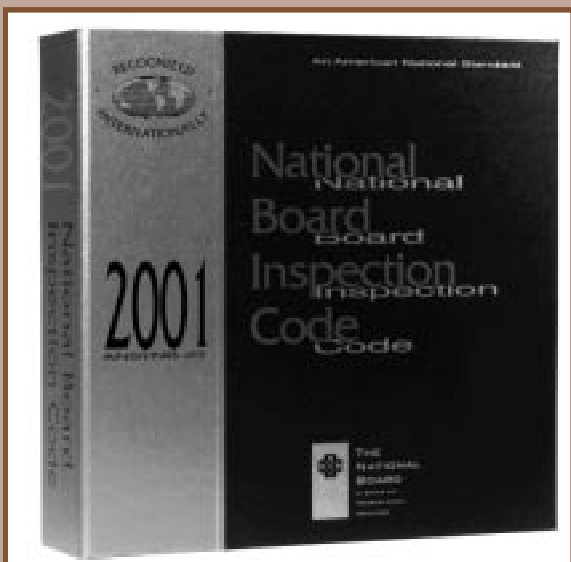
There is a distinct difference between a code and a standard.

A code is a document written with the intent that it becomes a legal requirement when adopted by a jurisdiction. Codes will typically identify both technical and administrative requirements and are developed as stand-alone documents. For example, the NBIC has been adopted by most jurisdictions in North America for inspecting, repairing and altering boilers, pressure vessels and piping. Once a jurisdiction adopts the NBIC, it becomes a legal requirement and enforceable under law. Both administrative and technical requirements identified in the NBIC become mandatory once adopted by a jurisdiction.

Standards, on the other hand, are developed not as stand-alone documents but instead will list specific requirements that may be referenced by codes or other documents. A standard is not intended to be directly adopted by jurisdictions other than as a reference. Examples of this are Standard Welding Procedures which were developed by the American Welding Society (AWS) to provide uniformity in welding procedure specifications. These standards are developed based on good engineering practices and experiences.

NBIC Committee — Responding to User Needs

The *National Board Inspection Code* Committee, like the above referenced American Welding Society (AWS), strives to develop standards that address not only historical issues of inservice and post construction, but also emerging issues. It stands to reason that when emerging technologies are used in the fabrication of pressure equipment, so too must emerging technologies and new approaches be used in responding to the needs of code users. That is one reason the *National Board Inspection Code* Committee has recently expanded its organization to include, besides the main committee, several subcommittees to improve, clarify, interpret and expand each specific part of NB-23. These subcommittees include Mandatory Appendices, Nonmandatory Appendices, Part RA, Part RB, Overpressure Protection, and Parts RC and RD.



As part of the restructuring process, the *National Board Inspection Code* Committee has added both upcoming subcommittee meeting agendas as well as past subcommittee meeting minutes to the National Board Web site to enable a wider audience to access this information. These items can be viewed at *nationalboard.org* under NBIC.

In addition, the NBIC has recently incorporated new sections for repairs/alterations to fiber-reinforced plastics, graphite composite vessels, and installation requirements for boilers and pressure vessels. Expansion in these new sections is ongoing. Presently, a draft for the complete reorganization and upgrade for Part RB, Inspection of Pressure-Retaining Items, is being reviewed for incorporation into the next NBIC addendum to be issued in December 2003.

The NBIC Committee is also working diligently to recognize various methods of repairs that are consistently utilized by repair organizations, including some methods that involve not only welding, but may be mechanical in nature as well.

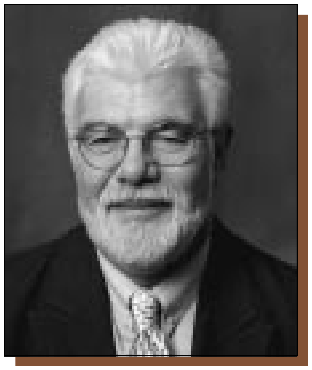
The Evolution of the *National Board Inspection Code*

The National Board of Boiler and Pressure Vessel Inspectors is constantly researching and exploring new challenges within our industry to ensure safety to life and property. An ongoing goal of the National Board lies in finding new and innovative ways to reach our target audience — users of the NBIC and other codes. The restructuring outlined above is one way the National Board is addressing this challenge. After all, as codes of construction continue to expand in intent, in philosophy and in implementing new technology, so must inservice and post-construction codes expand to address these changes.

The challenge for the NBIC is to review technical standards and integrate these concepts in a fashion that jurisdictions and their constituents can use.

Working closely with standards-writing organizations such as the American Welding Society and ASME International, the NBIC will continue to develop and expand as a leading inservice repair and alteration code for use by jurisdictions, repair organizations, inspectors and users of pressure equipment — always with the ultimate goal of safety in mind. ❖

For updates on the National Board Inspection Code, *consult nationalboard.org/NBIC.*



Considering Electronic Quality Systems

BY CHUCK WALTERS, ASSISTANT DIRECTOR OF INSPECTIONS

In the summer 1973 addendum to the *ASME Boiler and Pressure Vessel Code*, it was mandated that each manufacturer establish a quality control system, effective January 1, 1974. After that date, a company had to document its quality system program. If this requirement was not satisfied, ASME International would not issue the requested ASME certificates. The *National Board Inspection Code* followed shortly with similar requirements for accrediting repair organizations.

The industry has evolved over the last 30 years from companies trying to decide what should be included in a quality system, to how to control the written system description in an electronic format. Moreover, some companies had to determine how to transmit the quality system program via the Internet, to remote locations where projects are in progress.

With advances in technology, we move more and more to a paperless society. Therefore, boiler and pressure vessel repair organizations, manufacturers, authorized inspection agencies, and inspectors will encounter some unique questions and issues related to the implementation of an electronic-based quality system (QS).

Developing the words for the document is not the issue; the issue is change. This change will greatly reduce or even eliminate the need for a printed copy of a document; instead, the quality system manual becomes a file viewed on a computer screen.

When considering implementation of an electronic quality system, manual controls are the same as for a printed copy. Designers of an electronic quality system must ensure that provisions are included for approvals, acceptance, issuance, and revisions of the documents.

Other considerations include questions such as:

- Who is authorized to access the program?
- How are changes made?
- How is the user of the program notified of revisions?
- How are approvals and acceptance identified?
- Is a printed copy of the document necessary?

As these items are evaluated, how the electronic version will be used should also be considered. Will the QS be used only on the company's network, on a CD-ROM, or on a local personal computer? If the program is used on a network system, the controls become simpler, since they can be included in the in-house system controls.

In-house system controls should designate an individual who is authorized to develop, revise, distribute and notify individuals of any changes to the QS. Also, a procedure should establish either a PIN number and/or electronic signature of individuals authorized to approve and accept the contents of the QS.

For a network system, some areas that should be addressed include:

1. The software used to develop the QS.
2. Responsibility for issuing, revising and distributing the QS. This information must be specified in the quality system program.
3. Responsibility for the review and approval of the QS documents.
4. Provisions for new documents and revisions to be reviewed and accepted by the authorized inspector.

5. Access to the file at locations where operations essential to the implementation of the quality system are performed. Additionally, file access should be limited to "read only."
6. A system for acknowledgment by authorized individuals that files have been received. This system could be as simple as an email program. Once the email is opened, there could be an automatic acknowledgment of receipt of the revision.
7. Controls for a printed copy of any document in the manual, to ensure that invalid and/or obsolete documents are promptly removed from all points of issue or use. The printed copy could be used when the system is audited by outside individuals.
8. Notice to users that for all joint reviews (accreditation audits), a printed copy of the manual must be furnished to each review team member.

For programs that utilize CDs, the system must describe how the CDs are to be generated, distributed and controlled. Some features should include:

- Responsibility for control of all CDs.
- Distribution system to assigned individuals.
- If downloaded, CDs must be protected to prevent changes by the user. This could be programmed in the disk as "read only."
- When revisions are required, a system must be in place for issue of the replacement CD as well as for the retrieval of previous editions of the QS.
- Controls for a printed copy of any document, to ensure that invalid and/or obsolete documents are promptly removed from all points of issue or use. The printed copy could be used when the system is audited by outside individuals.
- Reminder to CD users that joint reviews or accreditation audits must include a printed copy of the manual furnished to each review team member.

The controls identified must be described in the electronic system and the system must be capable of being audited.

There are additional and more subtle considerations that should be addressed as well. For example, most companies that introduce an electronic QS will provide orientation for their employees. But what about the inspector? The inspector should receive the same orientation as the employees. The inspector should also have complete access to the system.

Another issue to consider is the level of automation that is included in the company's workflow. For example, is an inspector expected to complete a written inspection report, or may inspections be recorded electronically?

The advantages of the electronic QS include reduction in processing time for initial issue and revisions to the system, as well as more efficient implementation of revised documents.

With the advancements of technology and the demand for more user-friendly systems, electronic-based systems are becoming the wave of the future, which will be good for the boiler and pressure vessel industry. ❖

Inspector Notices

Subcommittee Shift

The NBIC Committee is undergoing restructuring. While the committee itself is not affected, new subcommittees have been formed for the purpose of expanding, reorganizing, maintaining and revising each section of the NBIC. The new subcommittee structure reports to the Main Committee while allowing Main Committee members to participate on at least two subcommittees. This participation should help minimize discussion time, thus streamlining the voting process at the Main Committee level.

The subcommittee structure also allows for more participation by interested parties who are not able to participate at the Main Committee level. When it is deemed necessary, a task group will be formed to address a specific issue. Such a task group will report to the subcommittee, which will then report to the Main Committee.

The subcommittees will consist of:

- SC on Part RA
- SC on Part RB
- SC on Parts RC and RD
- SC on Overpressure Protection
- SC on Mandatory Appendices, and
- SC on Nonmandatory Appendices.

To streamline issuance of the NBIC, beginning in 2004 the new edition will also include the 2004 addendum.

For information about NBIC changes, email Chuck Withers at *cwithers@nationalboard.org*. ❖

History Lesson

The National Board is looking to strengthen its resource library. In particular, we are looking for donations of historical reference books about the boiler and pressure vessel industry. If you own and are no longer using these materials, please consider adding your name to our honorary list of donors. If you have a donation, please contact Clarice Billy at 614.888.8320, ext. 254, or by email at *cbilly@nationalboard.org*. ❖

Small Print, Big Picture

The National Board has maintained a position since the inception of registration: authorized inspectors may list their National Board commission number (plus endorsements, if any) only on manufacturers' data reports for items actually registered with the National Board.

With new inspectors constantly joining the ranks of National Board commission holders, this bears repeating.

An easy way for an authorized inspector to remember this requirement is to look for a National Board number on the data report he or she is about to sign. If a National Board registration number is listed, then the authorized inspector must list his/her National Board commission number and endorsement. If no National Board registration number exists on the data report, then the use of the authorized inspector's National Board commission number is not permitted. ❖

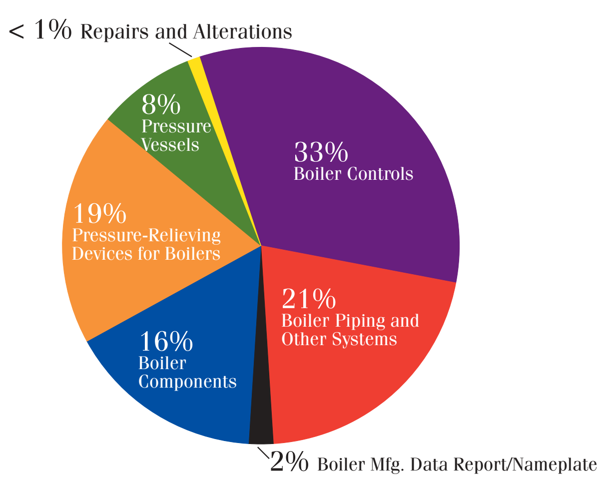
2002 Report of Violation Findings

The Annual Violation Tracking Report identifies the number and type of boiler and pressure vessel inspection violations among participating member jurisdictions. The National Board of Boiler and Pressure Vessel Inspectors releases this report for the year 2002.

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

Annual Report 2002

Category	Number of Violations	Percent of Total Violations
Boiler Controls	12,017	33%
Boiler Piping and Other Systems	7,751	21%
Boiler Manufacturing Data Report/Nameplate	785	2%
Boiler Components	6,076	16%
Pressure-Relieving Devices for Boilers	6,858	19%
Pressure Vessels	2,999	8%
Repairs and Alterations	232	< 1%



Summary for 2002

Number of jurisdictional reports:	308
Total number of inspections:	430,629
Total number of violations:	36,718
Percent violations:	9%

A Study in Failure – Taking Pressure Vessels to Burst

By Zachary Quandt, P.E., Maurice Cain and Bob Webb

Video footage of a deliberate pressure vessel burst in Virginia.

Most people wouldn't want to be anywhere near a pressure vessel during a catastrophic failure. But Zachary Quandt, Maurice Cain and Bob Webb are not like most people. The engineers deliberately brought 19 pressure vessels to failure — and then methodically recorded the results in The Pressure Vessel Burst Test Study *and* Pressure Vessel Hazard Assessment Workbook. *Their work with General Physics Corporation — a performance improvement company supporting chemical, manufacturing, and government organizations around the world — brought them to the attention of clients such as the Air Force and NASA. What follows is their account of the vessel testing, conducted at a facility in Dahlgren, Virginia.*

Introduction

Both NASA and the Air Force contracted with General Physics Corporation (GP) in the early 1990s to conduct a series of full-scale pneumatic bursts of pressure vessels to derive the overpressure, impulse, and fragment velocities associated with the rapid catastrophic failure of pressure vessels.

The Air Force and NASA use a large number of high-pressure pneumatic systems at Cape Canaveral Air Force Station and Kennedy Space Center. In fact, it is common for these institutions to store gases in pressure vessels between 2,000 psig to 6,500 psig. The safety standard for these sites requires operators to establish processes to shield/protect launch site workers as well as national resources.

Background

Pneumatic explosion types (i.e., mechanical energy explosion types) were historically compared to TNT explosion types (i.e., heat energy explosion types) as the standard. Before the completion of the burst test study, the basis for establishing safe areas for pressure vessels was related to TNT equivalence.

Associating stored energy to TNT equivalence is a concern. Error sources include:

- Energy from detonations (heat energy) versus energy from mechanical explosions (pressure vessels)
- Instant release of gas from a point source, versus from a cylindrical shell
- Height of burst
- Variations between real gas properties and ideal gas properties
- Environmental conditions.

Table 1 — Vessel Dimensions						
Vessel Type	**Length (ft.)**	**Outside Diameter (ft.)**	**Volume (ft.^{3})**	**Material of Construction**	**Burst Pressure**	**LSCs* (ft.)**
Vessel 2-1	22	2	53	SA372	3,500 psig	7
Vessel PC	—	1.83	2.7	SS Kevlar	3,975 psig	6.5
Vessel 6A-1	22	3	53	SA516	3,280 psig	56
Vessel 6A-4	22	2	53	SA372	3,450 psig	96

*Linear-Shaped Charges

These variations result in either an increased cost to the government for unnecessary protective structures, or worse, an undersized system that places personnel, equipment and mission assurance at greater risk. The energy of explosion for a pressure vessel may be computed when considering the internal and ambient pressures, the vessel volume and the ratio of specific heats.

In many studies that address TNT equivalence, energy is based on ideal gas. As pressure increases above 1,500 psig, the errors introduced become larger. These errors have been well documented, and corrections can be made.[1]

Despite their historic use, many methods to measure released energy from pressure vessel failures have proven problematic. To examine these theories and make appropriate comparisons, GP took 19 pressure vessels to failure, using gaseous nitrogen, at pressures ranging from 1,475 psig to 7,125 psig. Due to the vast increase in stored energy in the pressure vessels, the Naval Surface Warfare Center (NSWC) in Dahlgren, Virginia, was selected as a suitable test arena with wide-open spaces, experience with explosive-handling and measurement, and test and video equipment.

Figure 1 — Vessels 2-1 and 6A-4 were both the same type of construction as shown above. Vessel 2-1 was split circumferentially in the center at a pressure of 3,500 psig. Vessel 6A-4 burst into 14 fragments when the two end caps were blown off, at a velocity of 500 feet per second.

Test Pressure Vessels

Three types of vessels were tested, with dimensions for each listed in Table 1. The first type shown in Figure 1 was provided by NASA. This type of vessel was fabricated by piercing/enlarging over a mandrel and stamped for a MAWP of 2,450 psig, per ASME Code, Sec. VIII, Div. I, Appendix 22. The pressure vessels varied in roundness and thickness, affecting early machining operations.

Figure 2 — Failure measurements were inconclusive for Vessel 6A-1, as shown above, because the linear-shaped charges did not hold their positions.

Figure 3 — Vessel PC, as shown above, was split horizontally, with the top fragment launched at a velocity of 978 feet per second.

The second type of cylinder shown in Figure 2 was fabricated specifically for burst testing by rolling the cylindrical section and welding on end-caps. Their function was to provide a variation in vessel geometry. The MAWP rating for these vessels was 1,770 psig, per ASME Code, Sec. VIII, Div. 1.

The composite spherical vessels of the third type (Figure 3) were composed of a cryostretched 301 stainless steel liner with Kevlar-epoxy overwrap, and were rated at 4,000 psi. NASA also provided these pressure vessels.

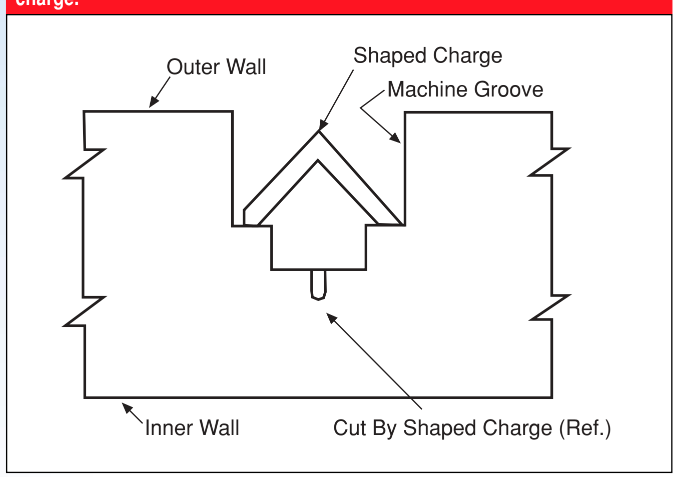
Test Setup/Design

Test pressure and fragmentation were both controlled with linear-shaped charges (LSC) in pre-machined grooves, minimizing the use of explosives. The goal was a small safety margin to the yield strength at burst pressure. When the shaped charge was detonated, the cut caused by explosives would not completely penetrate the vessel's wall, but would allow the internal pressure to increase vessel stress above ultimate. A diagram of the machined vessel wall with LSC attached is shown in Figure 4, where the LSC's direct high explosive energy is used to make a cut.

Test Plans

Test plans were written for all 19 tests, addressing variation of burst height (from 3.5 to 14 ft.), axial location of burst, and burst pressure (from 1,475 to 7,125 psig). Additionally, test plans addressed facilities/test needs such as: variations in pressure vessel diameters, materials

Figure 4 — Typical vessel cross section showing groove and shaped charge.



of construction (steel vs. composite), stresses in the shells, inspections, "groove" dimensions, linear-shaped charges, as well as site preparation of instrumentation, break-wire systems and recording systems (high-speed video). For brevity, this report will only discuss four of the 19 vessel bursts.

Nitrogen Pressurization System

A gaseous nitrogen system was designed for 7,500 psig output and was capable of local and remote operation. Test vessel pressure was read with a transducer and a gage at the pumping system for calibration between tests. The bunkhouse master gage read vessel pressure accurately under condition of no flow.

Test Site and Instrumentation

The NSWC arena consisted of an earthen semicircle with wiring installed beneath the surface for 96 locations (6 radii by 16 angles), as shown in Figure 5. Pressure transducer locations were limited to 48 and were selected as part of test planning. The sensing surfaces were installed flush with the ground surface.

Testing and Analysis

During the testing, pressure vessel halves, weighing up to 1 ton each, bounced along the ground for up to four seconds before reaching a final position (up to 1,644 feet away). However, high-speed data was recorded while the fragments traveled the first 30 feet. High-speed video (400 frames per second) and digital data systems were both started 15 seconds prior to burst.

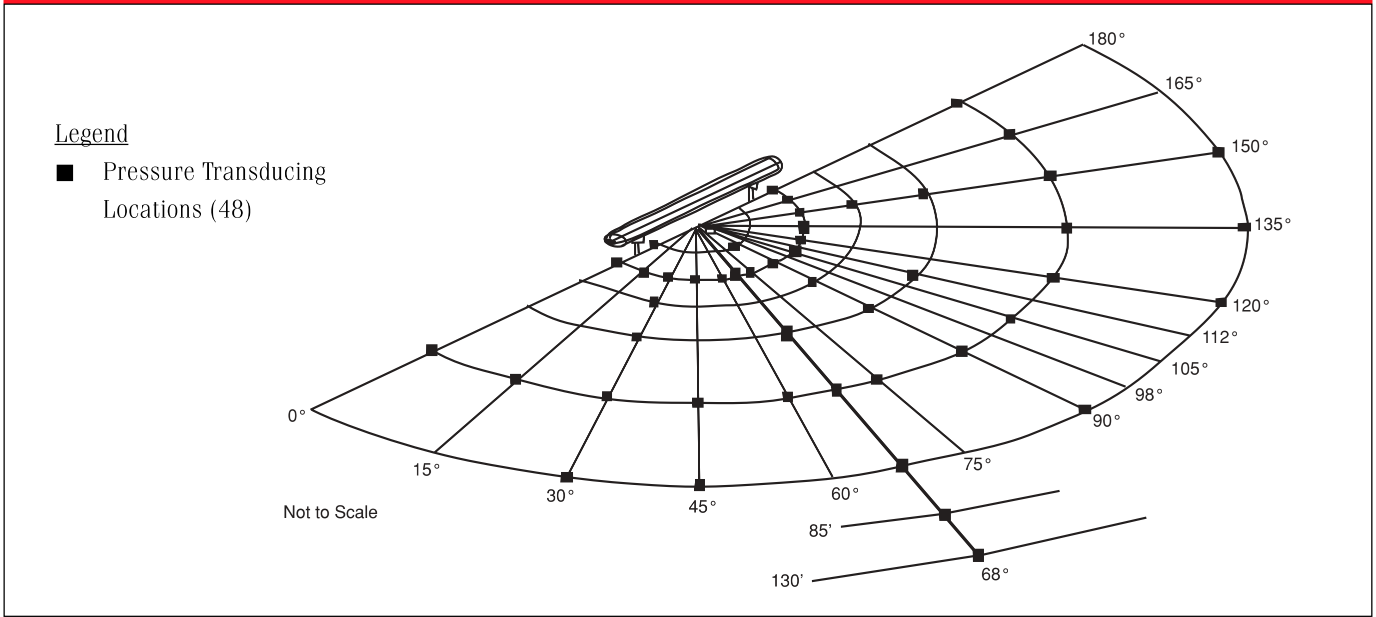
Vessel Test 2-1

Vessel 2-1 is one of a number of virtually identical vessels that were split circumferentially in the center at a nominal pressure of 3,500 psig.

Vessel Test PC (Preliminary Composite Vessel)

Spherical Vessel PC was split in the horizontal plane with the top fragment being launched vertically through a framework of break/wire grids. These grids were used to record fragment velocity of 978 feet per second. High-speed photography was also used and later analysis of the motion pictures provided a maximum fragment velocity of 889 ft. per second. The wire grid data is

Figure 5 — Diagram of pressure vessel test site in Dahlgren, Virginia.



believed to be the more accurate because the overwrap "fluffed up" when the overwrap filaments were cut by the LSC. The white-painted overwrap then exhibited high drag characteristics, allowing the inner stainless steel liner to pass the outer overwrap. The liner was dark and could not be tracked. Little horizontal distance from ground zero was achieved with a vertical launch.

Vessel Test 6A-1

Vessel 6A-1 was intended to be a multi-fragment test with two end-caps being blown off as well as a number of side fragments. However, the LSCs were not accurately held in position prior to detonation, resulting in insufficient depth of cut prior to the end-caps blowing off and relieving the internal pressure.

Vessel Test 6A-4

Vessel 6A-4 was a multi-fragment burst with a 2 ft. diameter vessel. After the marginal success of Test 6A-1, the longitudinal-shaped charges were painstakingly placed in position with depth micrometer measurements being taken and the angles tightened against the shape charges to help hold them in place. As a result, two end-caps plus 12 sidewall pieces were found after the burst. All the charges caused failure at the grooved areas. The bottom fragments were driven down and wrecked the support stand. The other sidewall pieces were found an average of 740 ft. away. Very few of the sidewall fragments were visible because of the condensation cloud. Of those that could be seen, the fastest initial velocity measured was 500 ft. per second.

Blast Overpressure Model

As expected, the field data collected over the various 19 bursts resulted in a series of data, distributed with upper and lower boundaries and measurable scatter factor. *The Pressure Vessel Burst Test Study* discusses in detail the results of the testing and provides graphs, charts, and figures of the data collected. The study also analyzes different forms of measuring released energy from pressure vessel bursts and compares them with TNT equivalencies. The methods include one-dimensional hydrocode calculations and Hopkinson's scaling. (Hopkinson's scaling occurs when data is scaled by dividing distance by cube root of TNT equivalence in pounds. The overpressure is never scaled.) Results showed that for the vessels tested, TNT overpressure calculations are greater than any of the actual pressure bursts in the near field and less than actual pressure bursts in the far field.[2] All results were computed using the program *Blast* from the *Workbook*.[3]

Conclusions

A pneumatic burst of a pressure vessel can hurl fragments at high speeds for great distances. Vessel 6A-4 burst into 14 fragments and therefore had a large vent flow, but differed from the spherical assumptions inherent in both the TNT and one-dimensional hydrocode calculations. Therefore, overpressure was less than predicted. The center-split cylinder, Vessel 2-1, had the least vent flow, and therefore the least overpressure. Meanwhile, Vessel PC, the spherical/lightweight pressure vessel, came closest to the TNT-equivalent model.

Since the original testing with gaseous nitrogen, bursts with other gases have been modeled with correction factors added for specific heats. The Air Force uses the information to assist in the quantity/distance analysis performed when locating pressure vessels and establishing safe areas around workers and national resources. ❖

About the Authors —

Zachary Quandt, P.E. is director of southeast operations for General Physics Corp. Mr. Quandt has provided mechanical integrity services to a number of commercial and government organizations across the United States, including NASA and Cape Canaveral Air Force Station. GP holds a Certificate of Authorization for repairs and alterations to pressure vessels under the *National Board Inspection Code*. **Maurice Cain** is an engineer for GP, and **Bob Webb** is an independent consultant.

Complete burst test study results can be found in *The Pressure Vessel Burst Test Study and Pressure Vessel Hazard Assessment Workbook* available through General Physics Corporation, at www.gpworldwide.com/burst-test/.

Endnotes —

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2 45SPW-TR-96-01, *Pressure Vessel Burst Test Study*, November 1996.

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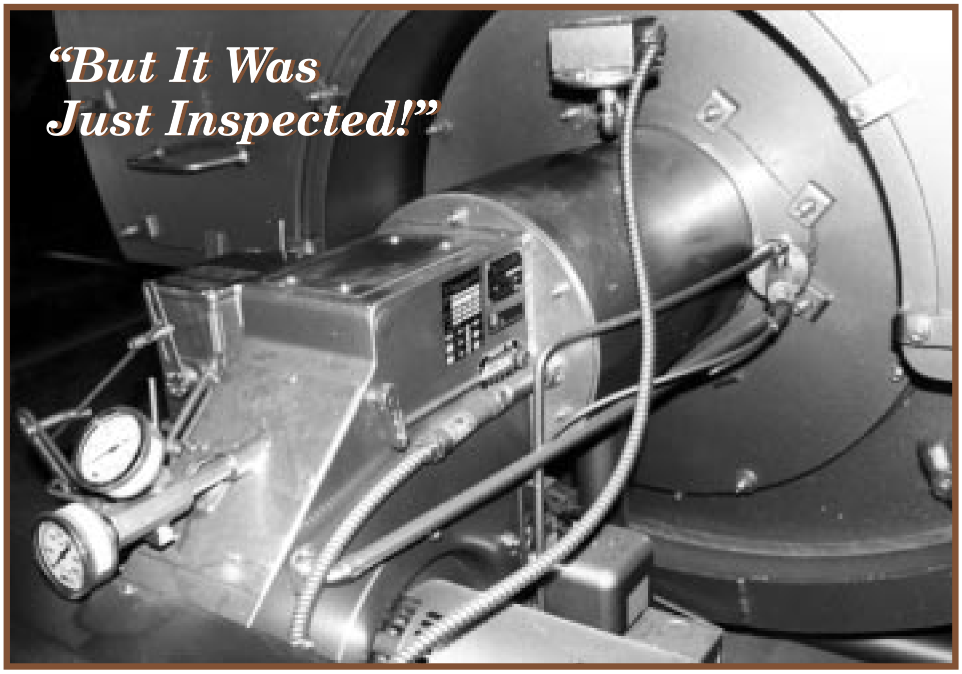
Before and After the Inspection *(The Rest of the Safety Story)*

By John R. Puskar, P.E., Principal, Combustion Safety Inc.



B *"But it was just inspected!"* is a desperate attempt to suggest that everything humanly possible was done to avoid a boiler or pressure vessel incident, after the fact. Few would dispute the vital role boiler inspection has played throughout modern history in ensuring public safety. Nonetheless, jurisdictional boiler inspection is not a "magic bullet" or armor shield. Jurisdictional inspections occur every one or two years and are an evaluation of the equipment at that moment in time, i.e., a "snapshot." Mandated inspections alone are not enough to protect any company's most important assets — *the lives of the employees*. The boiler owner must supplement periodic jurisdictional inspections every day.

Some companies now have combustion equipment safety programs that go well beyond the minimum, legally mandated requirements. These safety programs include a detailed check of combustion systems. This usually includes an analysis for code compliance, installation deficiencies, interlock testing, screening for maintenance practices that may have an impact on safety, and assessing technological advances that can improve safety.

Most facilities, however, do not have personnel properly trained in combustion equipment maintenance, start-up or shutdown procedures, and/or equipment operations. Most sites also do not follow proper interlock and safety testing guidelines even though they are mandated by law.

Boiler safety laws passed by a number of states hoped to help this. In most states these laws call for inspecting, but not testing, only the pressure vessel part of each boiler system. In 29 states, ASME CSD-1 has been adopted, mandating actual operational combustion safety systems training. In these states, jurisdictional inspectors ask to see evidence of gas train and safety interlock testing. However, it is outside of their work scope to actually perform this testing.

"Grandfathering" Old Equipment

Jurisdictional inspectors often have their hands tied when it comes to what they can ask an owner/user to do. What they are inspecting for is often limited by exactly the letter of the law. Although sometimes equipment can be updated to meet current codes (i.e., burners can be updated to CSD-1 in some jurisdictions), more often than not, owner/users can only evaluate equipment for its compliance with the code in effect at the time it was installed.

There's typically no screening for how far away from the most recent codes the old "grandfathered" technology is. This kind of inspection sometimes means that you could be technically "in compliance," even with archaic and antiquated equipment that is 50 or more years old. This could be equipment that requires many manual steps to operate safely and puts your site at serious risk of improper manual start-up or shutdown daily. Such equipment may be nowhere near current codes' level of safety.

Consider also that unless you are in an ASME CSD-1 jurisdiction, inspections rarely address gas trains and/or fuel system issues. Interlock testing is usually assumed to be a responsibility of the owner. Yet interlocks are among the most vital safety components available for ensuring that your systems work safely.

What Is Interlock Testing? Why Does It Matter?

Burning fuel is useful as long as it is accomplished through a controlled process. Control means that combustion takes place where we want it, when we want it, and at the rate we want it.

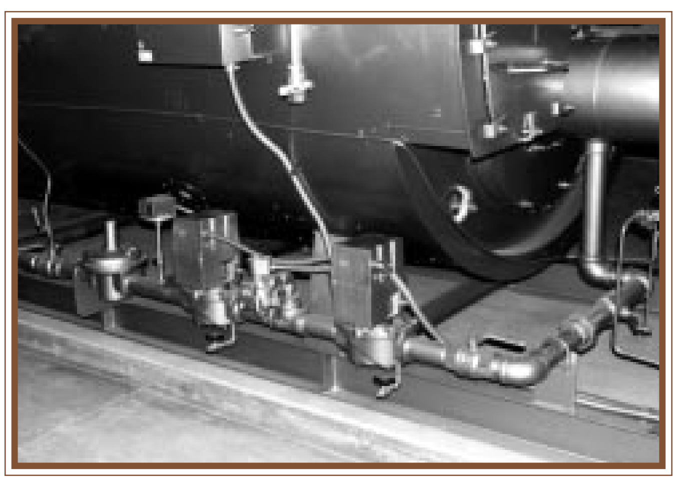
Gas trains keep gas out of the combustion chamber when no combustion is taking place through a series of tight, specially designed shut-off valves that are spring-loaded to close. These are the safety shut-off and blocking valves. Larger gas trains require dual valves. Some also have a vent between these for added safety. The specific configuration that you have depends on your insurance and local code requirements.

Gas trains also have a number of components designed to ensure that safe light-offs take place and that shutdowns occur immediately if anything goes wrong during the operation of the equipment. These components usually include a series of pressure switches that sense when gas pressures being sent to the burner are too high or too low. They typically also have switches to make sure that airflows are correct for purging residual combustibles prior to light-off, and that airflow is correct during operation.

Flame-sensing safety components ensure that flames are present when they are supposed to be present and not present at the wrong time.

Other components check that the fuel valve is at low-fire position prior to light-off. Depending on the type of equipment, there may also be furnace pressure switches, high temperature limits, and/or water level cut-outs.

All of these components are logically linked, or interlocked, to a burner management system controller, or BMS. The BMS is the brain that supervises and sequences all of the light-off efforts and monitors the combustion process. BMS systems manage the timing and adequacy of



the purge prior to light-off and the time intervals allowed for getting pilots and main flames lit.

All of this equipment is supposed to be checked on a regular basis by law, but with maintenance budgets among the first to be cut, proper checks and testing may not be performed. Codes and manufacturers define what these frequencies are for different types of equipment. Frequencies of required testing range from daily for some items like observing flames, to annually for some block-and-bleed valve tightness testing requirements. It is in this frequency area that we find many problems in industry today.

Often, owners/operators are not aware of regular testing requirements as specified by various codes. Most sites assume some level of testing semi-annually or annually. The level of comprehensiveness varies, however, depending on who is in charge and that person's knowledge of the equipment or systems.

The thoroughness of testing may also depend upon the age of the facility and its combustion equipment. Let us look at the case of a new facility just being built and this same facility after it has been in operation for a year.

New Facility

Consider a new facility being built to include gas-fired process equipment and a heating system that includes a boiler.

Perhaps the project was conceived and directed by someone on your corporate staff. It may give you an underlying sense of confidence to think that degreed professionals designed the facility. The plans were then most likely reviewed by a number of people, including the city's building department, the local fire department, an architect, and an insurance company representative. A licensed contractor probably installed the equipment. You may expect to rest peacefully knowing that probably a dozen skilled professionals have reviewed and approved everything about the installation.

But all may not be well. Here are some disturbing issues about this scenario.

A. City Building Departments

City building departments often farm out the review of plans to architects or engineers since they usually do not maintain staff for large projects. Typically, the city building department inspector looks for very significant local code-related issues. This is most likely not a detailed examination of how your system was selected or installed and it has *nothing* to do with how it is operated.

B. Corporate Project Engineering Staffs

Having been a corporate staff engineer for a major oil company, I know that we relied on specialized consultants to advise us on equipment selection. In most cases the firms we used relied on vendors to tell them what they needed. This information was translated to drawings and a conceptual specification was generated. Rarely did this level of design include detailed gas train piping drawings and wiring schematics.

If the design process works correctly, a selected vendor provides detailed drawings for insurance approvals. This is then followed by a very detailed and thorough commissioning at the site to verify that all was installed and working properly. If these steps happen, then you are likely to be starting off with a very safe site.

C. Project Architects

Architects receive little or no formal training in building mechanical or combustion systems. It is simply not in their scope. Most likely they will rely on the city's code officials, a hired consulting engineer, and/or a contractor or vendor for combustion system design.

D. Project Managers

These are usually general contractors hired to be "schedule and budget" people. Once again, it is not typically in their scope of work to spend much time or effort focused on meeting fuel, combustion, or boiler safety codes.

E. Insurance or Mandated Jurisdictional Inspectors

In many cases, jurisdictional inspectors have their hands tied. They are only supposed to review pressure vessel and piping issues including air tanks, water tanks, and boilers. Their responsibilities do not include system issues such as the gas piping at the site, the gas train component settings, control logic, and/or the burner flame pattern.

F. Local Fire Departments

Rarely does a fire department have a boiler or gas equipment expert on its staff. Obviously, the majority of a fire department's training program is devoted to fire-fighting technology and issues, like sprinklers, firewalls, and alarms.

So where does that leave us? It makes for a case where many people may have looked at or in some way have been involved in our new combustion equipment installation, yet no one may have specifically been focused on combustion safety or fuel system-related issues.

Same Facility, a Year Later

Let us assume that you ended up with a properly installed and commissioned system. Who is now qualified to operate and maintain the equipment?

Operations and the human element are the biggest safety issues. The National Board of Boiler and Pressure Vessel Inspectors' statistics for boiler and pressure vessel incidents from 1992 through 2001 show that 60% of all deaths, 69% of all injuries, and 83% of all accidents are caused by human error or poor maintenance [National Board Incident Reports].

The day after the consultants, vendors and inspectors have blessed your site and left, one person and a well-placed screwdriver can reduce your building to rubble.

Codes offer very little specific direction in the area of owner/operator training. Section VII, Subsection C2.110, of ASME International's *Boiler and Pressure Vessel Code* states, "Safe and reliable operation [of boilers] is dependent . . . upon the skill and attentiveness of the operator and the maintenance personnel. Operating skill implies knowledge of fundamentals, familiarity of equipment, and a suitable background of training and experience. Regularly scheduled auto-manual changeover, manual operation, and emergency drills to prevent loss of these skills are recommended." Unfortunately, this kind of important training, especially mock upset, troubleshooting or emergency training, is mostly ignored.

Other codes not related to boilers, such as NFPA 86 1-5.1 – 1-5.5, require that "all operating, maintenance, and appropriate supervisory personnel shall be thoroughly instructed and trained under the direction of a qualified person(s) . . . and shall receive regularly scheduled retraining and testing." This same code also states that operator training "shall include the following, where applicable: combustion of fuel-air mixtures, explosion hazards, sources of ignition including auto-ignition, functions of control and safety devices, handling of special atmospheres, handling of low-oxygen atmospheres, handling and processing of hazardous materials, confined-space entry procedures, and operating instructions."

Many facilities assume combustion safety training is something that happens on-the-job in an informal sense.

So Far We're Running Safely, But . . .

Deterioration happens with age. Dirt accumulates in parts of the burner from the combustion air taken in. Maybe the boiler water treatment has not been stellar, so some sludge has accumulated in places. Perhaps you smell gas occasionally when you stand in a certain place.

Other examples of possible operational issues which warrant further investigation, at the minimum, include:

1. During rounds you see what appears to be a slight wisp of steam coming from a small crack near the manhole cover of the boiler mud drum.
2. You keep getting low-water alarms on a regular basis.
3. There appears to be a blackish haze coming from the stack of one of your boilers.
4. You notice paint peeling from the sidewall of a boiler.
5. The feedwater line appears to regularly be swaying where it didn't use to.
6. During a trip to the roof you thought you smelled gas.
7. One of the relief valves seems to be weeping through.
8. During boiler light-off you hear a "whoomp."

These are all examples of possible operational or maintenance issues that could spell trouble for you and your site. Specific and regular maintenance of certain sized boilers and their components is an owner/user responsibility and is mandated by safety codes in many, but not all, states, provinces and cities. These safety requirements do not cover all boilers, making it even more incumbent upon the owner to ensure regular maintenance and testing.

Gas Explosions Can Be Avoided

Fuel gas and combustion equipment safety continues to be a "black art" among industrial users. Personnel are often not adequately trained in either the safe start-up/shutdown of equipment or its proper testing and maintenance. One survey of industrial users found that less than 10% actually perform manufacturer or code-recommended preventive maintenance, including testing of critically important safety interlocks. The combination of these two circumstances can spell disaster, and in numerous facilities, it has.

When assessing your site's circumstances, consider the following:

1. <u>Most explosions and fire incidents are due to human error.</u> All of the safety and interlock equipment in the world will not help if someone in your facility attempts to short-circuit or jumper-out safety controls. There is no substitute for proper training on the safe operation of combustion equipment.

2. <u>Start-up and shutdown are your biggest risks.</u> You need well-written, clear procedures, so that everything is very simple and straightforward.

3. <u>Make sure that you perform regular and complete interlock testing.</u> Jurisdictional inspectors cannot be at your facility every day. Combustion safety and testing need to be part of your organization's culture.

It may require much initiative on your part to change your company's combustion safety culture. In the beginning, you will probably hear such comments as, "Gee, we've been doing it this way for years."

But the bottom line is that implementing comprehensive combustion equipment safety programs saves lives. ❖

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From the *Sultana* to Medina, the Whole Nine Yards —

9 Nine Boiler Accidents That Changed The Way We Live

By Margie L. Emigh
Communications Coordinator

There was a time in 1865 when Thomas B. Reeves surely considered himself a lucky man. A Union Army lieutenant, he had survived internment at the notorious prisoner-of-war camp in Andersonville, Georgia, a place where thousands of other POWs had died as a result of malnutrition and disease. Now, he just wanted to return home. It had been a long war.

The year was 1933. Virginia farmer Zeke Kelly was simply going about the daily business of owning a farm. He and 15 other local men had taken their corn to Earl Breeding's gristmill for grinding.

Fast forward 70 years later. Eighteen-year-old Bryan Hammond was enjoying a typical summer day in northeast Ohio. His boss loved antique tractors, and Mr. Hammond had volunteered to assist his employer with an antique steam tractor at the county fair.

On the surface, the lives of these three men seem to contrast more than converge — a 55-year-old farmer who had marked the major passages of his life by a season's harvest; a young man with most of his life ahead of him, looking forward to an upcoming marriage; and an army officer who had no doubt witnessed some of the worst examples of human suffering during a war that divided a nation.

However, history brings them together through a common legacy: each died from injuries sustained during boiler accidents. Lt. Reeves was a victim of the *Sultana* steamboat boiler explosion of 1865, while Mr. Hammond lost his life as a result of the 2001 Medina steam tractor explosion — both accidents well known and widely followed in the industry. Zeke Kelly, on the other hand, was one of three victims claimed by a small yet equally catastrophic boiler explosion at a Virginia gristmill.

The seeming randomness of such accidents serves to underscore the point that tragedy can occur at any time, to anyone who is simply in the wrong place at the wrong time. After all, who would think that attending a county fair could lead to death? Or going about the simple day-to-day activities of one's occupation, such as taking crops to the local mill? And while the industry has come a long way in terms of improvements in the practice of equipment inspection (sometimes as a direct result of boiler accidents), the Medina catastrophe — which occurred on July 29, 2001 — reminds us that such tragedies are not simply a legacy of the distant past, and that danger lies in complacency.

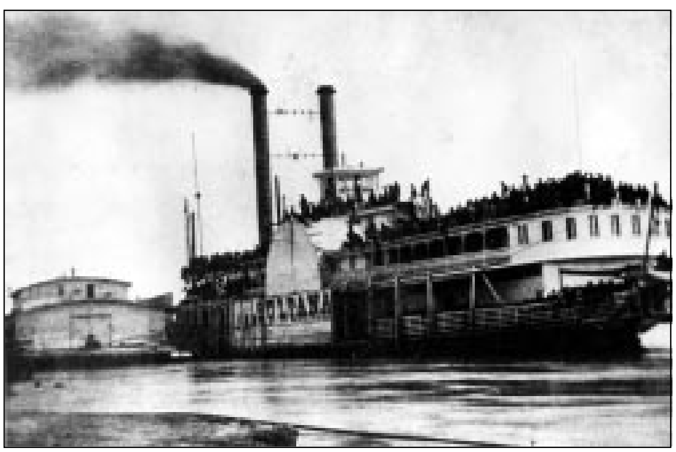
That is why the National Board has undertaken the daunting task of ranking the most notable boiler accidents of our time. With more than 25,000 accidents occurring in the last ten years alone, not to mention the almost daily accidents that occurred at the turn of the 19th century, the work was cut out for us, to say the least. Some accidents immediately stood out due to their extreme destructive force and resulting loss of life, while others affected the public in a more indirect manner, and the impact was only seen and felt years later.

1

Hartford Fales and Gray Car Works, Hartford, Connecticut — This explosion occurred on Thursday, March 2, 1854. Nine people were killed instantly, and several more died later, as a result of injuries sustained when an unattended boiler failed catastrophically. Several rumors circulated about the specific cause of the accident, one account going so far as to claim the operator left the boiler unattended to get a beer. Regardless, a total of 21 people lost their lives in the accident and an additional 50 were injured. It was widely reported at the time that the accident would never have occurred if the boiler had been equipped with a fusible plug or a properly functioning pressure relief valve.

Despite the tragedy, this accident left a vital imprint on the boiler and pressure vessel industry. As a result, several men interested in science in general and steam safety in particular founded the Polytechnic Club of Hartford. Though the group was disbanded a few years later at the start of the U.S. Civil War, the idea of combining inspection and insurance together was first germinated here.

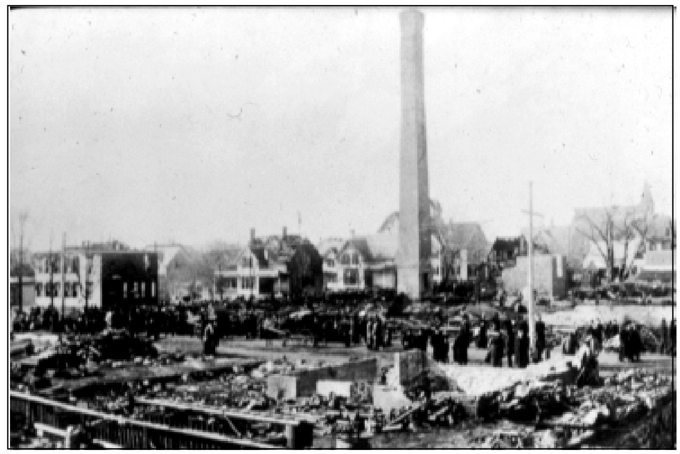
***Sultana*, on the Mississippi River, outside Memphis, Tennessee** — Most people in the industry are familiar with the tale of this most infamous of boiler explosions. For those who aren't, this important story can't be repeated too often. The year was 1865 when the steamboat *Sultana*, carrying a load of approximately 2,000 people, left Vicksburg, Mississippi, transporting many surviving Union soldiers who were returning home from the war. Several problems plagued the steamer from the moment it left port, among them extreme overcrowding (the normal carrying capacity was 300 passengers) and boilers in a state of disrepair.



Finally, on April 27, 1865, one of the steamer's boilers exploded just outside of Memphis, resulting in the death of approximately 1,800 people. Although at the time it was clearly the worst disaster in recent memory, it was largely ignored by the general public, due to competing news events such as the assassination of President Abraham Lincoln and the daily accounts of horrors which emerged from the Civil War. That's not to say the awful accident didn't leave an indelible mark on the world.

"The *Sultana* is really what started our whole industry in motion," says Bob Schueler, senior staff engineer of the National Board. In fact, immediately after the terrible accident, two former members of the disbanded Polytechnic Club of Hartford founded Hartford Steam Boiler Inspection and Insurance Company.

Before and after photographs of the Grover Shoe Factory boiler explosion that leveled the building and killed 58 people on March 20, 1905, in Brockton, Massachusetts.



Grover Shoe Factory, Brockton, Massachusetts — Though not as well known in industry circles as the *Sultana* disaster, this March 20, 1905, accident contained just as much deadly force. Another instance of a boiler left unattended, the unfortunate result was an overheated boiler that exploded and tore through the roof of the four-story shoe factory, killing 58 people. This extreme example of the destruction that can be caused by steam is illustrated in stark before-and-after pictures showing the leveled building. As a direct result of the accident at the Grover Shoe Factory, Massachusetts enacted the most rigid boiler inspection laws in the country to date.

4

American Sheet and Tin Plate Company, Canton, Ohio — Of the seven boilers in the complex at American Sheet and Tin Plate, three failed simultaneously on May 17, 1910. The remaining four were knocked from their foundations due to the force of the explosion. With 100 workers in the area at the time of the afternoon blast, local newspapers reported a gruesome scene. Fragments of the factory were blown 600 feet to the north and body parts were strewn about. In fact, one body was actually forced through a man's home, coming out the other end and landing on a fence. Death toll estimates ranged from 15-17, with an additional 50 people injured. The blast was costly not only in terms of loss of life, but also because the company promised to pay all hospital expenses for the wounded as well as for families of the dead. The accident occurred when an operator noticed a low-water reading and added cold water to the boiler.

Again, it took a tragedy to bring about necessary legislation. Ohio had no boiler laws on the books at the time, and was widely reported to be a dumping ground for old boilers from surrounding states. One year later, a boiler inspection act was passed in the Ohio General Assembly and signed into law the following year. Two years later, in 1913, the Industrial Commission of Ohio was formed, which still exists today.

Where the boiler of the New York Telephone Co. came to rest after traveling approximately 120 feet.

New York Telephone Company, New York, New York — Another workplace tragedy, this October 3,1962, boiler accident left 23 dead and 94 injured. The failed boiler was a low-pressure type, and weighed seven tons empty and 11.5 tons with water. Like many previous accidents, the initial focus on the cause of this tragedy was the boiler operator, who reportedly started the boiler, then left the building to have lunch.

However, the boiler operator had several other factors working against him that October day. Three different safety systems were not operational. First, the operator started the boiler with the shutoff valve in the header closed. Second, a mercury switch had not been attached to the master board, inadvertently unplugged by a maintenance worker. Third, a pair of safety valves on top of the boiler apparently did not function when they exceeded pressure limits.

Regardless of the cause, the outcome was disastrous. The force of the explosion propelled the boiler forward about 120 feet, through two concrete walls, killing and disfiguring employees who were dining in the nearby cafeteria. Out of the wreckage of one of the most deadly boiler accidents of the time, New York enacted a low-pressure boiler law.

Gate City Day Care Center, Atlanta, Georgia — A place of employment for one victim, the Gate City Day Care Center was simply a place of play for four other victims, preschool-aged children who died when a cast-iron boiler exploded on October 13, 1980. The explosion occurred less than an hour after the boiler had been started for the first time during the heating season. Reports indicated the boiler was only partly filled with water, and that the low-water burner cutout control had been wired out of the circuit, thus rendering it ineffective.

The tragic death of one adult and four children (not to mention the seven other children who were seriously injured) certainly caught the attention of Georgia lawmakers, as the terrible accident became the driving force behind Georgia's passage of a boiler and pressure vessel act in 1984.

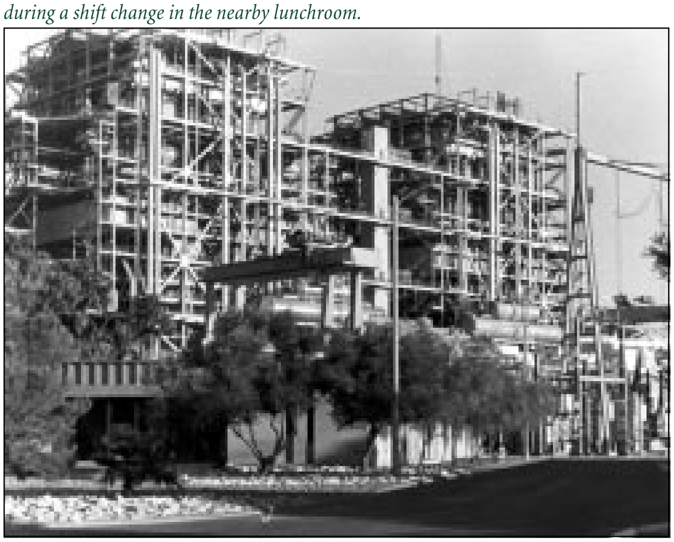
7

Star Elementary School, Spencer, Oklahoma — Any boiler accident has the potential for fatalities, but on the afternoon of January 19, 1982, one of the most tragic explosions in recent memory occurred. Six children and one adult were killed instantly, and an additional 42 other people were injured, when an 80-gallon water heater exploded at Star Elementary.

The water heater, located in the cafeteria kitchen, had been in a state of disrepair for at least three years. The controls showed evidence of tampering, the temperature probe had been removed, and the pressure relief valve was improperly installed. Oklahoma's boiler and pressure vessel law, like New York's before 1962, only covered high-pressure boilers. Therefore, the school's water heater was exempt from inspection.

Again like New York, the tragedy of Star Elementary led to the passage of more stringent laws. In fact, nine months later, the Oklahoma legislature passed broader safety laws governing water heaters and heating boilers of all types, as well as providing for annual inspections.

Six workers were killed and 12 were injured when a hot re-heat pipe ruptured at Nevada's Mohave Generating Station in 1985. Most of the victims were killed or injured during a shift change in the nearby lunchroom.



Mohave Power Plant, Laughlin, Nevada — Though not a boiler explosion in the technical sense of the phrase, the rupture of a hot re-heat pipe at the Mohave Generating Station, nonetheless, had a lasting impact on the boiler and pressure vessel industry. Six workers died and 12 were injured on June 9, 1985, when the 30-inch-diameter pipe ruptured without warning, creating a 6' x 8' fishmouth opening, larger than the size of an average human being! Those killed were caught by the sudden release of 600 pounds of steam pressure (reaching temperatures up to 1,000 degrees F.), which struck them as they were changing shifts in the area of the lunchroom and control room, about 30 feet away.

Several explanations have been advanced as to the cause of the accident, including problems with welding of the rolled pipe, as well as creep failure. Regardless of the cause, the end result was not only tragic but costly, resulting in approximately $100 million in property damage to the power plant structure.

However, the implications reached far beyond costs at Mohave. Due to the large size of pipes that were needed, the facility employed rolled pipe welded on the longitudinal seam. When the pipe ruptured along that longitudinal seam, it was one factor that caused power plants across the United States to re-evaluate their piping systems (many of which were identical to the system used at Mohave). Though there were a handful of other similar explosions at power plants, none had caused the level of destruction witnessed in Nevada.

Medina County Fair, Medina, Ohio — Still in the forefront of industry consciousness after only two years, the antique steam tractor explosion at the Medina County Fairgrounds on July 29, 2001, is not likely to be forgotten any time soon. Five people died and another 48 were injured

The aftermath of a fatal antique steam tractor explosion which took the lives of five people and injured 48 at the Medina County Fairgrounds.

when an antique steam tractor catastrophically failed, lifting the 18-ton structure ten feet in the air and raining hot soot and shrapnel on a crowd of fairgoers, as well as engulfing those nearest the tractor in live steam.

In response to this tragic accident, the State of Ohio created an Historical Boiler Licensing Board and established licensing requirements for historical boilers. Though other jurisdictions have not yet followed suit, the long-term impact of this most recent boiler tragedy remains to be seen.

Conclusion

Though boiler accidents have been an unfortunate and common part of history ever since the Industrial Revolution of the 19th century, the proliferation of today's more stringent rules and regulations have helped to combat the frequency of such tragedies. Nonetheless, as the Medina accident illustrates, the potential for the kind of gruesome fatalities of yesterday still exists in today's modern world. An axiom that was true 100 years ago is still true today: disaster can strike at any time. In fact, many of the victims in the boiler accidents above were simply going about their daily lives, eating lunch, supervising children at play, or awaiting the start of a county fair.

Due to the past frequency of such tragedies, it is impossible to comprise an all-encompassing list of the worst boiler accidents ever. After all, even the smallest boiler accident, barely significant on a national or international scale, could be **the** most tragic if the victim is a loved one. The widow and children of farmer Zeke Kelly could have certainly attested to this fact, after the beloved husband and father died in a small boiler explosion at a Virginia gristmill.

Though the tragedies of the past are certainly difficult to evaluate, in each of the instances above, we can take at least some small comfort in the fact that the loss of life was not completely in vain. Out of the ashes of death and destruction arose necessary safeguards — and in some cases even legislation — to protect future generations from tragedy. ❖

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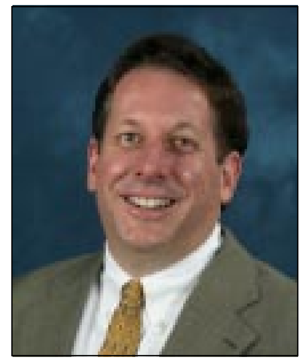
Cook Elected to Represent California

Donald C. Cook, principal safety engineer for the State of California, has been elected to the National Board. Mr. Cook has been employed with the California Department of Industrial Relations, Division of Industrial Safety and Health, since 1989. Previously, Mr. Cook worked as an engineer at Hopper Inc., from 1984-89.

Mr. Cook was graduated from the California Polytechnic State University at San Luis Obispo with a degree in mechanical engineering. He is secretary/treasurer of the California Boiler Inspector Association, and holds National Board Commission No. 11074 with "A," "B" and "N" endorsements. ❖



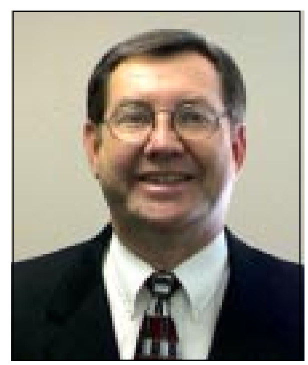
Donald C. Cook

Parks Elected to National Board Membership

Terry Parks, chief boiler inspector with the Texas Department of Licensing and Regulation, has been elected to the National Board. Mr. Parks has been employed by the department since 1996, first as a deputy boiler inspector and then in 2001, as an inspection specialist.

Prior to joining the Department of Licensing and Regulation, Mr. Parks served in the U.S. Navy for nearly 22 years, as a senior chief machinist mate. After naval service, Mr. Parks worked at Clayton Industries as a lead technician.

Mr. Parks is a certified team leader and holds National Board Commission No. 12337 with an "A" endorsement. ❖



Terry Parks

Elliott Named to Chair NBIC Committee

Robert M. Elliott of Eastman Chemical Co. has been named chairman of the *National Board Inspection Code* Committee. Mr. Elliott, who served on the NBIC Committee from 1987 to 2000 and again in 2002, replaces former chair George Bynog, retired chief boiler inspector of Texas.

Robert M. Elliott

Mr. Elliott was named NBIC chairman during the January committee meeting in San Antonio. He will serve a term of three years.

A former member of the National Board Advisory Committee from 1995 to 2000, Mr. Elliott has held a variety of positions at Eastman Chemical during his 34-year tenure, including as mechanical engineer — machine design, vessel specialist and vessel technology engineer. Currently, he is an engineering associate — vessel technology.

Mr. Elliott attended the University of Virginia at Charlottesville and was a commissioned ensign in the U.S. Naval Reserve, retiring in 1992 as captain. ❖

73rd General Meeting Call for Presentations

The National Board of Boiler and Pressure Vessel Inspectors, in conjunction with the ASME International Boiler and Pressure Vessel Committee, has announced a call for presentations to be delivered at the 73rd General Meeting, on May 10, 2004, in Nashville, Tennessee.

The General Meeting is conducted each year to address important issues relative to the safe operation, maintenance, construction, repair and inspection of boilers and pressure vessels.

To be considered, presentations should address one or more aspects of the aforementioned subject areas and be limited to no more than 30 minutes. Additional subject areas may include safety valves as well as other unit components, testing, codes and standards, risks and reliability, and training. Presentations of a commercial or promotional nature will not be accepted.

Those interested in submitting presentations for consideration should send a typewritten abstract of no longer than 200 words in English (do not include supplementary materials) to: Paul Brennan, Director of Public Affairs, The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229. Submissions may also be sent electronically via email to pbrennan@nationalboard.org. Submissions must be received by September 2, 2003.

For more information on submitting presentations for consideration, contact the public affairs department at 614.888.8320. ❖

The National Board Remembers John McLoughlin

The National Board regrets to announce the January 3 death of ASME consultant and former National Board Assistant Director of Inspections John D. McLoughlin. He was 63 years old.

John McLoughlin

Mr. McLoughlin began his 16-year career with the National Board as a consultant and team leader in 1980. Having attended Park College in Parkville, Missouri, he previously served with the U.S. Coast Guard and began working in the boiler and pressure vessel industry as an AI/technical consultant with Commercial Union. He subsequently lived in Japan while employed as an AI/code consultant with Royal Globe.

In 1981, Mr. McLoughlin was appointed National Board assistant director of inspections. In addition to being a commissioned inspector, he served on numerous ASME committees, subcommittees, working groups and subgroups. Mr. McLoughlin held National Board Commission No. 6257 with "B," "N" and "NS" endorsements and served as an ASME qualified team leader. He retired from the National Board in 1995 and went on to work as a consultant for ASME International.

"John McLoughlin was a tireless advocate of both the *National Board Inspection Code* and the ASME Code," remembers National Board Executive Director Donald Tanner. "His passing leaves a tremendous void in the boiler and pressure vessel industry."

Mr. McLoughlin is survived by his wife, Gene, and son, John III. ❖

National Board Mourns Death of Former Chairman Duane R. Gallup

The National Board is saddened to report the January 15 death of Duane R. Gallup, former National Board member and chairman of the Executive Committee. He was 79 years old.


Duane R. Gallup

Mr. Gallup served the National Board in several capacities, beginning in 1961 when he was elected to membership representing Illinois. He served on the National Board Executive Committee, which later became the Board of Trustees, from 1973 to 1983. He held positions as first vice chairman and second vice chairman before being elected chairman, a post he held from 1979 to 1981.

Mr. Gallup retired from service in 1986, and was awarded an honorary membership to the National Board that same year. During his tenure in the industry, he was instrumental in ensuring the passage of Illinois' pressure vessel law. At the National Board, he served on the ASME Conference Committee, the Executive Committee when the National Board's current headquarters was built, and as chairman in 1979, commemorating the 50th anniversary of the General Meeting.

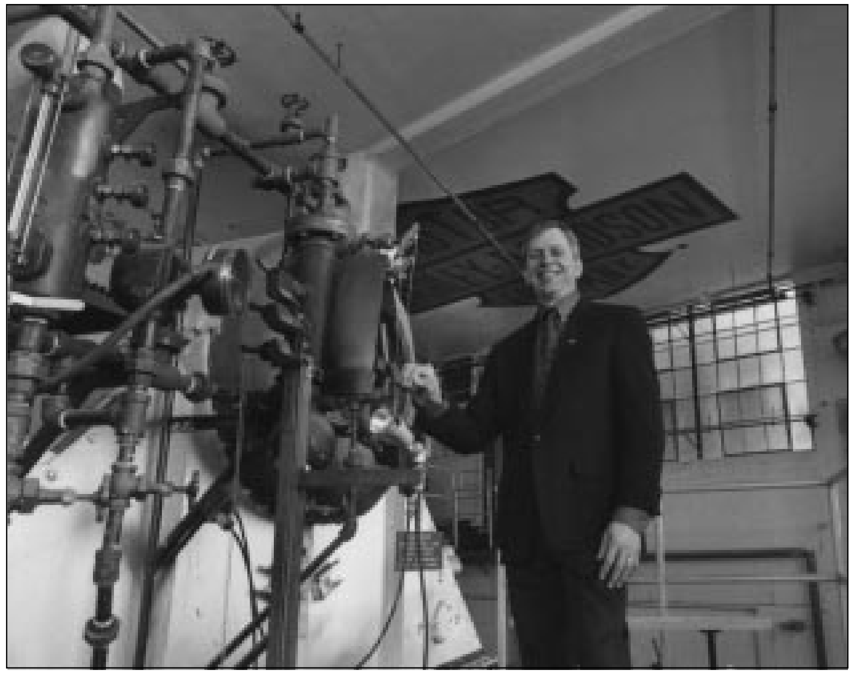
According to National Board Executive Director Donald Tanner, "Mr. Gallup was responsible for hiring a number of key officials in our industry, including Illinois Superintendent/Chief Inspector and National Board Chairman David Douin, as well as National Board Director of Inspections Vic Bogosian. Mr. Gallup's many contributions to the safety process will long be remembered."

Mr. Gallup held National Board Commission No. 3799, with "B," "N" and "S" endorsements.

Mr. Gallup is survived by his wife, Jean, as well as by his daughter and two sons. ❖

Michael J. Verhagen

Chief Boiler Inspector, State of Wisconsin



Wisconsin's chief boiler inspector is rather blunt when it comes to looking back at his life.

"If I had it to do all over again, I would probably have taken my education a lot more seriously while growing up," Mike Verhagen admits without reservation.

"Looking back at my formative years," he observes, "I can see how easy it was to be side-tracked with things that seemed important at the time." Like his passion for work and motorcycles. And the money he needed to accommodate his passion for motorcycles.

"I always enjoyed working," the state official explains. In fact, growing up in Appleton, Wisconsin, Mike had a role model who readily encouraged his burgeoning work ethic.

"My dad was a millwright . . . a real hands-on type guy," he recalls with a smile. "He could literally do anything. And that's why I enjoyed working around him, helping out and learning what I could." It was through his dad that Mike developed an appreciation for work, family, and motorcycles.

As with many kids, Mike's very first job was delivering newspapers at age 12. "Back then, I really had no interest in participating in sports or other activities unless it involved making money," he adds. A paper route and a job busing tables at a local restaurant allowed Mike to purchase his first motorcycle at the age of 16.

"Because I didn't want my parents to know," Mike fondly recollects, " I kept it at a friend's garage." It was the perfect arrangement until the friend's mother spilled the proverbial beans while speaking to Mike's mom one day. Confronted with his parents' discovery at a family gathering, the future state official was gratified to learn — after a lecture on responsibility and honesty — that he would be allowed to keep the motorcycle. On his way home less than an hour after visiting an insurance agent, Mike skidded and dropped the motorcycle to the pavement to avoid a collision with a car that pulled in front of him. The collision severely dented the young man's pride as well as his new transportation.

"My parents never found out about that incident although I was able to repair the cycle with money earned at an industrial laundry service where I worked part-time," he adds.

For Mike, the laundry company not only represented a paycheck but a prophetic look to his future. "It was where I got my first real exposure to boilers and welding," he explains.

Taking on the laundry job full-time after high school, Mike began thinking about career directions. For about half the residents of Appleton, that meant working at the area paper plants.

"Having just received my draft notice, there was also the option of going into the service," Mike adds. Less than a few months out of high school in 1972, he enlisted in the Navy after getting some advice from a cousin who just returned from the Vietnam conflict.

Heeding what he felt was wise counsel, Mike signed on with the Navy in an effort to see the world and travel during the ensuing four years. "I was told that I had a test score showing a 'high mechanical proficiency,'" the state official notes. In Navy parlance, that meant the future National Board member was about to become a machinist mate.

"My mechanical background made my job rather easy in the Navy," Mike freely admits. "As a matter of fact, I became quite good at power plant engineering." So good, it should be acknowledged, that the 21-year-old was frequently promoted and assumed responsibility for the forward engine room and training his shipmates. "I really loved the educational aspect of being able to share my knowledge," he adds.

Upon completion of his four-year commitment to the Navy and achieving the rank of machinist mate second class, Mike packed his gear and headed to the one part of the world he missed during his extensive travels with the Navy: California. Holding forth in Los Angeles, he decided that he wanted to pursue a new career in something other than mechanics.

But as economic reality set in, the Wisconsin official assumed a job at a metal fabricating plant. "It paid the bills and the four-day work week allowed me to devote time to my hiking, camping and dirt bike activities," he recalls.

It also allowed him to entertain the many California-bound friends and relatives who visited from Wisconsin. Like when his sister Sandy and her friend Kathy showed up "for a couple of days."

But days turned into months. It was during this time that Kathy and Mike became engaged and decided to marry and make their home in Wisconsin. Shortly after the wedding in December of 1977, Mike decided to attend the University of Wisconsin - Fox Valley on the G.I. Bill. Working part-time at a local grocery store, the state official became increasingly aware of his unstable financial situation and the need to expand his education — particularly in light of new family obligations.

"Because I didn't take high school seriously, I had to take some remedial courses in math," Mike reveals with a nod. "But I was finally able to get my associate's degree."

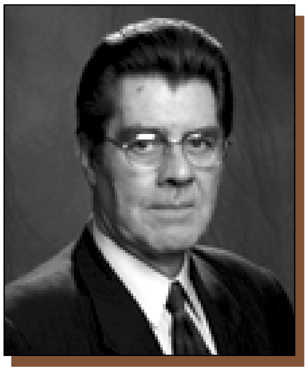
Deciding to parlay his hard-fought academic achievement into a four-year mechanical engineering degree, Mike moved Kathy and their two small boys to Milwaukee so he could attend the University of Wisconsin – Milwaukee. "Times were tough," Mike laments. "I took another part-time job while at college and as for Kathy — I couldn't have made it without her being with me every step of the way."

After two years, Mike came to the financial realization that he would have to suspend his academic pursuits in order to take a full-time job. Now with four children, he worked as a maintenance supervisor at a health care center for two-and-a-half years before landing a job in 1987 as a boiler inspector for the City of Milwaukee. Accumulating appreciable experience in refrigeration, welding, and boiler inspection for the city allowed him to assume the position of refrigerant handling program coordinator for the State of Wisconsin in 1991.

In 1996, Mike was appointed chief boiler inspector following the retirement of past chief inspector Virgil Kanable. With a staff of seven district inspectors, he presently oversees approximately 38,000 boilers, 20,000 pressure vessels and nearly 2,500 refrigeration units in Wisconsin. In addition, the boiler safety section is responsible for structural steel welding, liquid petroleum gas, compressed natural gas, anhydrous ammonia and liquid natural gas programs.

Ironically, for someone who failed to take his education seriously as a youngster, the adult Mike Verhagen derives great professional satisfaction from teaching. For the past 17 years, he has been employed as a boiler operator instructor at Milwaukee Area Technical College. "I've learned and experienced a lot since then," he notes with a wide grin.

But if there are any additional regrets of his youth, Mike says they don't apply to his passion for work and motorcycles. Especially motorcycles, as evidenced by the sleek, red Harley Davidson Electra Glide Ultra . . . proudly parked in *his* garage. ❖



The Results Are in: Pre-Commission Examination Course Makes the Grade

BY RICHARD MCGUIRE, MANAGER OF TRAINING

In the last issue of the *BULLETIN*, this column space was devoted to a class offered at the National Board for the very first time — the Pre-Commission Examination Course (PEC). As the name implies, this two-week, intensive course prepares students to take the rigorous National Board Commission Examination.

Now that the first Pre-Commission Examination Course has been completed, once again, this column space is being devoted to the same subject matter, for a very important reason. The results are in. Every student who took the February PEC passed the National Board Commission Examination!

It would certainly appear that students were pleased with the first PEC, given their successful test results. However, the National Board doesn't plan to take this first success for granted. That is why the Training Center is planning an in-depth telephone survey of students to find out exactly what areas of the first PEC best prepared them for the commission exam — and more important, what areas the Training Center can improve upon.

It's called Quality Assurance. And one of the ways the Training Center is constantly improving the quality of instruction for all courses, and particularly the Pre-Commission Examination Course, is through the use of experienced inspectors in the classroom. These experienced instructors share real-life situations and problems they have come across in the field, and then pass that knowledge on to students.

Another point that has helped ensure the success of the first PEC, and the success of the first group of students, is that the National Board does NOT teach the examination. All PEC materials deal exclusively with the body of knowledge required for students to become commissioned inspectors, instructing them so that they know how to use the necessary codes, and how to research problems and find solutions independently. Workshops are used to familarize students with how to solve problems by finding answers in the applicable code section.

An additional area in which the first Pre-Commission Examination Course would seem to be a success is in feedback. Specifically, students are given a mock commissioned examination, consisting of three two-hour sessions (as opposed to the complete examination, which is comprised of three four-hour sessions). The results are reviewed immediately after the mock test, to reveal any weak areas students may have, granting them instant feedback.

Though the results are in, and the inaugural PEC appears to have made the grade, the National Board isn't resting on laurels. Instant feedback through mock tests, experienced faculty instructors, and course material covering the body of knowledge for commissioned inspectors are all factors that have certainly made the first PEC a success. But the Training Center is taking it one step further by soliciting student voices to reveal what went well — and more importantly — what needs more work. After all, preparing students for real-world careers is what the Pre-Commission Examination Course is all about. And in the real world, hard work is the key to success. After all, you can't rest on reputation. ❖

For updates on the self-study portion of the Pre-Commission Examination Course, consult the Web site at nationalboard.org.

ENDORSEMENT COURSES

(A) **Authorized Inspector Course** (ASME Code Sections I, IV, V, VIII – Divisions 1 and 2, IX, X, and B31.1) — TUITION: $2,500

August 4–15

(B)
(O) **Authorized Inspector Supervisor Course/Owner-User Inspector Supervisor Course** (Duties and attributes of a supervisor) — TUITION: $1,250

August 18–22

CONTINUING EDUCATIONAL OPPORTUNITIES

(1-Day) **Data Report and *National Board Inspection* Code Highlights** — TUITION: $115

August 11 September 19

ASME Section IX — TUITION: $275

August 12 September 17

ASME Section VIII — TUITION: $275

August 13 September 18

Two one-day seminars or two participants earn 5-percent discount

(CWI) **Certified Welding Inspector Seminar** —
TUITION: $1,150 (all three seminars),
$375 Structural Welding (D1.1) Code Clinic
$440 Welding Inspection Technology (WIT)
$335 Visual Inspection Workshop (VIW)

August 4–8 (CWI Exam August 9)

Only time offered in 2003!
(IBI) **Introduction to Boiler Inspection** — TUITION: $2,500

July 14–25

New Course!
(PEC) **Pre-Commission Examination Course** — TUITION: $2,500

August 11–22

(R) **Boiler and Pressure Vessel Repair Seminar** — TUITION: $335

August 11–12

Only time offered in 2003!
(RTL) **Review Team Leader Seminar** — TUITION: $300

July 8–10

(VR) **Repair of Pressure Relief Valves Seminar** — TUITION: $1,250

July 28–August 1

(WPS) **Welding Procedure Workshop** — TUITION: $670

August 13–15

REGISTRATION FORM

Please circle the seminar/course(s) and date(s) you wish to attend. Please print.

☐ Mr. ☐ Ms. ☐ Mrs.

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ____________________

State/Zip ____________________

Telephone ____________________

Fax ____________________

Email ____________________

NB Commission No. ____________________

PAYMENT INFORMATION (CHECK ONE):

☐ Check/Money Order Enclosed
☐ P.O. # ____________
☐ Payment by Wire Transfer
☐ VISA ☐ MasterCard ☐ American Express

Cardholder ____________________
Card # ____________________
Expiration Date ____________________

HOTEL RESERVATIONS

The National Board recommends the Holiday Inn Worthington. The room rate is $85.00 plus tax. Reservations may be made via the Internet by visiting *holidayinnworthington.com* or by calling 1.800.HOLIDAY. Reference group code NBB.

All seminars and courses are held at the National Board Training and Conference Center in Columbus, Ohio, unless otherwise noted, and are subject to cancellation.

For additional information regarding seminars and courses, contact the National Board Training Department at 1055 Crupper Avenue, Columbus, Ohio 43229-1183, 614.888.8320, ext. 300, or visit the National Board Web site at *nationalboard.org*.

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* Feature Article

National Board Bulletin Index By Author

Postcard From Home

Contemplating the Wreckage . . .

A young man strikes a pose similar to Rodin's "The Thinker," as he stands precariously close to the remnants of a boiler shell that has failed circumferentially. Atop the shell of this riveted HRT boiler sits a weighted-lever safety valve, predating the spring loaded varieties with seals, which if broken, reveal tampering.

Know anything else about this postcard? Email getinfo@nationalboard.org. ❖