SUMMER 2016

BULLETIN

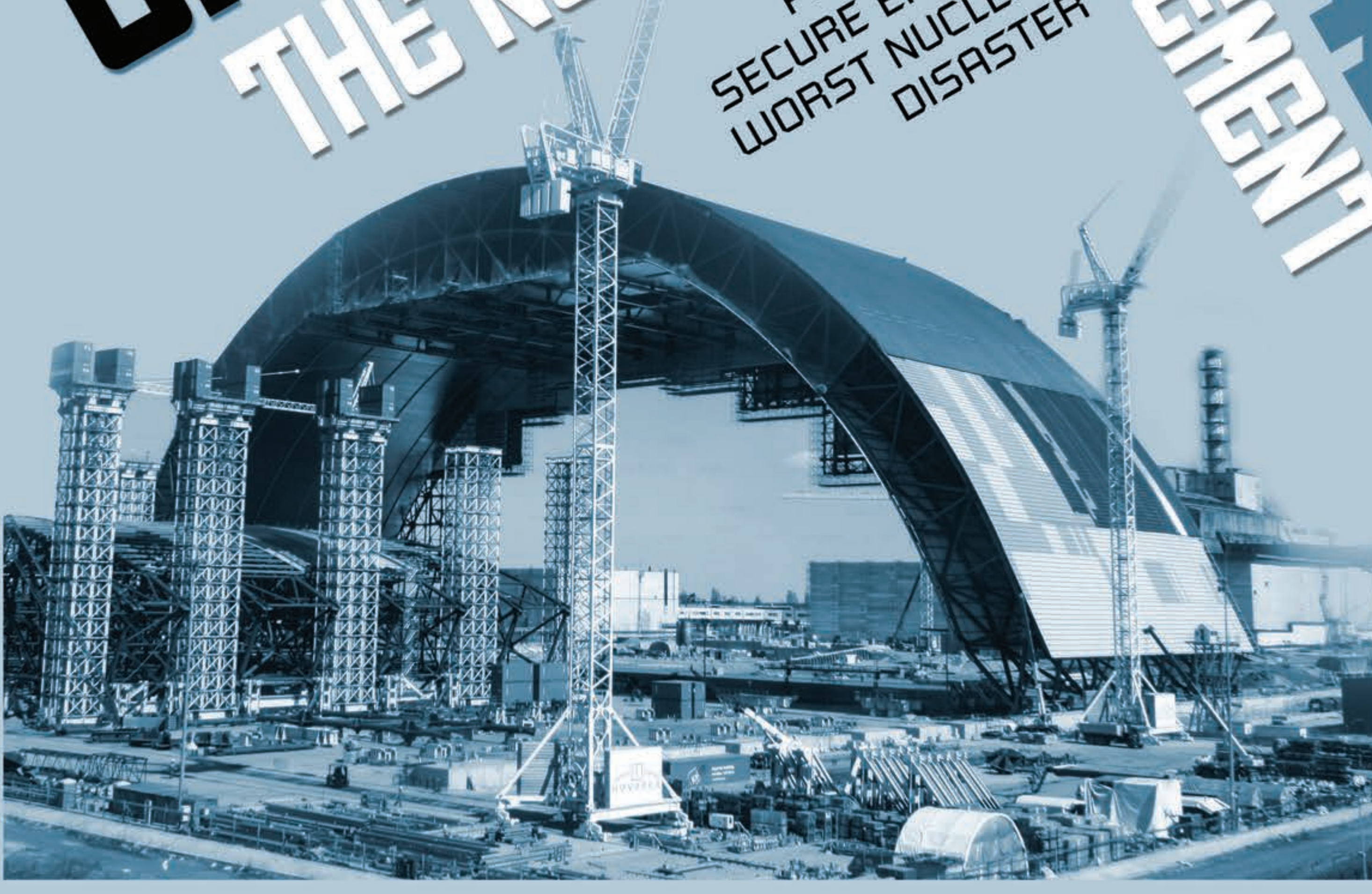
TECHNICAL JOURNAL OF THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

THIRTY YEARS AFTER THE 1986 ACCIDENT

CHERNOBYL

THE NEW SAFE CONFINEMENT

INSIDE THE PROJECT TO SECURE EARTH'S WORST NUCLEAR DISASTER



THE NATIONAL BOARD

Introducing a New Mark of Quality

The National Board T/O Program for Certified Testing Organizations

T/O

- Formalizes the "Test Only" process by providing National Board certification to organizations conducting inservice testing of pressure relief devices.
- Includes adjustment for restoring nameplate set pressure.
- Provides customer and inspector confidence in testing capabilities.

T/O *Certificates of Authorization* will be extended to current VR certificate holders. New applicants can obtain a T/O *Certificate of Authorization* by meeting program requirements.

Learn more on pages 6 and 8 in this issue, and by visiting the Pressure Relief Devices page on the National Board website at

www.nationalboard.org.

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

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.

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Radioactive Chernobyl Unit 4 reactor building (left) and first half of the New Safe Confinement arch, April 2014.

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Safety: Why Remembering

BY DAVID A. DOUIN, EXECUTIVE DIRECTOR

April 26 marked the 30th anniversary of the Chernobyl nuclear power plant accident. As our cover story illustrates, this event was a worldwide game changer in the nuclear power industry. The events that occurred at Chernobyl remind us why safety is critical.

The National Board's commitment to nuclear safety is demonstrated in our nuclear inspection training courses and endorsements. A well-inspected nuclear plant is a safer plant. While nuclear power evokes strong political sentiments on both sides of the aisle, neither can dispute the priority of safety.

The USSR's nuclear power stations were not governed or developed with the safety features of their US counterparts (see page 22). Flawed design, operator error, and the lack of a transparent safety culture resulted in the Chernobyl disaster – the worst nuclear accident to date – necessitating decades-long lessons of how to secure an accident scene this vast.

That's where the New Safe Confinement comes in. The structure is designed to protect the environment from radioactive exposure for 100 years by enclosing the damaged Unit 4 reactor and surrounding structures and providing a safe work space for dismantling the contaminated wreckage. Meanwhile, acres of land surrounding the Chernobyl Power Plant – the Exclusion Zone – remain uninhabitable and will for many generations to come.

An estimated 330,000-plus people from Ukraine, Belarus, and Russia made the mass exodus from their homes in the days following the Unit 4 explosion. The largest city evacuated was Pripyat in Ukraine. It was established in 1970 as one of the USSR's "nuclear cities" to support the neighboring Chernobyl Nuclear Power Plant, and was home to nearly 50,000 people. Now it is known as a "ghost city" – a shadow of a once-thriving community.

The city remains as it stood in April 1986, except for the looting, decay, and other effects of abandonment 30 years after Soviet officials evacuated and relocated its residents. Citizens were told to pack the essentials for just a few days; that the evacuation was temporary. They were driven out en masse on buses. A few days turned into several weeks, dragged on into months, and, incredibly, have become 30 years and counting. People walked out of their homes on April 27, 1986, and would never – *could* never – return.

Pripyat, Ukraine, before being evacuated after the April 26th disaster. Prior population was estimated at 49,360. Right: Pripyat

In 2011, Pripyat was declared a tourist attraction. The images that have emerged of deserted homes, schoolrooms, and public spaces evoke a quiet, haunting stillness. "Extreme" tourists can now see for themselves the broken remains of a bygone Soviet city. A Chernobyl blogger wrote of Pripyat: "Time stands still… measured by dosimeters, not clocks."

Time *has* stood still in Pripyat; the memories of the once-proud city are preserved by her exiles. They hold the memories of *before* Chernobyl. The world put a spotlight on what came after.

And as we watch to see what happens next with the New Safe Confinement, Pripyat will evermore remain an atomic city relic – a fact that should cause us to take pause.

The benefits and the hazards of nuclear power are undeniable. And yet, the features of safe systems, such as those established for US power plants, can preclude an accident similar to Chernobyl's. The containment of Three Mile Island's radioactive release and the fact that there was no loss of life is an example of this.

And that is why *safety* remains the absolute mission of the National Board, and always will.

Chernobyl Matters

AN ESTIMATED 330,000-PLUS PEOPLE FROM UKRAINE, BELARUS, AND RUSSIA MADE THE MASS EXODUS FROM THEIR HOMES IN THE DAYS FOLLOWING THE UNIT 4 EXPLOSION. THE LARGEST CITY EVACUATED WAS PRIPYAT IN UKRAINE.

Photos courtesy of the European Bank for Reconstruction and Development (EBRD)

Transitions

BY JAMES R. CHILES

My workplace is close to a railyard. When the road engines first yank on a long line of boxcars, it sets off a rolling thunder from the head end to the tail end as the draft gear on each car stretches and then transmits a shock wave to each car's steel sidewalls. It's a mile-long set of bass drums, booming in sequence.

In his book, *Inviting Disaster,* Mr. Chiles narrates the system breakdowns of both Chernobyl's Unit 4 and Three Mile Island's Unit 2 reactors. He maintains a technology blog at Disaster-wise and can be contacted at **j.chiles2015@gmail.com.**

Getting a train underway is one of many human activities that fit under the word *transition*. It's a big umbrella, that word. Industrial risk managers have pegged transition times as deserving extra-special attention from everybody involved. This issue's narrative of what happened at Chernobyl Unit 4 is a reminder that poor handling of transition times can be very dangerous. Late on the night of April 25 through the early hours of April 26, 1986, Unit 4 experienced two ill-managed transitions. The first type, which I'll be spotlighting here, was an operator shift change at midnight, from the evening crew to the next crew, or what some trades call the graveyard shift.

Another transition was the transformation of Unit 4 from a clunky but serviceable power producer to a "run-down" experiment, timed to take advantage of a scheduled outage for maintenance, and requiring that key safety systems be disabled. This would test whether residual steam from a scrammed reactor, fed to the station's own turbo-generators, could bridge the minute-long gap between grid power loss and when the station's emergency diesel gensets came up to speed and could drive the cooling pumps. It was not an idle question, because RBMK reactors needed non-stop water circulation.

Station managers had tried similar run-down tests before, without blowing anything up, and the transitions required by this fourth set of tests probably would have gone okay were it not for orders from regional grid managers, who faced an unexpected power shortage on April 25 and told Unit 4 to keep generating power longer than planned. This pushed back the critical test hours to after midnight, to a shift that was not prepared to deal with the bizarre cascade of events that began with a steep energy drop shortly after midnight, followed by ill-advised improvisations to boost the energy level, which led to the severe meltdown. The point is that neither transition – the crew change or the experimental risks – received the advance attention it deserved.

Transitions come in many sizes and shapes, but in general, anything involving a startup, a shutdown, or a major rework in a high-energy system is likely to bump up the risk. That's because most systems run better in a steady state than when meters and dials are jumping around. Depending on the level of preparation and training, transitional risks might stay well under control, or the results might crash like a freight train right into the control room, analogous to what happened at Chernobyl. What we want to avoid is what the Israeli military thinkers once dubbed "fundamental surprise."

Besides the everyday type of transition I'm featuring here – scheduled crew changes – important transitions are underway all across the technological landscape. Daily. Here are examples:

- Shifting fuels: Some cargo lines are shifting their freighters from bunker fuel to liquefied natural gas. This can save money and reduce exhaust emissions but needs a whole new set of equipment and safety skills.
- "Cut-outs" of legacy automation systems: This is when plants shut down to replace old computer systems, often to boost automation and "run in the dark" remote operations. The hope is that on-call experts will be available to parachute in when things go wrong.
- Blast furnace relining: Every five to 10 years, steel mills shut down their blast furnaces for elaborate and expensive refits, including replacement of the refractory protection.
- Turnarounds: These are major rehabs at chemical processing plants.

A safety-critical transition: the "handover."

For now, let's focus on the garden-variety transition called the shift change. How to deal safely with shift changes has generated much study in health care and aviation. Think about it: in both of these fields experts have to play a part in long-duration events, then have to pass the job along. It's got to be done right, or else we see overdoses and airplane crashes. Experts in these fields use a term I like better than shift change: the handover. Why is it better?

For one, "handover" calls up the simple and powerful image of a relay race. Every relay runner knows that a mistake in passing the baton can be the difference between a finalist and the also-ran. Or think of the snap from the center to the quarterback. It's all the same idea: Mistakes during a handover can cost the whole game.

Think of the immense explosions on the Piper Alpha offshore rig in the North Sea in 1988, when sloppy transfer of status reports and permit-to-work documents allowed unfinished repairs on a natural-gas compressor to pass unnoticed. That opened a path for later operators to route gas into the compressor. What followed were a high-pressure leak, then sky-high fireballs, explosions, and 167 fatalities.

Finally, "shift change" is just too limp a term, too passive. It's like talking about a "time change" from standard to daylight-saving. Time changes just seem to happen without any communication or thought. But shift changes can't be treated like that. So the term "handover" is better at nailing down their safety-critical function.

Let's listen in on a bad handover:

Incoming operator: "So … what's up?"

Outgoing operator: "You're late, that's what. Take a seat, 'cause I'm outta here."

Incoming operator: "Yeah, yeah, be that way. Can I help it if my battery died last night?"

With shift changes as bad as this, it's not just batteries that die.

So what makes a good handover? NASA has studied its mission-control handovers in great detail, and compared them to best practices from the fields of aviation, medicine, manufacturing, and nuclear power. Some takeaways:

The bare minimum is to have and follow an established handover procedure, one that's been developed in cooperation with the operators. They need to relay key information to the next shift in writing, because that builds accountability and reduces confusion. In that computer log or paper form, they've got to have blank space to call out anomalies and weird readings.

A good handover log goes well beyond itemizing what's been done in the last eight or 10 hours. It needs to flag issues that look like they'll soon be problems. A good handover describes what the earlier shift thought might be the cause, and what they've tried. That's the kind of thing NASA calls an *open issue*.

But how can a written log sum up open-ended issues like that? The answer is that logs usually *can't* do all that, and that's why the outgoing and incoming operators need time for quality Q&A, whereby reviewing the logs and following up with conversation, they can work toward common understanding.

As the incoming operator poses questions to the outgoing one, the two of them can confirm that they are on the same page regarding any concerns. By the end of the handover period, the two have a *shared mental model* of what the new operator should do and know.

If for some reason the two can't talk face to face, they should have a telephone or radio conversation soon after the incoming operator has scanned the activity log. Writing plus talking: yes, it's redundant, but redundancy is often the difference between pulling up safely at home, and dying along the way.

All this talk about the dangers of atypical shift changes may seem like yet another case of bad news bringing more hassles in its wake. But it should be heartening that good shift handovers can do more than just keep a lid on problems from one shift to the next.

Sometimes an incoming crew saves the day and in dramatic fashion. Not just because rested people are coming in, but because they bring a fresh point of view. An example of this is when incoming supervisor Brian Mehler saved the day with very little time to spare during the nuclear crisis at Three Mile Island. Given tools and training, there are many good people out there who can, and will, rise to the occasion.

Inservice Testing for Pressure Relief Valves

BY THOMAS P. BEIRNE, P.E., TECHNICAL MANAGER, PRESSURE RELIEF DEPARTMENT

Two questions often asked of the Pressure Relief Department are:

1. How often should we be doing inservice testing of pressure relief valves?
2. How can an organization become certified to do inservice testing and adjustment of pressure relief valves?

This article answers the first question. The second will be answered in the article by Joseph Ball on page 8.

The *National Board Inspection Code* (NBIC) Part 2, paragraph 2.5.1a), states: "The most important appurtenances on any pressurized system are the pressure relief devices (PRDs) provided for overpressure protection of that system. These are devices such as safety valves, safety relief valves, pilot valves, and rupture disks or other non-reclosing devices that are called upon to operate and reduce an overpressure condition."

Reading on, paragraph 2.5.1c), states: "Periodic inspection and maintenance of these important safety devices is critical to ensure their continued functioning and availability when called upon to operate. See NBIC Part 2, 2.5.8, for recommended testing frequency for PRDs."

Something of this importance often gets overlooked by users who may not be knowledgeable enough to know that pressure relief valves require ongoing inspection, operational checks, set pressure tests, maintenance, and repair once they are installed.

Types of Inspection and Testing

Inservice inspection of pressure relief valves can be broken down into three main categories: 1) inspection of the device condition, 2) inspection of the installation condition, and 3) inspection of operation. This article focuses specifically on the inspection of operation and testing.

Operation testing must be performed on pressure relief valves periodically to ensure that they are functional. Testing should include set pressure, blowdown (if possible), and seat leakage evaluation. Acceptance criteria for these tests are found in the original code of construction.

Set pressure testing may be performed on the piece of equipment on which it is installed or at a qualified testing facility (see next article).

If set pressure testing is performed on the piece of equipment on which the valve is installed, care should be taken that it be performed by qualified personnel under controlled conditions using a written procedure. The inspector should make sure that the test equipment has been calibrated and the calibration results documented by the owner of the equipment.

If set pressure testing is performed at a test facility, the record of these tests should be evaluated to ensure they meet the requirements of the original code of construction.

Many times lift-assist devices are used when a full pressure test is impractical or may cause damage to the valve. Lift-assist devices use an auxiliary load applied to the spindle in conjunction with system pressure at the inlet. The measured pressure at the valve inlet, applied load by the lift-assist device, and other valve data are used to calculate the set pressure of the valve. If a lift-assist device is used to determine the set pressure, the requirements of NBIC Part 3, paragraph 4.5.3, shall be met. It is important to note that if a valve is damaged or leaking, using a lift-assist device may result in an indeterminate or false set pressure measurement.

Test Media

If valves are not tested on the equipment on which they are installed using system fluid, NBIC Part 2, paragraph 2.5.7d), states the requirements for the testing medium that is to be used. The following table summarizes the requirements of paragraph 2.5.7d):

Table 1, Requirements of NBIC Part 2, para. 2.5.7d)

Service	Test Medium
High-pressure boilers, high-temperature hot water boilers, low-pressure steam heating boilers	Steam
Hot water heating boilers	Steam, air, or water
Potable hot water heaters	Air or water
Air and gas process	Air, nitrogen, or other suitable gas
Liquid process	Water or other suitable liquid
Steam process	Steam or air with manufacturer's steam-to-air correction factor

Table 2, NBIC Part 2, para. 2.5.8, Testing Frequencies

Service	Inspection Type/Frequency
Power boilers less than 400 psi	Lift-lever test every six months, set pressure test annually or prior to planned boiler shutdown
Power boilers greater than 400 psi	Set-pressure test every three years or prior to planned boiler shutdown
High-temperature hot water boilers	Set-pressure test annually
Low-pressure steam heating boilers	Lift-lever test quarterly, set pressure annually prior to heating season
Hot water heating boilers	Lift-lever test quarterly, set pressure annually prior to heating season
Water heaters	Lift-lever test every two months
Pressure vessels/piping steam service	Set-pressure test annually
Pressure vessels/piping air/clean, dry gas	Set-pressure test every three years
Pressure vessels/piping propane/refrigerant	Set-pressure test every five years
Pressure relief valves in combination with rupture disks	Set-pressure test every five years
All others	Per inspection history

Alternative Testing

As an alternative to set-pressure testing, the valve may be checked for freedom of operation using the lift lever. For ASME Code Section I and Section VIII valves, this should only be done at 75% of the stamped set pressure or higher to avoid damaging the valve or lifting device. ASME Code Section IV valves are designed to allow the lifting device to be used without pressure. However, all freedom-of-operation tests should be done with some pressure at the valve inlet to flush out debris. It is important to note that freedom-of-operation testing alone does not provide any information regarding the actual set pressure of the valve. It merely shows that the valve is not stuck shut. For this reason a set-pressure test is always preferred.

Testing Frequency

NBIC Part 2, paragraph 2.5.8, gives recommended testing frequencies for valves in various types of service. These testing frequencies should be used as a recommended starting point if no prior operating experience or testing history is available. Table 2 summarizes paragraph 2.5.8. Where recommended test frequencies are not listed, it is up to the user and inspector to determine and agree upon inspection and test intervals based on a variety of considerations. Items to consider are as follows, but not limited to: jurisdictional requirements; test data from similar devices in similar service; manufacturer's recommendations; number of overpressure events (more events require more frequent inspection); visual signs of damage, leakage, or corrosion; installation in a system with a common header; and system criticality.

When the effects of operation under service conditions are unknown, it is recommended that a short inspection interval, not exceeding one year or first plant shutdown, be established. The device should then be inspected and tested. If the results are unacceptable, then the inspection and test interval should be reduced by 50% until acceptable results are obtained.

Evaluation of Results

If a valve is stuck shut then it must be immediately taken out of service and repaired or replaced. If the set-pressure test shows that the set pressure is outside of the tolerance set forth by the original code of construction, but is in otherwise acceptable condition, minor adjustments (no more than twice the set-pressure tolerance) shall be made by a National Board accredited organization (see next article). If the valve is leaking, damaged, exhibiting signs of degradation (such as corrosion or deposits), or if major adjustments are needed, the valve should be evaluated further and may need to be repaired.

For more detailed information regarding inservice inspection and testing of pressure relief devices, please see NBIC Part 2, paragraph 2.5.

Conclusion

Pressure relief valves are the "last line of defense." Therefore, inspection and testing of pressure relief valves that are protecting pressure equipment are among the most important activities necessary to ensure continued safe operation of that equipment. ✤

T/O Program for National Board-Certified Testing Organizations – A New Mark of Quality

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

Thomas Beirne's article on page 6 points out the importance of the periodic testing of pressure relief valves (PRVs) as part of the periodic inspection of these critical safety devices. When testing is performed, all involved want to be sure that the testing organization provides accurate, reliable results regarding the status of their pressure relief valves. Important decisions must be based upon accurate information.

The user wants to know: *How was the valve functioning to protect the system? Do we have a safe inspection interval? Can the inspection interval be lengthened, or should it be shortened? Should this valve be serviced? Can we continue to use this valve or should it be replaced?* An inspector wants to know: *When was this valve last inspected and tested? Did the testing company know what they were doing?*

All of these questions can be answered using data from a test process, but the decisions made will only be as good as the information they are based upon, which comes from the knowledge and capability of the testing organization.

Concerns that only qualified companies perform inservice testing have resulted in a new National Board program designed to certify testing organizations. This program was recently approved by the National Board's Board of Trustees and will provide an independent third-party review of testing organizations that intend to perform this work. The program is called the **T/O** program, which comes from the "TEST ONLY" status discussed in the *National Board Inspection Code* (NBIC), which has been turned into the certified **T**esting **O**rganization concept.

The NBIC has long recognized the importance of testing valves that have been inservice as part of periodic inspection and it includes provisions to restore valve performance within certain limitations by making adjustments to the valve. However, the NBIC is somewhat vague in defining the standard for *who* is considered qualified to perform this work. NBIC Part 2, paragraph 2.5.7g), indicates adjustments shall be made "by an organization accredited by the National Board." This requirement could be interpreted in several different ways.

One example would be the National Board **VR** Valve Repair program. **VR** stamp holders go through a thorough review and demonstrate their quality program and procedures. They are certified to perform complete repairs, including testing and adjustments. Most **VR** certificate holders also test pressure relief valves; however, a **VR** symbol is not applied to a valve that was solely tested, because the **VR** program requires that a repaired valve be disassembled, internally inspected, and repaired as necessary.

NBIC Part 3, paragraph S7.10, includes another process for recognition of testing organizations. A jurisdiction (members of the National Board) may authorize an owner/user or their designee to perform adjustments to pressure relief valves. The NBIC includes a brief outline of the elements a jurisdiction would typically want to see as part of this process, such as training of personnel, preparation of a quality system, documentation, and marking of tested valves. While this process has been in the NBIC for quite a while, it is rarely implemented because jurisdictions have limited personnel to perform the required review. Furthermore, some jurisdictions may not recognize this procedure. This qualification also lacks the key provisions of a periodic review to ensure the organization remains capable and a physical demonstration of capabilities.

The decision to implement the **T/O** program was helped by a number of inquiries to the National Board Pressure Relief Department. Some were seeking a credential for companies wishing to perform pressure relief valve testing services. Users also contacted us to confirm that the testing facility they were utilizing was a reliable organization. The test companies and the user organizations recognize that pressure relief valves are safety devices, and jurisdictions and inspection agencies have a keen interest in ensuring their continued safe performance through testing done by a qualified entity.

When we were approached with questions about credentials for testing organizations, our first response was to refer the inquirer to the National Board **VR** program. While this suits some organizations, many test companies are not equipped to perform repairs, and in many cases the tested valves are smaller and not economical to repair. When a nonconforming valve is identified, it is replaced with a new one.

Therefore, the **T/O** program was formulated to provide a well-defined system for recognizing companies that only intend to perform testing, and to give users a mark of quality that a testing organization has demonstrated its capabilities.

The **T/O** program will offer a *Certificate of Authorization* with a scope of work that includes only testing and adjustments of pressure relief valves. Program rules are included in a new

National Board document, NB-528, *National Board Accreditation of **T/O** Test Only Organizations*. This document is now available on the National Board website and outlines the necessary steps to acquire the **T/O** certificate. The program format is similar to the current **VR** program.

T/O Application Process

1. The applicant submits an application form and application fee (same application fee as the **VR** program).
2. A quality program manual is prepared to control the testing activity.
3. A National Board auditor will visit the facility, review the quality control manual and its implementation, and witness the testing of sample pressure relief valves.
4. Those valves will be sent to a National Board- accepted test lab, and a verification test will be performed to demonstrate that the test organization's results are in agreement with the data obtained at the test lab.

All tested valves will be identified by a metal tag that includes the name of the test organization, a test traceability number, valve set pressure, test date, and the National Board **T/O** symbol. This symbol is a registered trademark of the National Board and can be pre-printed on the tag. The mark indicates the valve was tested successfully by an accredited organization. The test number provides a link to the test report generated by the **T/O** organization.

Once applicants have demonstrated their testing quality program and procedures by successfully completing the verification tests, the National Board **T/O** certificate will be issued. This certification will be valid for a period of three years. At the end of the three years, the companies will need to reapply and a renewal review will be necessary.

To ensure the new **T/O** program will not have a negative effect on **VR** certificate holders, the National Board included a provision that allows current **VR** certificate holders to automatically receive a **T/O** *Certificate of Authorization*. There is no additional application fee, and the only requirements will be to sign the appropriate application form and make sure their quality manual addresses the testing process and assigns test numbers. No additional site work, audit, or testing will be required.

The testing process is not merely a test. The procedure also must include a visual inspection documenting the as-found condition of the valve. Indications of problems, such as physical damage to the valve; excess deposits or corrosion; or a missing nameplate or missing or broken adjustment seals; would subject the valve to being rejected (and therefore not receiving a **T/O** nameplate). When valves are tested and the results indicate the valve fails to open within the allowable adjustment limit or has excessive leakage, the valve is also considered to have failed. By the rules of the **T/O** program, a valve with physical damage, or one that has failed to meet test requirements, must then be referred to a **VR** certificate holder for repair.

Benefits of the T/O Program

1. Users of pressure relief devices are confident that vendors supplying testing services have completed a thorough, independent audit of their testing processes and quality program. Also, testing organizations must provide training for their personnel, calibrate their equipment traceable to a National Standard, and provide a numbered test report documenting each tested valve's condition. A durable metal nameplate is evidence on the valve itself of its test status.
2. Inspectors of pressure equipment have additional confidence in the capabilities of test organizations. The test tag provides a means to show when the periodic test was performed. The test number on the test tag links the valve to a test report documenting its condition.
3. Testing organizations have a means to show potential customers that they have completed a thorough audit by an independent third party. This will differentiate them from non-certified companies and perhaps alleviate the need to be audited by potential customers.
4. **VR** certificate holders are recognized automatically as being qualified to perform tests to a uniform standard that other testing organizations must work toward, and the differences between repairs and in-service testing are more clearly identified. When repairs are identified by any test only organization, those repairs must be directed to a **VR** certificate holder.
5. Jurisdictions have a new method of ensuring that organizations performing periodic testing of inservice pressure relief valves have qualified and demonstrated their capabilities to a third party. Those organizations will be required periodically to renew the certification to confirm they remain qualified if their personnel and procedures change over time. An audit by the National Board could relieve the jurisdiction of the need to do this audit themselves, thus lightening their workload and freeing up time for other required activities.

Pressure relief valves provide a critical function for the protection of pressurized equipment. Periodic valve testing is a key element in a pressure equipment maintenance program because it demonstrates valves are continually reliable. It is the hope of The National Board of Boiler and Pressure Vessel Inspectors that the new **T/O** program will become a well-recognized mark of quality for the testing process by verifying that testing companies can be relied upon when providing this critical service.

CHERNOBYL'S COLOSSAL GUARDIAN

THIRTY YEARS AFTER THE HISTORIC NUCLEAR POWER PLANT MELTDOWN, CLEANUP OF THE UNIT 4 REACTOR AND ITS EXISTING SHELTER IS BECOMING A REALITY.

By Wendy White, *BULLETIN* Editor

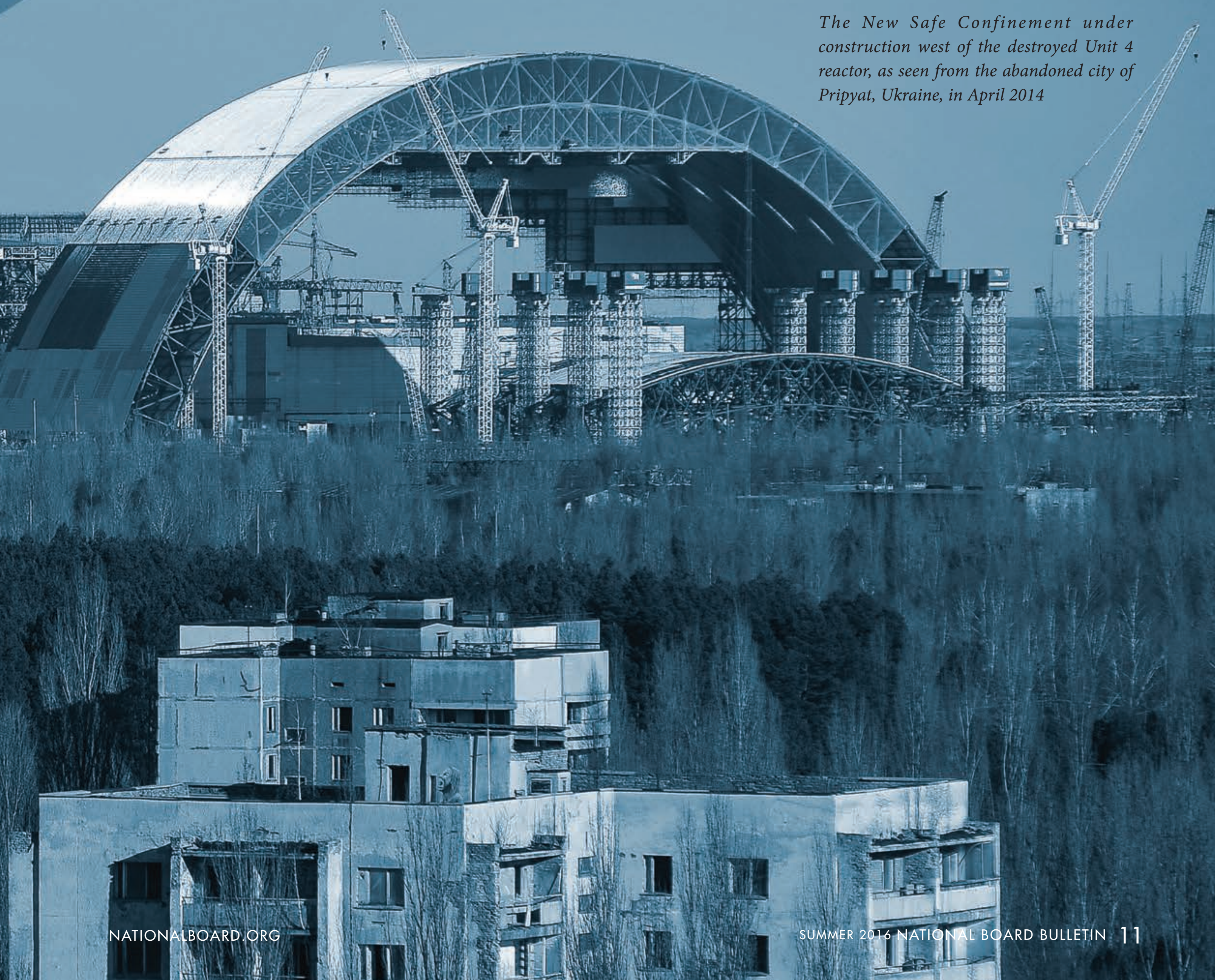
Photos courtesy of the European Bank for Reconstruction and Development (EBRD)

The prodigious 31,000-metric-ton, 361-foot-tall steel arch is as unprecedented as the 1986 nuclear catastrophe it was designed to entomb. Called the New Safe Confinement (NSC), this formidable structure has risen above the abandoned landscape of Chernobyl, Ukraine's 1,660-square-mile Exclusion Zone, constructed under the ominous glare of the power plant's wrecked Unit 4 reactor and its degraded sarcophagus.

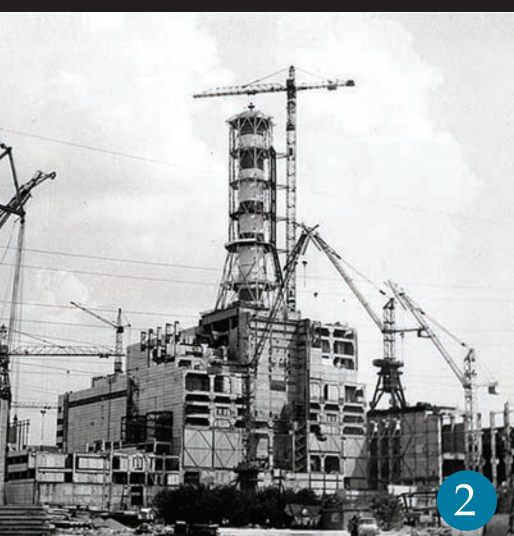
An iconic, man-made metallic rainbow, the NSC promises 100 years of impermeable shelter from the lava-like radioactive corium that melted into the depths of Unit 4 in the days and weeks after the April 26, 1986, explosion.

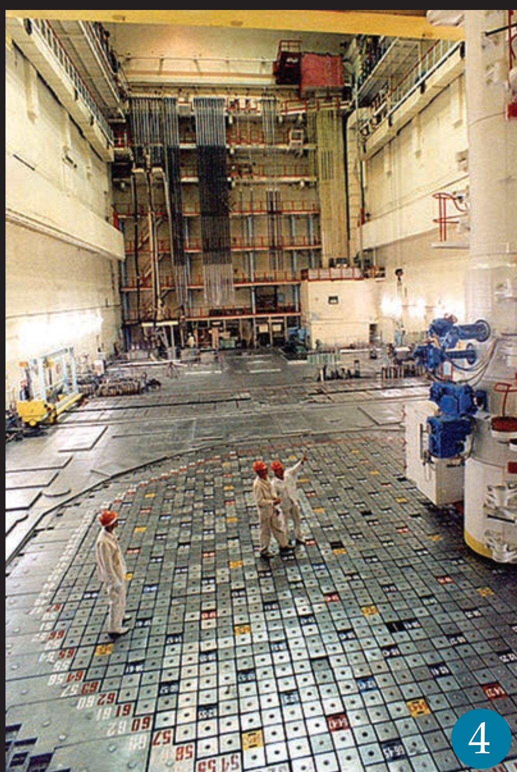
The story of the NSC is one of global collaboration, ingenuity, commitment, and financing. The world's fingerprints are all over this project, and coordinating international efforts has been among its greatest challenges. And a reason for its success.

But containing the Earth's worst nuclear accident would take nothing less than a complex and nuanced plan executed by an international consortium, more than 20 years of persistence, and funds exceeding $1.7 billion generated by grants from the world's largest economies (the Group of Seven) and donations from over 40 nations.



The New Safe Confinement under construction west of the destroyed Unit 4 reactor, as seen from the abandoned city of Pripyat, Ukraine, in April 2014





April 26, 1986

According to the World Nuclear Association (WNA) publication *Chernobyl Accident 1986* (updated April 2016), the Unit 4 reactor explosion was a "product of a flawed Soviet reactor design coupled with serious mistakes made by the plant operators. It was a direct consequence of Cold War isolation and the resulting lack of any safety culture." (See pg. 22 for information on the flawed Russian RBMK reactor design.)

The accident occurred during a safety system test that was being performed before a routine shutdown. The test produced a runaway increase in power that started a chain of severe reactions and resulted in a massive steam explosion. Within seconds, the reactor was totally destroyed; its core exposed. During further explosions and an inferno that burned for 10 days, radioactive material erupted into the atmosphere.

Hardest hit were three Soviet republics, now countries: Ukraine, Belarus, and Russia, but the effect was far-reaching: low levels of radioactive material were detected over the Northern Hemisphere, causing international alarm. It is said that the release put 400 times more radioactive material into Earth's atmosphere than the atomic bomb dropped on Hiroshima.

1&2: *Chernobyl construction photos. The plant and nearby city of Pripyat, Ukraine, were built to house workers and families in 1970, with Reactor No. 1 commissioned in 1977.*
3: *Inside the control room of Chernobyl Power Plant circa 1977.*
4: *Inside Chernobyl Nuclear Power Plant.*
5: *Aerial view of Pripyat.*
6: *Aerial view of destroyed Chernobyl Reactor No. 4 after the accident in 1986, showing the extent of the damage caused.*

Opposite Page: *New Safe Confinement with both halves joined together, March 2016*

In the days and months following the explosion, workers tried to limit the release of radioactive particles. The WNA estimates that at least 5% of the initial radioactive material in the Chernobyl Unit 4 reactor core (which had 192 metric tons of fuel in it) was discharged in the accident.

In the chaos that quickly followed, workers injected 200-300 metric tons of water into the intact half of the reactor by using auxiliary feedwater pumps; but stopped the process amidst concerns that reactor Units 1 and 2 would flood. Then, over the next week, approximately 5,000 metric tons of sand, lead, and boric acid were airdropped onto the burning core via helicopters in an attempt to extinguish the inferno and minimize the radioactive release. While a daring and noble attempt, the results were not ideal. Reports the WNA:

> *During the first flights, the helicopters remained stationary over the reactor while dumping materials. As the [radiation] dose rates received by the helicopter pilots during this procedure were too high, it was decided that the materials should be dumped while the helicopters travelled over the reactor. This procedure caused additional destruction of the standing structures and spread the contamination.*
>
> *Boron carbide was dumped in large quantities from helicopters to act as a neutron absorber and prevent any renewed chain reaction. Dolomite was also added to act as heat sink and a source of carbon dioxide to smother the fire. Lead was included as a radiation absorber, as well as sand and clay, which it was hoped would prevent the release of particulates. While it was later discovered that many of these compounds were not actually dropped on the target, they may have acted as thermal insulators and precipitated an increase in the temperature of the damaged core, leading to a further release of radionuclides a week later.*

The compounds that did make it to the target mixed with the nearly 200 metric tons of uranium and formed the poisonous mass called Fuel Containing Materials (FCMs). When completed in 2017, the New Safe Confinement will stand as a colossal guardian over this radioactive material.

By October 1986, around 200,000 Soviet workers – called the Liquidators – scrambled to clean up the site and build a concrete and steel, 21-story-tall "sarcophagus" over the destroyed reactor to limit further release of radioactive material. The Object Shelter, as it's also known, was quickly constructed under dire conditions and was not properly secured to the original building, causing gaps that left it vulnerable to weather and other environmental concerns. The Object Shelter eroded over time and began to crumble. A more permanent containment and cleanup solution was necessary.

In 1992, Ukraine launched an international competition seeking projects and technical solutions to make the Object Shelter an ecologically safe system. From this, the New Safe Confinement structure was conceived. In 1997, the Chernobyl Shelter Implementation Plan (SIP) – a step-by-step strategy for making the site of the 1986 nuclear accident safe – was developed by Ukrainian and international experts. Actual construction of the NSC began in 2012, after nearly a decade of planning.

In simple terms, the purpose of the NSC is to contain radioactive material, protect the existing Object Shelter from weather damage, and provide a safe work space for the decades-long task of dismantling Unit 4.

The construction of this massive structure itself, however, has been far from simple. What follows are the specifications of what the European Bank for Reconstruction and Development calls "a monster cage to contain the beast."

ADDING IT UP: The New Safe

A "monster cage to contain the beast"

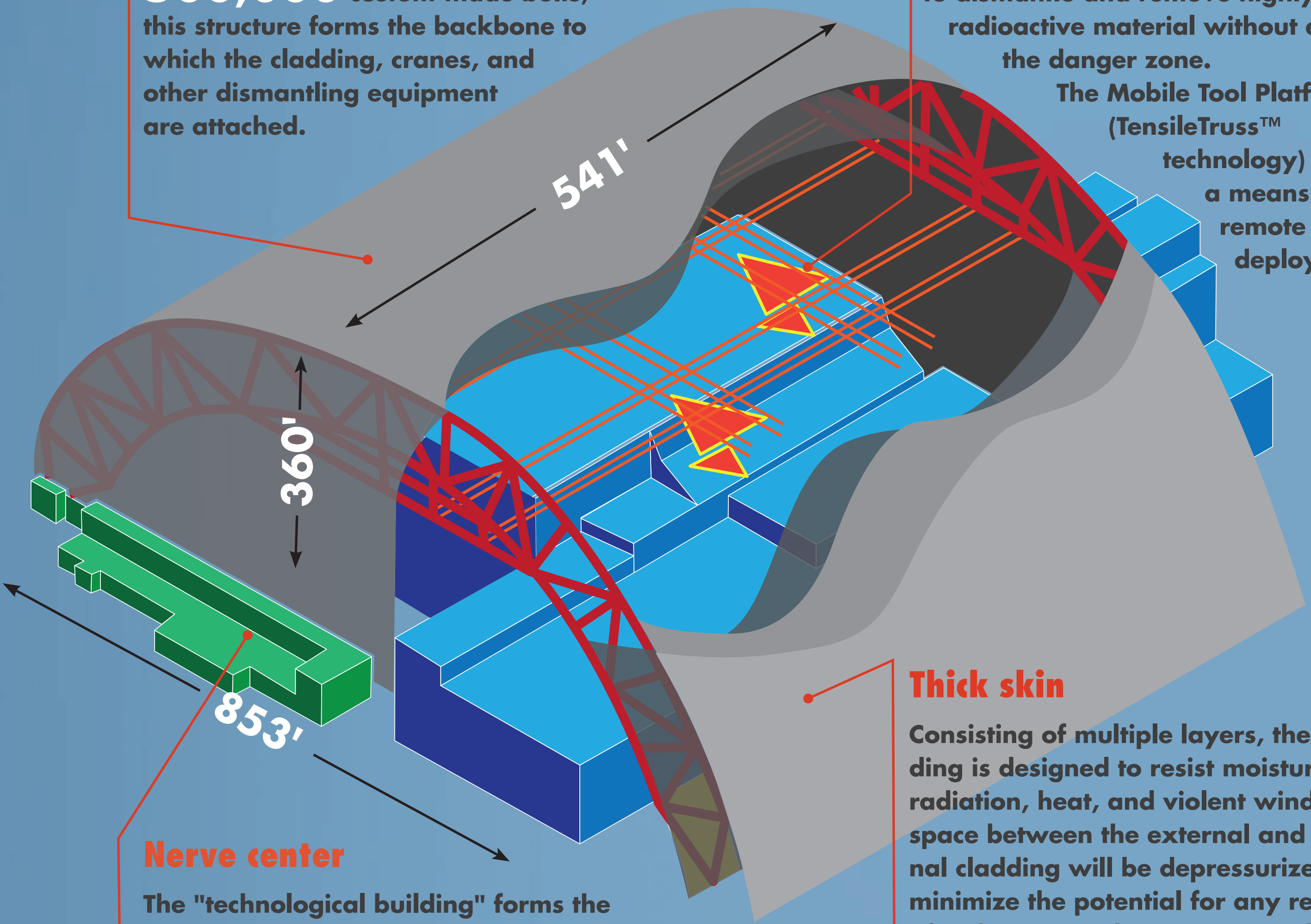
The NSC was constructed in two halves that were lifted to their full height and joined together.

Big bones

Sixteen enormous steel trusses run from one side of the NSC to the other. Knitted together by over **500,000** custom-made bolts, this structure forms the backbone to which the cladding, cranes, and other dismantling equipment are attached.

Heavy hands

Two remotely operated **96** meters long bridge cranes will hang just under the roof of the NSC, allowing workers to dismantle and remove highly radioactive material without entering the danger zone. The Mobile Tool Platform (TensileTruss™ technology) provides a means of remote tool deployment.



Thick skin

Consisting of multiple layers, the cladding is designed to resist moisture, radiation, heat, and violent winds. The space between the external and internal cladding will be depressurized to minimize the potential for any release of radioactive substances. A sophisticated ventilation system will minimize the risk of corrosion, ensuring that there is no need to replace the coating.

Nerve center

The "technological building" forms the "brains" of the NSC operations, a high-tech center housing the crane control and monitoring systems that are critical for the safe operation of the NSC.

Confinement By the Numbers

Source: EBRD brochure, "Transforming Chernobyl"

Location

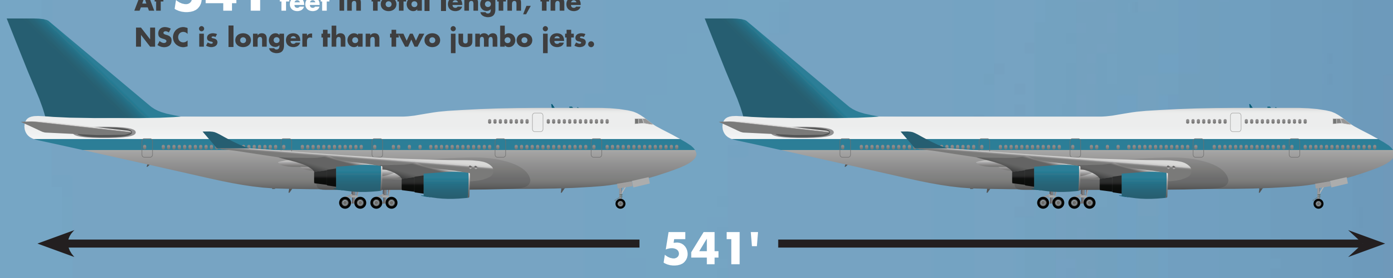
A **two**-hour drive north of the Ukrainian capital of Kiev. The radio-active dust contaminated the surrounding area and also spread across Europe.

Height/Weight

Standing **360** feet tall, it's large enough to fit the Statue of Liberty inside. The metal frame alone weighs **25,000** metric tons. Total equipped weight is **30,000** metric tons.

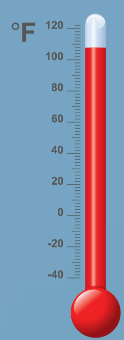
Length

At **541** feet in total length, the NSC is longer than two jumbo jets.



Weather

The NSC is built to withstand temperatures ranging from **-45**°F to **+113**°F and wind speeds of a category-3 tornado (up to **206**mph).



Exposure

To ensure workers are safe from excessive exposure to radiation, strict dose limits are observed. Dose rates in the main arch area are **0.0075**mSv/hr. An average dental x-ray is **0.014**mSv.

Epic Endeavor

Every aspect of the New Safe Confinement project has been epic in proportions. Before work on the NSC even began, the project had to overcome the unmatched challenge of being located at the most radioactive site in the world. Extensive planning involving research, engineering concepts, site infrastructure, and worker protection, was critical.

Vital safety practices had to be incorporated, including an advanced biomedical protection and screening protocol for workers, and enforcing strict radiation dose limits. The construction site itself was built to protect workers from possible exposure to ground radiation.

The visionary project began with site preparation, cleaning and clearing the 970,000-square-foot erection area; then pouring the concrete slabs, which formed the work surface and provide protection from ground radiation. Next was the extensive civil engineering work o and deep foundation and piling work in the trenches. The arch construction involved lifting operations that used towers designed to lift loads of over 1,000 metric tons.

To learn more about the nuances of the project, the *BULLETIN* contacted Novarka, the 50/50 joint venture of French construction companies Vinci Construction Grands Projets and Bouygues Travaux Publics. The two companies have been working in tandem to build the outsized structure, each company applying its own expertise to the project. Through email correspondence, Novarka Project Director and civil engineer Nicolas Caille shared what it's like to manage this unique international project.

ABOVE: *Workers' safety briefing at NSC construction site, December 2014*

BELOW: *Preparing for NSC foundations west of the Unit 4 reactor, November 2011*

“I took over my position for the Chernobyl project four years ago,” Caille wrote. “The projects are now becoming larger and larger. The total value for the Chernobyl project is around 1.5 billion euros [$1.7 billion] and the workforce is more than 2,000 people.

“The project is very complex from an engineering point of view. From a managing point of view, the fact that the staff comes from 23 different countries does not simplify the task, but it gives you the opportunity to learn from everyone. Everybody working on the project is proud to do something that is good for the environment,” he said.

When asked about the technical challenges the project has faced, Caille’s answer is a bit of a surprise. “Every single problem has been solved [but] the most difficult task has been to coordinate all of these experts and engineers who have different backgrounds and mentalities. It’s as if I’ve been a coach of a great football team – no problems with competencies, but you have to make everybody play with each other.”

Caille says there are strategies that can help with the challenges that accompany a multinational project: “Try to keep the design and construction methods as simple as possible. Take into account where the project is built (climate, infrastructure, remote area, etc.), and always – even and especially in difficult situations – maintain good communication with the client, engineers, and subcontractors.”

Inside the NSC roof, January 2016

Combating Corrosion

The NSC has several critical engineering features built into it to accommodate the unique radioactive environment it will enclose. Keeping the internal structure corrosion-free is one way the NSC intends to keep its promise of lasting for 100 years. Other structures have stood as long (the Eiffel Tower is often referenced), but corrosion is avoided because these structures are painted regularly. This type of maintenance will not be possible inside the NSC once it is operational.

To avoid the potential for condensation, a special venting system will control ambient temperature and humidity conditions inside the vast structure.

Explains Caille: “The relative humidity must be maintained below a target of 40%. This is achieved by using desiccant wheels in the air-conditioning system, which remove the moisture from recycled and fresh air, which then is distributed into the annular space by a system of ducts. The conditions within the annular space are monitored by sensors installed throughout the space. Results are reported through the control system.

“It is important to note that the ventilation system also maintains a positive pressure within the annular space of 75 to 100 Pascals (.011 to .014 psig) to prevent the ingress of moist air from outside or the egress of contaminated particles from within. This ensures the containment of the main volume (open space) around the Object Shelter."

"Push-Pulling" 31,000 Metric Tons

Another unique design quality of the NSC is that it is “mobile” and will be slid to its final resting spot atop the Object Shelter. Caille says that before it is slid into place, it will be resting on 30 temporary bearings, 15 on the north side and 15 on the south side. These bearings are supported on concrete foundation beams. Rails, similar to a train track, are installed on the beams. For sliding, the arch is elevated and the temporary bearings are exchanged for “push-pull” sliding units, which rest on the track.

“The push-pull units act in a coordinated and very controlled manner to push and pull the arch, using hydraulic

The failed Unit 4 reactor as seen from inside the arch during construction. Photo courtesy of Novarka.

jacks, along the track from the erection zone, through the transition zone, to the service zone above the Object Shelter, which houses the failed reactor Unit 4," says Caille.

The distance of 1,083 feet (330m) is expected to be covered in 33 hours of uninterrupted sliding at an average speed of 33 feet (10m)/hr. The maximum speed which may be attained by the arch is 74 feet (24m)/hr.

"At all times the control system is monitoring the relative positions of adjacent units and applying compensation for minor deviations. The maximum deviation between adjacent vertical and horizontal supports is 5mm (0.2 in). In the event of deviations, the sliding will be stopped and corrections applied using jacks before re-starting," explains Caille.

Once in its final position, the arch will be elevated again and the sliding units removed, and the arch will be lowered onto the permanent bearings.

In order to clear some of the features on the existing structures, the east wall of the NSC is fitted with "tilting panels," which are raised for the sliding and will then be lowered or closed into position after the arch has reached its final location. These panels are then locked into position and form part of the east wall of the arch.

Caille says that after the sliding process and the positioning on the permanent bearings, the first activity will be to install the membranes which will seal the arch to the existing and newly built structures and form the actual containment.

"Simultaneously, all the systems' connections which could not be installed before the arch is in the final position will be completed. These include the connections to the technical building, which houses the control room. Many of the systems will have been subjected to commissioning procedures prior to the sliding, and stringent commissioning procedures will continue for about six months."

Codes and Standards

By the time the arch is slid into place and the final work completed, the project will have included over 300 subprojects involving many nations. With so many cooks in the kitchen, which codes and standards recipes were followed? How were differences reconciled?

The *BULLETIN* contacted Bechtel Corporation, which along with Battelle Memorial Institute and representatives of Chernobyl Nuclear Power Plant (ChNPP) make up the consortium that manages the SIP project and provides technical and fiduciary oversight. Electricité de France (EDF) was part of the original consortium but withdrew in 2010.

Bechtel's Oscar "Mac" McNeil is the managing director of the Chernobyl SIP's Program Management Unit. He confirms that the New Safe Confinement is implemented in accordance with Ukrainian norms and standards.

"Over the lifetime of the project, many of these have become standardized with European norms," he says. "But the application of codes has sometimes been challenging, as the Ukrainian regulators in some cases are

Lifting the PaR Systems Main Cranes System in the NSC, March 2016

not familiar with international codes and standards."

McNeil shares how the process has worked: "Normally, the contractor proposes use of a particular code that it feels is most applicable to the situation. The Project Management Unit (which is contracted to the State Specialized Enterprise Chernobyl Nuclear Power Plant [SSE-ChNPP]) reviews the proposal, makes a decision, and drafts a letter for SSE-ChNPP to send to the regulatory authority (RA).

"The lead Ukrainian RA is the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU), which obtains review by other RAs as appropriate, and concurs or rejects the proposed design."

McNeil says the SNRIU is also the principal regulatory interlocutor for project implementation. But, he adds, "There are a range of other regulators involved, including fire safety, construction, and health regulators who also play a vital role in oversight of project implementation."

The next stage will be dismantling the Object Shelter and the Unit 4 reactor. Outline proposals for the first stage

Memorial to Soviet Liquidators at the Chernobyl Power Plant with reactor Unit 4 in the background

of deconstruction work have been put forward. "However," McNeil explains, "detailed design is not likely to be taken forward in the short term, and decisions on this will be guided by the views of the government of Ukraine and the international community."

He says that the policies and procedures regarding site inspection once the NSC is operational will be determined during the commissioning of the NSC in a collaborative manner between the contractor (Novarka) and the SSE-ChNPP.

Long-Term Cleanup

While it's taken nearly two decades for the New Safe Confinement structure to come to fruition, once it is in place and operational, the real work begins. The new structure buys the people of Ukraine time to develop a careful strategy for the long-term dismantling of the Object Shelter, Unit 4, and removing the dangerous Fuel Containing Materials within. This cleanup will take decades to complete.

To make this unprecedented cleanup possible, PaR Systems, headquartered in Minnesota, developed two remotely-operated and radiation-hardened 315-foot-long (96m) bridge cranes, the Main Cranes System (MCS), which will be the primary workhorses inside the NSC to safely clean up the Unit 4 reactor and surrounding structures. The MCS uses two interchangeable hoist carriages and one Mobile Tool Platform (MTP) carriage. Both hoists will be used for heavy lifting duties; one hoist has redundant lifting design features for safe movement of personnel using a shielded protective box. The MTP carriage provides a unique, rigid platform for remote decommissioning tool deployment (PaR's TensileTruss™ technology), which is essentially the "point of the spear" of the NSC.

Chernobyl's Afterburn

The New Safe Confinement is an extraordinary bandage to help heal a deep nuclear wound. The men and women who have worked on this project are to be commended, as are the estimated half-million USSR military veterans who were involved in the extensive and dangerous cleanup efforts in the "Battle of Chernobyl." Many of those soldiers still battle health ailments from their work at the damaged site. To this day, the facts on the number of casualties and long-term effects of radiation exposure are disputed, and environmental studies are ongoing.

The scope of the Chernobyl project is fascinating and complex. The same could be said of Ukraine itself. Despite economic, political, and social difficulties the country has faced in the 30-year afterburn since the Chernobyl meltdown, construction at the NSC has persevered and is nearing completion. The ChNPP has been working to change the perception of Chernobyl from negative to positive, requesting media replace "accident" terminology associated with Chernobyl to words such as *technology*, *safety*, and *benefits*.

Associating today's Chernobyl with technology, safety, and benefits seems a fair request. The technology of the NSC is highly advanced, designed to provide a safe means for dismantling the radioactive wreckage of Unit 4. Plans are also underway for the safe storage of the spent nuclear fuel in Units 1-3, which will increase nuclear safety on the site.

While cleanup at the Chernobyl Nuclear Power Plant will continue for decades, safety is the polestar guiding the effort. And perhaps the lessons of Chernobyl will foretell a lasting legacy of nuclear safety for the world.

To learn more about the New Safe Confinement project, visit nationalboard.org, click on the *BULLETIN* button on the left side of the homepage, and find a list of links and related material the author used in researching this story.

Financing Nuclear Safety at Chernobyl: The World's Wallet

"The Chernobyl Shelter Fund (CSF) is the largest-ever international collaboration for nuclear safety," Vince Novak tells the *BULLETIN*. Novak is the director of the Nuclear Safety Department at the London-based European Bank for Reconstruction and Development (EBRD) – the international financial institution managing the Chernobyl Shelter Implementation Plan (SIP).

Novak oversees the EBRD's nuclear safety projects, including seven multilateral grant funds, in which more than 40 governments and the European Union (EU) have pledged over $4.5 billion. The funds provide assistance for critical nuclear energy safety, decommissioning, and spent fuel and waste management programs in Bulgaria, Lithuania, the Slovak Republic, Russia, and Ukraine. A key initiative of the nuclear safety arm of the EBRD is decommissioning Soviet-era nuclear facilities and equipment.

The EU established the EBRD in 1991 to help former Soviet bloc countries face extraordinary challenges in developing market-based economies. Former Soviet premier Mikhail Gorbachev has acknowledged that the 1986 Chernobyl disaster's financial, political, and social blowback was a precursor to the revolutions of 1989 – the very events that ushered in the EBRD's establishment.

The EBRD set up the Chernobyl Shelter Fund in 1997 at the invitation of donors. Two years earlier, the international community got involved with the Chernobyl disaster's aftermath when the EU and Group of Seven committed to assist Ukraine in dealing with the consequences of the accident in the Memorandum of Understanding in exchange for closure of Chernobyl Units 1 and 3, which were still in operation. (Unit 2 was closed after a fire in 1991).

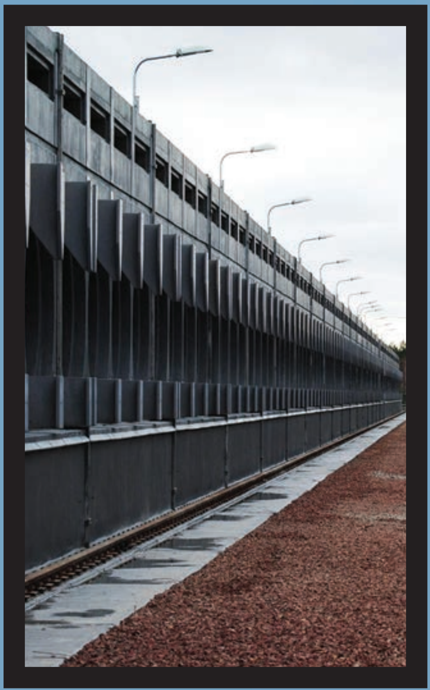


Photo: EBRD

The Interim Spent Fuel Storage Facility 2 (ISF-2) is a key facility for the decommissioning of Chernobyl reactor Units 1-3.

"The commitment to convert the site of the damaged reactor into a safe condition has been reaffirmed and reiterated at the G7/G8 summits since, and more than 35 countries joined the G7 and the European Commission in financing the Chernobyl projects," Novak says.

The fund finances work related to the destroyed Unit 4 reactor, as outlined by the SIP. "The New Safe Confinement construction and completion represents the culmination of the SIP program," Novak states. "At a cost of $1.7 billion, the NSC is the most prominent element of the overall Shelter Implementation Plan total of $2.43 billion. In April 2015, an international donor conference secured financing for the completion of the project."

Novak says the NSC will be managed and operated by Ukrainian authorities. "It is the clear expectation of the donor community that the long-term operational costs of the facility will be borne by Ukraine. As this task will be largely carried out by the existing Chernobyl staff, the additional operating costs will be limited to the utility costs and the long-term maintenance of the equipment. The nuclear waste management tasks will have to be defined in the context of Ukraine's strategy for the repository of the high-level radioactive waste."

A separate fund, Novak explains, finances other crucial work at Chernobyl. "Internationally funded works related to the decommissioning of Units 1, 2 and 3 are funded by the Nuclear Safety Account, the EBRD's first such fund, set up in 1993. Specifically, this fund finances the implementation of the Interim Spent Fuel Storage Facility (ISF2), which is currently in the final phase of construction. It will process, dry, and cut more than 20,000 fuel assemblies and place them in metal casks. These will be enclosed in concrete modules on site and stored safely and securely for a minimum of 100 years. Completion of the facility is scheduled for late 2016, and the total cost is estimated to be in excess of $339 million."

Though decommissioning will take decades, Novak says the crucial next phase of Chernobyl's transformation is about to begin. "Impressive progress has been made with the construction and we are confident that the NSC will be completed and in operation by the end of 2017."

Could Chernobyl Happen Here?

BY ROBERT P. MARTIN PH.D., P.E., BWX TECHNOLOGIES, INC., LYNCHBURG, VA.
METHODS DEVELOPMENT LEAD, SAFETY ANALYSIS
CO-AUTHOR, "CHERNOBYL: AN UPDATE" PUBLIC INFORMATION WEBSITE

The day following the Chernobyl accident in 1986, the *Houston Chronicle* ran a story speculating that 20,000 people had been killed. I was an undergraduate in nuclear engineering at Texas A&M at the time and the story had me questioning my choice of profession. Over the next few years the official number of casualties was confirmed to be much lower. Notably, the United Nations and the World Health Organization reported an official death toll of below 50, many of those from consequences other than acute radiation sickness or cancer.

In graduate school in 1995, I and others from the Penn State Student Chapter of the American Nuclear Society (ANS) volunteered to create a public information website in anticipation of Chernobyl's 10th anniversary. At that time, using the internet to communicate public information was still considered novel, its audience limited. This was uncharted waters for the ANS. It was important that we did not hide or diminish the facts. Our purpose for the website was simply to communicate the circumstances, event timeline, and lessons learned.

Twenty years after drafting the words for that Chernobyl accident website, I'm a seasoned nuclear safety professional. Regarding Chernobyl's legacy, I can say that in the span of my career I have seen significant international investment in related research and development. Revealed insights have been explicitly incorporated into plant licensing; that is, new designs must now consider broad incorporation of severe accident loads (i.e., thermodynamic and radiological).

Expansion of civilian nuclear power will depend on public acceptance based on safety, the marketplace, and the environment. Advanced designs reflect the many lessons learned since the previous generation of designs. Further, the newest designs are all substantially smaller than today's operating fleet, enhancing safety through simplicity and accident consequences that scale with size. Unfortunately, with inexpensive fossil fuel, market forces are not favorable. Can environmental concerns tip the scales in favor of nuclear power? Time will tell. In the meantime, new nuclear power stands ready as a viable and safe alternative to fossil fuel, which is necessary to combat climate change.

RBMK VS LWR

Could Chernobyl happen here? This is the chief concern of US citizens. The US has 61 commercial nuclear power plant sites with 99 operating nuclear reactors in 30 states – more than any other country – and many of them are near large population centers. The vast majority of nuclear engineers would answer this question with an emphatic "NO."

There are many significant design and operational differences between the Chernobyl-type reactors (RBMK, Russian acronym for light water graphite reactor) and US commercial light water reactors (LWR) that make a Chernobyl-style disaster essentially impossible in the US.

Major design flaws of the RBMK nuclear power plants heightened the magnitude of the Chernobyl disaster. Within the closed society of the Soviet Union, products of technology did not face the same scrutiny as their counterparts in the US and Europe; thus allowing risky ventures to reach fruition. The light water reactors built for commercial power in much of the world outside the Soviet Union contain passive and active features that would have prevented the Chernobyl accident.

There are a number of major and minor differences between the RBMK and US light water reactors. For the purposes of this discussion, only the major differences relevant to the Chernobyl accident are highlighted.

FUEL ASSEMBLIES

The fuel assemblies in the RBMK are contained in individual pressure tubes, whereas one pressure vessel contains all of the assemblies in a LWR. The reason for the RBMK design feature is that assemblies can be loaded and unloaded individually without shutting down the reactor. This is an advantage if the reactor is to be used for both plutonium and electricity production.

LWRs must be shut down for refueling and therefore the fuel is kept in as long as is economical. Water acts as both coolant and moderator in LWRs so that a loss of coolant also stops the fission reaction.

MODERATORS

In the RBMK, the moderator is solid graphite and the water coolant acts as a poison, meaning that the presence of water absorbs the reaction. If coolant is lost or is converted to steam, reactor power may increase. This is known as a positive void coefficient and it represents a serious design flaw. Under certain operating conditions, the power can increase uncontrollably until the reactor disintegrates. This is what happened at Chernobyl. No power reactor in the US can be licensed for construction or operation if it possesses this feature. The graphite blocks are also flammable at high temperatures. A number of Soviet citizens died in the process of putting out the fire caused by the explosion.

CONTAINMENT VESSELS

In addition to the shielding, LWRs have an even thicker wall of steel-reinforced concrete surrounding the reactor structure. This structure, called a containment vessel, prevents radioactive release in the event of an accident. Because of this feature, no member of the public was injured or killed when the reactor core melted at Three Mile Island in 1979 [and Fukushima in 2011]. By contrast, the Soviet RBMK does not possess a containment vessel.

STRICT REGULATIONS

In addition to these fundamental differences in design, US reactors are operated under strict regulations. Unlike those at Chernobyl, US reactor operators are unable to disable the safety systems which prevent dangerous situations from developing. Although equipment can malfunction and operators can make errors, the design of US light-water reactors prevents these mishaps from leading to dangerous releases of radiation.

CULTURE OF SAFETY

What is arguably the most significant difference between what was the Soviet nuclear industry and that of the US is the culture of safety that exists here.

Every analysis performed, every decision that is made, and every action taken is done so in the context of the safety of the plant, its personnel, and the local community. Contrary to what many people may believe, this safety culture does not reduce the profitability of the electric utility. Ask any plant manager and he or she will tell you that a safe plant is an efficient plant.

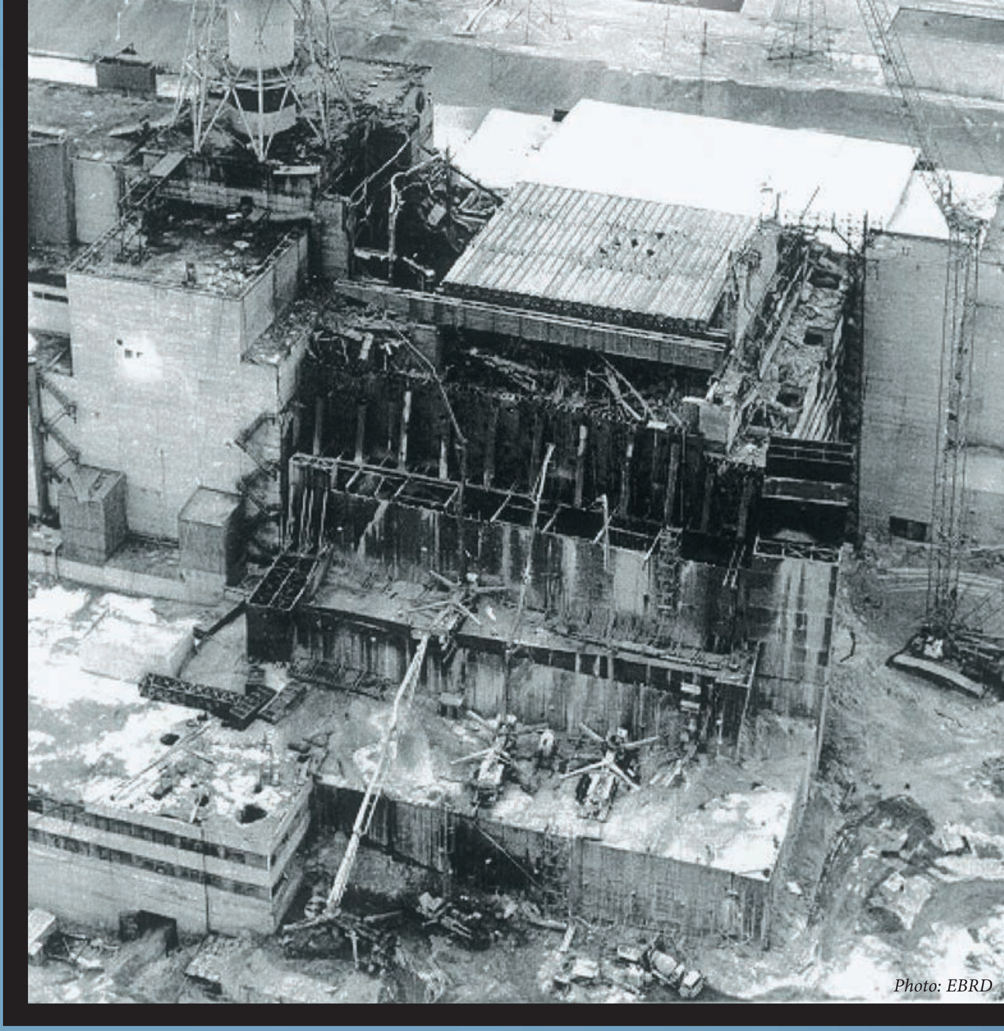
Equipment failure or operator mistakes can cost the utility millions of dollars in revenue in addition to regulatory fines. More important, however, is the fact that plant employees and their families are members of the local community and have a personal interest in the economic and safe operation of the plant.

RBMKs TODAY

There are currently 11 operating RBMKs in the world, all located in Russia. In the years since the accident at Chernobyl, major modifications have been made to these RBMK reactors and plants, and safety standards have been revised to improve safety.

The world's other RBMK plants (non-operating) are located in Ukraine (four reactors) and Lithuania (two reactors). The two Lithuanian Ignalina plants were closed in 2004 (Unit 1) and 2009 (Unit 2) as a condition for entry into the European Union.

Ukraine's Chernobyl Unit 1 was closed in 1996; Unit 2 in 1991; and Unit 3 in 2000.



Chernobyl reactor Unit 4 after the accident in 1986, showing the extent of the damage.

Robert P. Martin, Ph.D., P.E., is the Safety Analysis Methods Lead for BWX Technologies, Inc., in Lynchburg, Va., where he supports the development and licensing of the mPower small modular reactor. In previous capacities he has supported safety-related engineering and licensing activities for both operating nuclear power plants and advanced designs. He also contributed to the development of the RELAP5-3D thermal-hydraulic systems code for the Department of Energy's Idaho National Laboratory.

So When Is Section V, T-150(d), Invoked?

Requirements for NDE Procedure Qualification in Current ASME Construction Codes

BY ALEXANDER F. GARBOLEVSKY, P.E.
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At the conclusion of the feature article, "Seeking Clarity: NDE Procedure Demonstration Versus NDE Qualification" [National Board *Bulletin*, Fall 2014] it was noted:

> "Until there is further clarification from the Section V Committee through interpretations or rewrites, it appears that T-150, paragraph (d), is not applicable to the current construction codes."

This particular statement attracted the interest of the ASME Standards Committee for Nondestructive Examination (Section V). As a member of this Committee, and with its support, I was asked to provide a response to shed light on where NDE procedure qualifications are required. This article is limited to non-nuclear ASME Construction Codes.

Section V functions as a service reference code. No changes are anticipated in the current wording of T-150(d), which includes the clear admonition to users in its introductory sentence: "When required by the referencing code section. . . ." We need to look to the construction reference code sections for that "further clarification."

ASME Section I

ASME Section I recently published Interpretation I-13-23 to clarify that required written nondestructive examination procedures need not be qualified in accordance with Section V, Article 1, T-150(d).

> **Interpretation:** I-13-23
> **Subject:** Qualification of Written NDE Procedures (2013 Edition)
> **Date Issued:** June 3, 2014
> **File:** 14-252
> **Question:** Is it mandatory that written nondestructive examination procedures that are required by Section I be qualified in accordance with Section V, Article 1, T-150(d)?
> **Reply:** No.

In the 2015 Edition of Section I, paragraphs A-260.1 and A-270.1 were revised to state that magnetic particle (MT) and liquid penetrant (PT) examinations, respectively, ". . . shall be performed in accordance with a written procedure, demonstrated to the satisfaction of the Inspector, and certified by the Manufacturer to be in accordance with the requirement of T-150 (a) or (b) of Section V."

When Section I refers to ultrasonic examination (UT) in PW-11, the reader is redirected to PW-52. PW-52.1 states that ultrasonic examination is to be performed to the requirements of Section V, Article 4, Mandatory Appendix VII, "Ultrasonic Examination Requirements for Workmanship Based Acceptance Criteria." Since Mandatory Appendix VII does not invoke any procedure qualification requirements, T-150(d) would not apply. Section I, therefore, makes it clear that NDE procedure qualification is not a requirement.

ASME Section VIII, Division 1

In the 2015 Edition of ASME Section VIII, Division 1, an Intent Interpretation was published to clarify likewise that (MT) and (PT) examination procedures need not be qualified in accordance with paragraph T-150(d). The original question and reply are shown below:

> **Question:** Is it the intent of paragraphs 8-1(b) and 12-1(b) to require qualification of examination procedures in accordance with paragraph T-150(d) of Section V, Article 1?
> **Reply:** No.

As a result of this Intent Interpretation, revisions to Appendix 8-1(b) and Appendix 12-1(b) were made in the 2015 Code Edition to remove references to "qualifications."

Ultrasonic examination (UT) in Section VIII, Division 1, is referred in UW-53. This paragraph further directs the reader to Mandatory Appendix 12. Similar to the wording for MT and PT, paragraph 12-1(c) appears to invoke all of T-150; however, UW-53 does not "turn on" qualification of written (ultrasonic examination) procedures by any reference. The conclusion is that T-150(d) does not apply to UT performed to the requirements of UW-53.

For Section VIII, Division 1, when ultrasonic examination is used in lieu of radiographic examination ("UT in lieu of RT") as permitted in UW-51 (a)(4), there is a different conclusion reached regarding the need for performance qualifications. UW-51(a)(4) refers to Section VIII, Division 2, paragraph 7.5.5. Subparagraph 7.5.5.1, which states, ". . . ultrasonic examination shall be performed in accordance with a written procedure conforming to the requirements of Section V, Article 4, Mandatory Appendix VIII" ["Ultrasonic Examination Requirements for a Fracture Mechanics Based Acceptance Criteria"].

In this Appendix, paragraph VIII-421.2 requires Mandatory Appendix IX be used. Mandatory Appendix IX requires that the qualification of a UT written procedure be detailed. As a result, procedure qualification in accordance with T-150(d) is required when performing UT in lieu of RT for Section VIII, both Divisions 1 and 2.

Thanks to the clarifying actions taken by Sections I and VIII, T-150(d), procedure qualification requirements can now be shown to apply only when written ultrasonic examination procedures invoking the requirements of Section V, Article 4, Mandatory Appendix VIII, are called out in Section VIII, Divisions 1 and 2, fabrication to the 2013 and subsequent Editions.

ASME Code Cases

The *ASME Boiler and Pressure Vessel Code* and B31 cases that address ultrasonic examination require a special mention.

Users of B31 Case 181-2 (ASME B31.3 – Process Piping) and B31 Case 189 (ASME B31.1 – Power Piping), [the latter case addresses alternative UT acceptance criteria rather than "UT in lieu of RT"], should note that paragraph 1) c) in each of these documents calls out that "Procedure qualification shall meet the requirements of ASME Section V, Article 4, Mandatory Appendix IX." As a result, procedure qualification in accordance with T-150(d) is required when performing UT in accordance with these Code Cases.

The alternative rules given in Code Case 2235-13 (Section I – Power Boilers and Section XII - Rules for Construction and Continued Service of Transport Tanks) and B31 Case 186 (ASME B31.12 – Hydrogen Piping and Pipelines) are worded differently. Paragraph (c) of each of these states, in part:

> "The ultrasonic examination shall be performed in accordance with a written procedure conforming to the requirements of Section V, Article 4. The procedure shall have been demonstrated to perform acceptable on a qualification block . . . ."

Despite use of the term "qualification block" above, "demonstration" of the procedure is called out rather than "procedure qualification." This means, for Section XII, demonstration to the satisfaction of the Inspector, and certification by the Manufacturer in accordance with the requirement of Section V, T-150 (a) or (b), are required; however, procedure qualification in compliance with T-150(d) is not required.

Similarly, B31 Case 186 (ASME B31.12) only requires an acceptable demonstration, not a procedure qualification.

The following table is provided as an aid in recognizing when the referencing Code requires either qualification or demonstration of a UT procedure. Users should always refer to the applicable Code of Construction for complete details. ✤

Referencing ASME Code (2013 Edition unless otherwise noted)	Primary Referencing Paragraph(s)	UT Procedure Requirement per Referencing Paragraph(s)	"UT in lieu of RT" Procedure Requirement per Referencing Paragraph(s)
Section I	PW-11, PW-52	Demonstration	See Code Case 2235-13
Section I	Code Case 2235-13		Demonstration
Section VIII, Div. 1	UW-53	Demonstration	
Section VIII, Div. 1	UW-51(a)(4)		**Demonstration and Qualification**
Section VIII, Div. 2	7.5.4	Demonstration	
Section VIII, Div. 2	7.5.5		**Demonstration and Qualification**
Section VIII, Div. 3	KE-301	Demonstration	
Section XII	TE-110.3	Demonstration	See Code Case 2235-13
Section XII	Code Case 2235-13		Demonstration
B31.1 (2012)	136.4.6	Demonstration	See Case 189
B31.1 (2012)	Case 189		**Demonstration and Qualification**
B31.3 (2014)	344.6	Demonstration	See Case 181-2
B31.3 (2014)	Case 181-2		**Demonstration and Qualification**
B31.12 (2014)	IP-10.4.5.6	Demonstration	See Case 186
B31.12 (2014)	Case 186		Demonstration

NOTE: (Code) Cases are optional, alternative rules.

THE 85th GENERAL MEETING ORLANDO, FLORIDA HIGHLIGHTS

Attendees of the commemorative 85th National Board / ASME General Meeting May 9-13 shared a busy week of business and technical meetings, unique guest tours, and a toe-tapping Wednesday Evening Banquet that included a special presentation to Hartford Steam Boiler acknowledging the organization's 150th anniversary. The tropical Gaylord Palms Resort & Convention Center served as host site for the week-long event.

Following a heart-pounding, interactive performance by Drum Café on Monday morning, Jungle Jack Hanna shared the stage with tropical birds, tiny monkeys, and a camel as he told captivating stories about his career as America's favorite zookeeper. His message of being safe around wild animals resonated with the conference's overall theme of safety.

That afternoon, six industry professionals addressed the technical session of the Monday program: Vance Murphy (Zurich North America Insurance), Gary Scribner (The National Board), Scott Lynch (ABMA), Denis DeMichael (The Chemours Company), Mark Masters (HSB Global Standards), and James R. Chiles (author).

The "jungle" theme continued for guests on a backstage tour of Wild Florida wildlife park on Lake Cypress.

Tuesday was a full day of meetings for National Board members. They attended the ASME Conference Committee; the Members' General Discussion Session; and the National Board Members' Meeting, where elections took place and a variety of business items were presented. Meanwhile, the guest tour delighted attendees with out-of-the-ordinary experiences: Orlando's chic I-Drive 360 with access to the Orlando Eye observation wheel, Madam Tussaud's Wax Museum, and SEA LIFE Aquarium; a visit to Escapology, a real-life escape game; and a Cuban-themed lunch at Cuba Libre restaurant.

HSB presentation. LEFT to RIGHT: National Board Executive Director David Douin, HSB Senior VP of Inspection Services Roger Royer, HSB Senior VP of Engineering Kenneth Pisciotto, HSB Global Standards VP of Codes & Standards Tom Pastor, and ASME Associate Executive Director of Standards & Certification Michael Merker.

On Wednesday, guests and attendees traveled to Kennedy Space Center for an afternoon of self-guided tours of the facility's many fascinating and patriotic exhibits. That evening, the Midtown Men performed hits of the 1960s following presentations to Hartford Steam Boiler in recognition of the company's milestone.

New Members Elected

At the Board of Trustees meeting on Saturday, May 7, two new members were approved. Marvin Byrum will represent the state of Alabama, and David Sandfoss will represent the state of Nevada.

Safety Medal Recipient

National Board Executive Director David Douin and National Board Chairman John Burpee presented former Québec member Madiha El-Mehelmy Kotb the prestigious Safety Medal Award at the Opening Session of the General Meeting on May 9. The award acknowledges Kotb's decades-long service to public safety and involvement in the boiler and pressure vessel industry.

David Douin, Madiha Kotb, John Burpee

Honorary Member Acknowledged

Dr. Ken Lau, former National Board member representing Alberta, Canada, was presented his honorary member plaque and pin at the Tuesday Members' Meeting. The members elected Dr. Lau an honorary member at the October 2015 Members' Meeting.

David Douin, Ken Lau, John Burpee

Board of Trustees Election Results

National Board members voted to fill seats on the Board of Trustees at the Members' Meeting on Tuesday, May 10. Joel Amato of Minnesota was re-elected first vice chairman. He will serve a three-year term expiring May 2019. Eben Creaser of New Brunswick was elected member at large for a three-year term also expiring May 2019. Tony Oda of Washington was elected member at large to complete the unexpired term of Ken Watson. Mr. Oda's term will expire in May 2018.

Joel Amato

Eben Creaser

Tony Oda


FINISH
Atlantis


SAFETY

LARRY LEET

Chief Pressure Systems Inspector, City of Seattle

BULLETIN Photograph by Smith Productions

For Pressure Systems Inspector Larry Leet, a life lived is an understatement.

Translated: "The most interesting man in the world" has been eclipsed and his replacement now resides and works in the city of Seattle.

Consider: Larry is a card-carrying Choctaw Indian and a non-card-carrying Cherokee Indian. He is also a Square Knot Sailor (a rather exclusive fraternity of mariners who have crossed the equator, the international date line, the Arctic and Antarctic circles, and circumnavigated the globe). No, he does not have the square knot tattoo because he is not a tattoo kind of guy. He also knows how to skin a moose. Add to his list professional diver, licensed pilot, racer of motorcycles and sailboats, and amateur hockey player. He has also lived in every state west of the Mississippi River. And there's more.

It all started in Vernal, a small community of natural gas drilling fields just east of Salt Lake City.

"Dad was a chemical engineer," Larry explains with a smile. "Because of his work, our family was always relocating. We left Vernal six months after I was born."

His dad's work meant growing up in Kansas, Nebraska, California, and Illinois, to name only a few states in which he resided. "While I was in high school, we spent five years on the Kenai Peninsula in Alaska. We lived above a furniture store."

Despite getting his motorcycle license at 13 years old, student events at Larry's Alaska high school were limited to frontier activities. "So my friends and I were always fishing and hunting," he reveals.

Of particular interest to those who hunted was moose. "They were everywhere! Sitting in class at Kenai High School, it wasn't unusual for a hunter to request four or five classmates to haul a dead moose from the forest that had been quartered and skinned to an awaiting truck."

Following graduation in 1969, Larry joined the Coast Guard and was stationed in Seattle. It was here he received his first exposure to boilers. "At the time, I had no idea what I wanted to do professionally, but I received some on-the-job training as a marine diesel mechanic traveling the world on an icebreaker."

During his four-year Coast Guard career, Larry spent two years on the icebreaker and another two years on a 65-foot tugboat. Following his discharge in 1973, he joined the United States Army in 1974 for what he said was a change.

"I was able to take some college courses in the Army," he explains, "and I really wanted to pursue something exciting, such as cinematography or the graphic arts. While mechanics were easy for me, I found it to be less challenging."

Stationed in Seattle, Larry left the Army in 1978 with a two-year degree in construction trades. "That led me to obtaining my certificate in nondestructive testing and a job for eight years in a nondestructive lab."

While working "all over the Pacific Northwest," Larry decided to satisfy a desire to become a professional diver, something he had been exposed to in the Coast Guard. Qualifying in Seattle, Larry followed others from his diving school to pursue available jobs in New Orleans.

Now with a family, the Seattle official realized the South paid far less than what his family required. After seven months, he returned to Seattle and earned a degree in digital electronics and robotics with hopes of obtaining work with remote-operated vehicles (ROV). "A lot of companies back then had robots," he observed, "but they had no idea what to do with them." After learning that ROV jobs were not as plentiful as first thought, he began sending out resumes.

"A friend was able to get me part-time work during the summer at a fabrication shop," Larry recalls. "I went from sweeping floors to full-time responsibilities as a welder, quality control inspector, and finally quality control manager – all within two years."

Moving on to positions at two other fabrication companies, Larry became familiar with the ASME Code. "At the last company, an authorized inspector suggested to me that I should become a boiler inspector. So I took the National Board Commission exam and was fired when my supervisor found out about it."

Out of work for a month, Larry received a telephone call from American State Insurance with an offer to work in its Madison, Wisconsin, claims office. "Fortunately, I was only there for nine months before getting an opportunity to work for the company back in Seattle," he smiles.

"I was with the insurance company six years when I began to receive inquiries from the city of Seattle." Faced with staying with the insurance company or accepting a job as boiler inspector with the city, Larry put his fate in the hands of God. "It must have worked" he says with a grin. "I took the city's offer in 1998 and several months later the insurance company was bought out. First casualty of the takeover was a shutdown of the boiler section."

After three years as a city inspector, Larry was named chief pressure systems inspector. He joined the National Board in March of 2014 following Seattle's designation as a National Board jurisdiction.

In addition to a city licensing program for operators, Larry's department is responsible for more than 14,000 boilers and pressure vessels. He is supported by six staff and 12 insurance inspectors.

While Larry admits his has been a life of adventure, he emphasizes that he has experienced his share of rough patches. In 2013, Janet, his wife of 42 years, passed away right before Christmas.

As fate would have it, he met a lady who had just lost her husband of 32 years. At Larry's first General Meeting in 2014 in Bellevue, just outside of Seattle, Linda and Larry were having a nightcap at a hotel bar following the Wednesday banquet. Larry proposed and Linda accepted. The rest, as they say, is history. The two now celebrate their anniversary at each General Meeting.

Over his career, Larry has spent much of his free time racing motorcycles, sailboats, "and just about anything." Riding his motorcycle to work each day, he explains his "need for speed" has always been part of his competitive nature.

While many still contemplate what should be added to their bucket list, Larry says his nearly empty bucket is more of an opportunity than a conclusion to a life lived.

"It just means more space to refill it with the things I still want to do." ✤

The Installation and Inspection of Pr Controls For Proper and Safe Oper

Part Two of a Two-Part Series

BY STEVE KALMBACH

Part One of this two-part series (winter 2016 issue) reviewed the inherent fail-unsafe potential if probe-style low-water cutoffs are not properly installed, maintained, serviced, or tested. It provided an overview of conductance-actuated level controls, and listed tips for checking these controls during installation. This article reviews techniques for checking these controls during routine testing, servicing, and inspection.

"The bottom line in boiler operation is safety, and one way to ensure a safe system is to use the guidelines in this article. By starting with the suggested installation practices, such as using a dual-probe system mounted externally, to testing the controls daily, and performing a thorough annual boiler inspection, conductance-actuated controls can provide reliable and safe operation for many years.

Steve Kalmbach is the owner of Kasco, a boiler repair shop in Colorado. He can be reached at SKalmb4427@aol.com.

Review

Conductance-actuated level controls have been used in the boiler industry for many years and provide a good alternative to float and mechanical low-water cutoffs. Conductance-actuated controls, however, are not completely reliable and safe if they are not installed and maintained properly. Unfortunately, these controls get overlooked during servicing and inspection due to the fact that there is nothing that breaks or requires replacement. Also, the fact that factory-installed secondary low-water cutoffs, when installed in the boiler shell, generally are not easy to test and are easily overlooked during the operation of the boiler.

ASME CSD-1 and NFPA 85 both require a secondary low-water cutoff but give no direction as to the proper and safe installation of these controls. A dual-probe that is mounted externally provides the safest and easiest control to test and verify proper and safe operation. A single-probe mounted externally may not provide a ***fail-safe*** operation, but at least it could be tested to check for proper and safe operation.

The test-and-manual-reset feature on the newer controls is reliable if there is no short-to-ground in the probe wiring. If there is a short-to-ground when you are testing the control, you may get a false positive and an indication that the control is functioning properly, when in reality you have no protection at all. If this is the secondary low-water cutoff, it is the last chance to prevent a firing of the boiler without the proper water level, and everything should be done to ensure that this is a safe and reliable control that will function when it is needed.

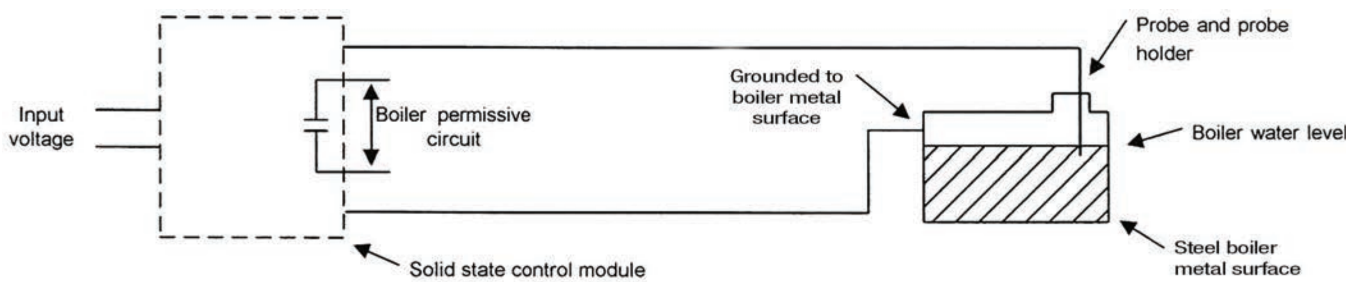
Now let's examine some techniques that can be employed during testing, servicing, and inspection.

Testing

Testing of low-water controls is generally performed daily and annually. A daily operational test is performed by the boiler operator and under actual operating conditions. This usually results in the boiler going offline for a period of time. When this is not possible, sometimes a low-water bypass switch is installed to allow uninterrupted

obe -Type (Conductance-Actuated) ation

Figure 1: Solid-State Relay (Grounded to Boiler Metal Surface)



boiler operation while testing the low-water controls. This does not prove proper and safe operation of the probes, however. The annual testing is done while the boiler is offline and the actual operation of the probes is verified for proper and safe operation. All testing should be performed by competent and qualified personnel. Consider the following:

1. Perform a resistance test on the probe holder and wiring during the annual boiler inspection. Disconnect the probe at the controller, and while there is no water contacting the probe, check for a high resistance. If the resistance is very low or zero, check for shorted or damaged probe wiring.
2. During operation, do a blowdown test of the probe under operating conditions to check for proper and safe operation. If the probe is externally mounted, this should be performed with the daily blowdown test of the primary low-water control. If the probe is located in the top of the boiler shell, a slow drain test will be required to indicate proper and safe operation. If the control has a test feature, this will not prove that the control functions properly if it is shorted to ground.
3. Use caution when performing a slow drain test to assess functionality of the control. To check the secondary low-water cutoff which is installed to operate at a lower level than the primary, bypassing of the primary low-water cutoff will be required. This may necessitate the attention of a qualified service technician and boiler operator. There is the possibility that this water level is below the visible part of the gage glass, and close monitoring will be required. This should be done while the burner is at its minimum firing rate to prevent any possible overheating of pressure vessel components due to the lowered water level. At the successful completion of this test, the bypass on the primary low-water cutoff should be removed and proper and safe operation of the primary low-water cutoff verified.

Servicing

Servicing usually is performed during the annual inspection. At this time the probe may be removed and visually inspected for the following:

1. Check probe wiring for any evidence of insulation damage due to overexposure of temperature. If probe conduit is in close proximity to high-temperature piping, check for heat damage to the wiring.

2. Perform a visual inspection of the probe-wiring-to-probe-termination connection. This area is exposed to the highest temperature, which may affect the probe wiring.
3. Check for proper sealing of the probe-to-pressure boundary on the pressure vessel. A leak at this location may allow corrosion to build up on the probe and possibly provide a short-to-ground.
4. Some controls may only be installed as a single probe. (See Figure 1.) Internally, the probe ground is connected to the control chassis. In this configuration it is critical that the correct connections be made at the control. Interchanging the probe and ground wiring will cause the control to ***fail-unsafe***. The test, reset, and power loss functions, if used, will still operate, however, and give a false positive.

Inspection

During the annual inspection, the waterside of the boiler is open, allowing a visual inspection of the probe-to-water interface.

1. Perform a visual inspection of probe, probe holder, and wiring to look for leaks on the pressure boundary, damaged insulation on the probe wiring, or any possible physical damage to the probe wiring conduit.
2. Perform a resistance test on the probe wiring and probe. Do this when there is no water contacting the probe, and the connection on the conductance-actuated control is disconnected. This resistance should be open (infinity) or at a very high resistance. Remember that these controls work on the conductivity of the boiler water, and as long as this resistance is higher than that of the boiler water, there will not be enough current to indicate that the water is in contact with the probe. This is an important test when a single probe is used. If the resistance is 0 ohms, look for a short on the probe wiring or, in the case of a solid-state control, interchanged probe and ground wiring.
3. Do a visual inspection of the probe while it is installed in the boiler, if possible, especially if there are internal parts or piping that may be in contact with the probe and pressure vessel.

Final Thoughts and Observations

Taking a proactive position when specifying new boilers or their installation will provide the benefit of having a control that reduces the possibility of ***failing- unsafe***. This will require the installation of a two-probe system in an externally mounted chamber, allowing testing of the control without doing a boiler slow drain test. If this probe is used as the secondary low-water cutoff, it can be tested and verified for proper and safe operation on the same schedule as the primary low-water cutoff test.

When the probe is mounted in the shell, which requires a slow drain test to check its functionality, it is a time-consuming event and presents numerous potential problems. The first item to be addressed is that the primary low-water cutoff needs to be bypassed. This in itself presents problems if the bypass is not removed at the completion of the test. Next, the boiler water level must be lowered through the bottom blowoff piping. This needs to be done at the minimum firing rate so there are no upsets to the boiler water circulation circuit, which could lead to overheating. The secondary low-water trip point must be of a level not lower than the lowest visible part of the gage glass. At the conclusion of this test, the primary level control must be verified as operational before leaving the boiler.

Good engineering and operating practice would require an externally mounted probe. Testing is easily done and the results are known immediately. The preference would be to use a two-probe system for ***fail-safe*** operation; however, a single probe is still acceptable as it could be tested on a regular basis to check for proper and safe operation. Still, a single probe does not provide for ***fail-safe*** operation.

The bottom line in boiler operation is safety, and one way to ensure a safe system is to use the guidelines in this article. By starting with the suggested installation practices, such as using a dual-probe system mounted externally, to testing the controls daily, and performing a thorough annual boiler inspection, conductance-actuated controls can provide reliable and safe operation for many years. ✚

The Inspector Supervisor (B/O) Course

New Agenda for Supervisor Course Provides Better Training for All

BY KIMBERLY MILLER, MANAGER OF TRAINING

Over the past several years there has been much discussion within the National Board Training Department regarding non-nuclear supervisor training, i.e., the **B** and **O** endorsed inspectors. During these discussions three main topics continued to surface:

- How can we balance technical training and the "softer skills" of being a supervisor?
- How can we best blend training for these two different types of supervisors?
- Is there a way to assess students outside of the technical content of the code books?

As you may know, our supervisor training course has always been geared toward the authorized inspector supervisor – the inspector seeking the **B** endorsement. And yet, this same training course has been used to train the inspector employed by an owner/user organization and needed to obtain the **O** endorsement. Although there are many overlapping aspects to these two positions, there are also many that are not. The biggest challenge we were faced with was providing a stronger course agenda for the inspector seeking the **O** endorsement, while maintaining the integrity of the material taught to the authorized inspector. And for both inspectors, our goal was a more applicable final examination, something we have received some negative feedback on from students over the years.

After much deliberation and many attempts to modify and improve topics, delivery, and overall flow of the training agenda, we believe we now have a winning formula. This past April we began implementing the new agenda, which includes classroom lectures delivered throughout the week covering topics such as duties and responsibilities; quality control; auditing techniques and attributes; and report writing. In addition, there are two expanded workshops (Assessment of Quality Programs and Auditing Checklists) which now have specific breakout sessions geared toward the owner/user supervisors in the room.

The agenda for the April class closed on day four with a two-hour discussion based upon real-life scenarios experienced by supervisors. This new discussion session is slated to become the third true workshop for the course, to be taught in the inspection room and enhanced with the integration of the room's equipment as part of each supervisor scenario. This new session will be integrated into the agenda during our next scheduled class.

As for the final examination, the composition of the exam was reviewed against the feedback we had received over the years. The outcome of that review is we learned we needed to begin assessing the students with a lesser emphasis on code questions and a stronger emphasis on those duties, responsibilities, and skills needed to be an effective supervisor – all of which is taught heavily throughout the course.

All in all, whether the student is an authorized inspector or an owner/user inspector, the new agenda provides for a much stronger foundation to all enrolled.

In addition, we now offer a separate examination specific to the owner/user inspector supervisor. And both the **B** and **O** exams now include at least one scenario statement with related questions to better evaluate the "non-technical" aspects of the week's training.

All in all, whether the student is an authorized inspector or an owner/user inspector, the new agenda provides for a much stronger foundation to all enrolled. This is why we have retitled this training the Inspector Supervisor **(B/O)** Course. We encourage all to attend!

Member Retirements


Gary Schultz

Gary Schultz, Nevada chief, retired January 20, 2016. Mr. Shultz started his career with the state of Nebraska in 1970 and then went on to join the United States Air Force in 1974. He retired as a chief master sergeant in 1996 with 22 years' service. Mr. Shultz then worked for the University of Nevada Reno as a boiler plant operator from 1998 to 2001. He was next employed by Traveler's Insurance as a loss control specialist from 2000 to 2001. He returned to Nevada in 2001 as a boiler/elevator inspector, safety supervisor, and chief boiler/elevator inspector.


Madiha Kotb

Madiha El-Mehelmy Kotb, P.E., retired December 18, 2015. Kotb's National Board membership as a representative of the province of Québec spanned 26 years. She was a member at large on the National Board's Board of Trustees from 1991 to 1993 and also served on both the Strategic Planning Committee and the Constitution and Bylaws Committee. In July of 2013, Kotb was elected to a one-year term as president of the American Society of Mechanical Engineers (ASME). She was ASME's 132nd president and the fourth woman to serve in that position. An ASME fellow and active member of the society for 30 years, her extensive leadership activities included serving on the ASME Board of Governors and as vice president of Conformity Assessment. She also served as a member of the ASME Committee on Governance and Strategy, the Council on Codes and Standards, the Committee on Ethical Standards and Review, the ASME Subcommittee on Nuclear Accreditation, and as lead volunteer member for Engineering for Change (E4C).


Benjamin Anthony

Benjamin Anthony retired December 31, 2015. He represented Rhode Island as a National Board member beginning in 2004. He served in the United States Marines from 1966 to 1970, including 14 months in Vietnam as an infantryman. He began his civilian career working as a heating plant engineer at a hospital in Rhode Island before accepting the position of chief engineer at Rhode Island College. In 1987, he went to work for the state as an inspector before becoming chief in 1999. He served on the National Board's Board of Trustees as member at large from 2014 to 2015.


Ralph Pate

Ralph Pate, who represented Alabama, retired April 1, 2016. Mr. Pate served in the United States Air Force, where he was trained as a heating systems technician. His civilian career began with Hartford Steam Boiler Company, followed by work for the state of Georgia under the very first Georgia chief, Earl Everett, for nearly 20 years. In October of 2003, Pate was recommended by Everett to temporarily help the state of Alabama set up a new boiler program. Then, in 2004, Pate was chosen as Alabama's first chief inspector.

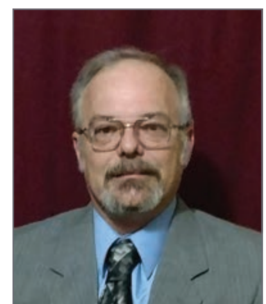
New Members


Aziz Khssassi

Aziz Khssassi represents Québec. Mr. Khssassi served in the Canadian Armed Forces as a vehicle technician from 1996 to 2000, then began his civilian career at Giben Canada Inc., as a field engineer. In 2009, he went to work for Giesecke & Devrient Canada Inc., as a senior field engineer. In 2012, he joined Régie du bâtiment du Québec. Mr. Khssassi holds a bachelor's degree in mechanical engineering and a master's degree in industrial engineering. ◆


William Anderson

William Anderson represents Mississippi. Mr. Anderson served in the United States Army. He is a boilermaker journeyman and was involved in the new construction of boilers in the early 1970s. Between 1973 and 2004 he was employed with Tennessee Valley Authority and supervised the construction of boilers in coal, fossil, and nuclear plants. He joined the state of Mississippi in 2012. ◆


Marvin J. Byrum

Marvin J. Byrum represents Alabama. Mr. Byrum served in the United States Navy for 26 years. He retired as a senior chief boiler technician and steam-generating plant inspector. During his time in the service, he authored the initial "Electronic Boiler Controls Program" and wrote the "Hagan Nuclear Feed Pump Controls" training course. He was hired by the Alabama Department of Labor in 2007 as a full-time boiler inspector. He is also a qualified elevator inspector. ◆

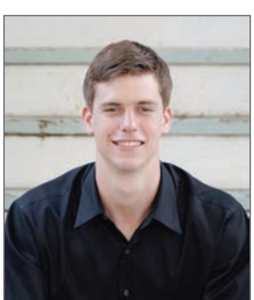

David A. Sandfoss

David Andrew Sandfoss represents Nevada. Mr. Sandfoss served in the United States Navy (SS) from 1977 to 1996, and retired as a nuclear machinist's mate. His civilian career began with CNA Insurance, where he worked as a loss control specialist until 2000. He then joined the state of Nevada as a safety specialist (boiler/elevator) from 2000 to 2008, until assuming the role of safety supervisor in 2008. ◆

2016 Technical Scholarship Winners


Sean Weech

Sean Weech attends Boise State University and is pursuing a degree in electrical/computer engineering. He will receive his undergraduate degree in 2018, and has been recommended to participate in an accelerated master's program where he can achieve a master's degree in just one year. Sean maintains a 3.5 grade point average and held an internship with McCain Foods, helping to improve the plant's safety procedures. His father is Commissioned Inspector Bruce Weech. ◆


Benjamin Wallace

Benjamin Wallace is a junior studying concrete industry management at Texas State University. His expected graduation date is December 2017. After graduation, Benjamin would like to pursue the National Board Authorized Nuclear Inspector (Concrete) "**C**" endorsement to add to his skill set. His career interests include project management, safety, and inspections. Benjamin maintains a 3.4 grade point average. His father is Commissioned Inspector Donald J. Wallace. ◆

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January 2016 NBIC Committee Meetings Summary

BY BRAD BESSERMAN, STAFF ENGINEER

NBIC Committee meetings were held January 11-14, 2016, at the Omni Hotel in Corpus Christi, Texas. Over the four days, the following 11 meetings were conducted:

- One NBIC special task group meeting: **NR** task group
- Four NBIC subgroup meetings: *Installation*; *Inspection*; *Repairs and Alterations*; *Historical Boilers*
- Four NBIC subcommittee meetings: *Installation*; *Inspection*; *Repairs and Alterations*; *Pressure Relief Devices*
- NBIC Executive Committee
- NBIC Committee

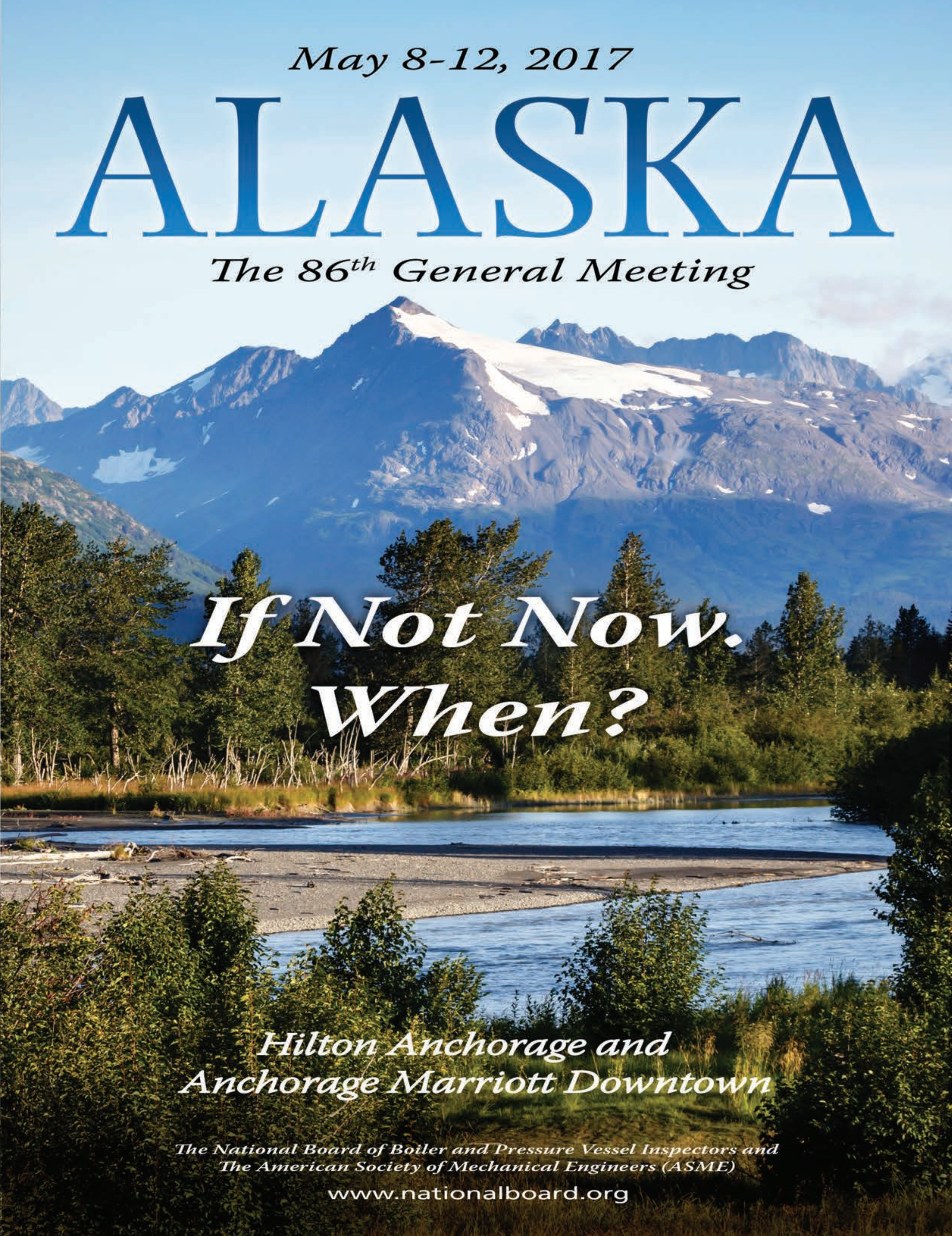
This week of meetings was one of the best attended in the history of the NBIC Committee. Well over 100 members and visitors worked on 117 proposals for code change or interpretation over the course of the week. By the end of the meetings, the following had been accomplished:

- 19 proposals for code change were approved
- 16 code change requests were reviewed and closed with no action taken
- Four committee responses to interpretation questions were approved
- 18 additional proposals for code change were sent to letter ballot, with the goal of approval prior to the July 2016 NBIC Meeting

The most notable code change approved by the NBIC Committee was the creation of NBIC Part 4, *Pressure Relief Devices*. Part 4 will contain all pressure relief device (PRD)-related information currently found in Parts 1, 2, and 3. Duplicate pressure relief device text will remain in Parts 1 and 2, but all pressure relief device information will be removed from NBIC Part 3. The NBIC will be published in four Parts starting with the 2017 Edition.

Other major code changes approved at this meeting include the creation of NBIC Part 1, Supplement 6, *Special Requirements for the Installation of Condensing Boilers;* and the creation of NBIC Part 2, Supplement 11, *Inspection of Biomass Fired Boiler Installations*.

The next NBIC meeting is July 18-21 in Columbus, Ohio.


May 8-12, 2017
ALASKA
The 86th General Meeting
If Not Now. When?
Hilton Anchorage and
Anchorage Marriott Downtown
The National Board of Boiler and Pressure Vessel Inspectors and
The American Society of Mechanical Engineers (ASME)
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Headquarters, Training and Conference Center,
and Inspection Training Center
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Columbus, Ohio 43229-1183
Phone 614.888.8320
Fax 614.888.0750

Testing Laboratory
7437 Pingue Drive
Worthington, Ohio 43085-1715
Phone 614.888.8320
Fax 614.848.3474