A quarterly publication brought to you by ABSA, the pressure equipment safety authority.

PRESSURE NEWS

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WINTER IS COMING – PROTECT YOUR PRESSURE EQUIPMENT

Alberta can experience very cold temperatures throughout the winter months. When pressure equipment is exposed to temperatures below zero, it can easily be damaged by the expansion of contained fluids as they freeze.

These incidents can result in significant financial losses both in damage to property and in plant down-time. Worse still, such damage can sometimes be difficult to detect, and subsequent operation of the equipment may have safety implications, with the **POTENTIAL FOR A CATASTROPHIC FAILURE CAUSING INJURY OR DEATH**.

Every year, ABSA receives numerous incident reports detailing damage to equipment due to freezing. There have also been reports of significant overpressure events due to operation of equipment when freezing damage to adjacent lines had isolated the equipment from its pressure relief device. Fortunately, in the last five years, there have been no serious injuries or fatalities as a result of these types of incidents, although the costs relating to repairing affected equipment and loss of production time have been **substantial**.

From 2017 to 2022 ABSA received 144 incident reports relating to freezing of pressure equipment. Several of these incidents resulted in damage so severe that pressure vessels or piping ruptured. The vessel in the adjacent picture was at a well-head site that ruptured when its contents froze, due to a loss of building heat. In 2023, 17 incident reports, attributed to freezing, have been received. Fortunately, none of these incidents resulted in an injury or fatality.

To help mitigate these occurrences, **it is important that equipment owners implement an effective pressure equipment winterization program**. It is imperative that any equipment affected by a freezing incident be taken out of service immediately. If freezing is suspected or has been observed, the equipment involved must not be placed back into pressure service until it's been subjected to a proper inspection and integrity evaluation.

The use of damaged components in pressure service can be highly hazardous, and components damaged by freezing often cannot be repaired. With the winter heating season also comes increased use of heating boilers. **Albertans are reminded to ensure that their boilers are in proper operating condition, including facilities providing for fresh air and evacuation of flue gases, and for proper ventilation of boiler rooms.**

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ABSA: In This Issue

COMPLEXITIES OF DESIGNING PRESSURE VESSELS FOR CYCLIC SERVICE

Pressure vessels serve as vital components in various industrial applications, ensuring the safe storage and transport of fluids under high pressure. As designers and users of these vessels, it is crucial to address the challenges posed by cyclic service where repeated loading can lead to fatigue failure.

While the ***ASME Code, Section VIII, Division 1***, provides general design guidelines, it lacks specific criteria for vessels in cyclic service. However, ***ASME Code, Section VIII, Division 2***, offers criteria to withstand cyclic loading. This article will explore the complexities of designing pressure vessels for cyclic service and highlight key factors to ensure safe and reliable operation.

Fatigue failure in pressure vessels refers to progressive, localized, and permanent structural changes that occur under repeated or fluctuating stresses with a maximum value lower than the material's tensile strength. Unlike other forms of degradation, fatigue damage is not solely influenced by the time in service; the number of stress repetitions is the critical factor.

"Unlike other forms of degradation, fatigue damage is not solely influenced by the time in service; the number of stress repetitions is the critical factor."

THE PROCESS INVOLVES THREE MAIN STAGES:

Crack Initiation → Crack Propagation → Eventual Rupture

A common example illustrating the concept of fatigue is straightening and bending a paperclip back and forth until it breaks.

THE FATIGUE LIFE OF PRESSURE VESSELS IS INFLUENCED BY VARIOUS CONDITIONS, INCLUDING:

Cyclic stress state	The number of stress cycles and the stress range
Geometry	Sharp corners, small radii, and small fillets ***decrease*** fatigue life
Surface quality	Polished surfaces ***increase*** fatigue life compared to non-polished surfaces
Weld quality	Any defect in a weld ***decreases*** fatigue life. Weld surfaces are machined to ***increase*** fatigue life
Material type	Some materials are more ***fatigue-tolerant*** than others
Residual stresses	Stresses resulting from manufacturing processes such as forming and welding ***decrease*** fatigue life
Size and distribution of internal defects	Inclusions like sulfides in steel ***decrease*** fatigue life
Grain size	Fine-grain steels are more ***fatigue-tolerant*** than coarse-grain steels
Environment	Corrosive environment ***decreases*** fatigue life
Temperature	Extreme high and low temperatures ***decrease*** fatigue life

It is vital to consider these factors during the design and fabrication stages to optimize vessel longevity and performance.

Design details play a critical role in minimizing stress risers and concentrations, which are common precursors to fatigue failure. While it may not be possible to eliminate all stress concentrations, certain design elements should be avoided in cyclic service.

THE DESIGN ELEMENTS INCLUDE:

- **Integral construction is *preferred* to reduce localized stress points.**
- ***Avoid* fillet welds for attachments to the pressure boundary.**
- ***Eliminate* reinforcing pads and threaded connections.**
- ***Minimize* partial penetration welds and stud bolt connections.**
- ***Avoid* placing nozzles in the knuckle region of heads.**

Additionally, abrupt changes in thickness, geometry, misalignment, defects in construction, and thermal gradients can lead to significant localized stresses in cyclic service. Minimizing peak stresses is essential, as they often become the key factors in fatigue analysis. Welded regions require special attention, considering factors like local surface notches, variation of material properties, residual stresses, internal defects, and weld repairs.

Fatigue analysis is a complex process that requires the expertise of experienced analysts. Determining the need for fatigue evaluation involves careful assessment. Refer to ***ASME Code, Section VIII, Division 2*** to evaluate specific requirement for this purpose.

As pressure vessels approach their predicted end of life, regular examinations should be conducted to identify any signs of wear, corrosion, or other degradation that may affect their fatigue life. This helps decide whether to replace the vessel or extend its life through proper repairs, analysis, and fitness-for-service assessments.

Designing pressure vessels for cyclic service presents unique challenges that demand a thorough understanding of fatigue failure and meticulous attention to design details. Strategic planning, regular examinations, and meticulous record-keeping and monitoring will contribute to extending vessel life, minimizing downtime, and optimizing resources throughout their operational lifespan. By adhering to guidelines set by ***ASME Code, Section VIII, Division 2***, and conducting comprehensive fatigue analyses, designers and users can ensure the safe and reliable operation of pressure vessels in cyclic service. Thus, enhancing the overall safety of industrial processes.

> **"Minimizing peak stresses is essential, as they often become the key factors in fatigue analysis."**

ASME CODE ADOPTION IN ALBERTA

A new edition of the Boiler and Pressure Vessel (BPV) Code was released on July 1st, 2023.

ASME mandates that 6 months after the release the 2023 BPV Code becomes mandatory (January 1st, 2024). Manufacturers are free to implement the Code earlier if they choose.

Under the provisions of the Safety Codes Act, unless the Minister adopts it sooner or later or with limitations, the 2023 BPV Code automatically *"comes into force on the first day of the month following the expiry of 12 months after the date on which the amendment or replacement is published."* Meaning it will be **mandatory in Alberta on August 1st, 2024**.

> **"Manufacturers are free to implement the Code earlier if they choose."**

FUTURE OF ASME B31.12 HYDROGEN PIPING AND PIPELINES

In July 2023, ASME B31.12 Section Committee, has approved to **move relevant requirements for hydrogen piping and pipelines from B31.12 to B31.3 and B31.8, ultimately withdrawing B31.12 after the transition is completed.**

WHY?

To address current issues with ASME codes for hydrogen piping and pipelines, the rationale for this ASME decision includes:

- Significant gaps or concerns with the current B31.12 Code
- No clarity or consistency in applying ASME rules for construction of piping and pipelines for hydrogen fluid services because the scopes of B31.1, B31.3, B31.12, and arguably B31.8 include hydrogen fluid services
- A large movement in the pipeline industry to update and improve ASME code language as they relate to hydrogen pipelines
- The energy industry has identified that transmission and distribution pipeline integrity are key areas for the success of the hydrogen industry
- Relevant changes made to both B31.3 and B31.8 have not been incorporated into B31.12

> "After both B31.3 and B31.8 are published for the second time with the relevant content, ASME will withdraw B31.12."

THE SCOPE OF THIS ACTION INCLUDES THREE STEPS:

STEP 1

Move relevant guidance and requirements for hydrogen pipelines into *ASME B31.8* and address the integrity management of hydrogen pipelines in *B31.8S*

STEP 2

Move relevant guidance and requirements for hydrogen piping into *ASME B31.3*

STEP 3

Withdraw *ASME B31.12* at a reasonable interval after steps 1 & 2 are published

HOW?

The ASME's plan for transition of these changes includes:

- After **Step 1** is complete, ASME will:
  - Publish at least one edition of B31.12 referring to B31.8 for alternate requirements for hydrogen pipelines; and
  - May develop one or more Code Cases to address the immediate or urgent issues prior to publication of hydrogen versions of B31.8 and B31.8S
- After **Step 2** is complete, ASME will:
  - Publish at least one edition of B31.12 referring to B31.3 for alternate requirements for hydrogen piping.
- Once **Steps 1 & 2** are approved, there will be no more B31.12 revisions. The B31.12 Section Committee will handle interpretation requests and development of Code Cases only
- After both B31.3 and B31.8 are published for the second time with the relevant content, ASME will withdraw B31.12.

WHEN?

For **Step 1**, the ASME's plan is to complete this move for inclusion in the 2026 edition of the B31.8 and B31.8S Codes.

For **Step 2 & 3**, ASME is in the process of establishing timelines.

NEW CRN FORMAT

ABSA is currently issuing boiler and pressure vessel CRNs using the single alphabet letter prefix and are issuing CRNs that are above Z9400.2.

It is estimated in November 2023, ABSA will issue CRN Z9999.2, and the transition to the new boiler and pressure CRN format will be necessary. ABSA is transitioning its processes to be ready for double alphabet letter prefix for boiler and pressure vessel CRNs.

The new CRN format will be the double alphabet letter prefix that was discussed during the 2010 ACI meeting in Halifax. Following this ACI decision, CSA B51 "License Plate" TSC discussed the new CRN format, accepted the approach, and concluded that additional examples may be added to Clause 4.3.5 of CSA B51 in the future.

For registrations across Canada where a design is registered first in Alberta, databases and software will need to be adjusted to accept the new CRN format. As a reminder, ABSA and industry has approximately **two months to prepare our processes for this transition**.

CURRENT FORMAT:

Y0001.2 to Y9999.2

Z0001.2 to Z9999.2

NEW FORMAT:

AA0001.2 to AA9999.2

AB0001.2 to AB9999.2

SUPERVISION OF WELDER PERFORMANCE QUALIFICATION TEST REQUIREMENTS PER ASME SECTION IX QG-106

In Alberta, some shops are misunderstanding the term "qualifying organization".

Shop owners thought the commercial welder test centers with ABSA AOQP program are the "qualifying organization", so welders are sent to be tested over there, once the welders passed the test, they will be working on the construction of ASME Section I & Section VIII-1 pressure components.

In fact, the commercial welder test centers with ABSA AOQP program are not the qualifying organization referenced in the Code. The qualifying organization is the shop themselves.

> "The qualification test must be under the full supervision and control of the Manufacturer."

ASME Section IX, paragraph QG-106

"Each organization is responsible for the supervision and control of material joining performed by persons for whom they have operational responsibility and control. The Code also states: "this responsibility can not be delegated to another organization".

ASME Section IX, paragraph QG-106.2 (a)

"The personnel who produce test joints for performance qualification shall be tested under the full supervision and control of the qualifying organization".

Paragraph QG-106.2 (c)

"Production of a test joints under the supervision and control of another organization is not permitted".

Per **paragraph QG-106.2 (c)**, the shops are allowed to subcontract any or all of the work necessary for preparing the materials to be joined in the test joint, and the subsequent work for preparing test specimens from the completed test joints, and the performance of non-destructive examination and mechanical tests, these are the works done by commercial welder test centers. Please note that the supervision of the test is not on the list which is allowed to be subcontracted. The welder or welding operator must be qualified by the boiler/pressure vessel Manufacturer to work on **ASME Section I** and **Section VIII Code** items. The qualification test must be under the full supervision and control of the Manufacturer.

THE ABSA CODE UPDATE (ACU) SEMINAR

Registration for the ABSA Code Update (ACU) seminar in Edmonton and Calgary are **near capacity**.

The seminar will also be recorded and available online for registrants unable to attend in-person in November 2023.

To register, visit: www.absa.ca/seminars

SEMINAR DETAILS

Edmonton: *October 12, 2023*

Four Points by Sheraton - Edmonton South.
7230 Argyll Road, Edmonton, AB T6C 4A6

Calgary: *October 19, 2023*

Best Western Premier Calgary Plaza Hotel & Conference Centre.
1316 33 Street NE, Calgary, AB T6A 6B6

UPCOMING SEMINARS

Design Registration	Edmonton	November 15–16
PESL	Edmonton	November 8–9
Pressure Piping	Calgary	October 4–5
Pressure Piping	Edmonton	November 1–2
Pressure Piping	Calgary	November 29–30
Quality Systems	Calgary	November 7–9
Repairs & Alterations	Calgary	November 22–23
Regulatory Information for Power Engineers	Calgary	October 27

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