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Welded boiler drums — a historical review

Author: Philip Gilston, Principal Engineer, Codes & Standards

On April 3, 2024, with three plaques acknowledging its history, the world's first welded boiler drum was installed at its new home at the National Board of Boiler and Pressure Vessel Inspectors (NBBI), 94 years after it had been "tested to destruction." After moving the drum in recent years from its longtime home in Chattanooga, Tennessee, to Windsor, Connecticut, General Electric Steam Power sought a permanent home for it and reached out to the NBBI.

The drum, which is 8 feet long, 34 inches in diameter, and has a wall thickness of 1 inch, weighs 4,000 pounds. The drum was registered as a national historic landmark, first by the American Society for Metals (ASM) in 1976 and again in 1980, by the American Society of Mechanical Engineers (ASME).

Fig. 1. Gilston, P. (2024). First welded boiler drum. GE Windsor, CT/USA

Fig. 2. The National Board of Boiler and Pressure Vessel Inspectors. (2024). First welded boiler drum. NBBI Columbus, OH/USA

Development of welding for boilers and its incorporation into the ASME Boiler and Pressure Vessel (BPV) Code

Beginning in the late 1920s, a subsidiary of Combustion Engineering Co. began test welding boilerplate material. These tests culminated in the first of a series of boiler drums being hydrostatically tested to destruction on May 2, 1930. The vessel, designed with a safe working pressure of 517 psig, eventually failed at a pressure of 3250 psig when the expansion under hydraulic pressure caused the manway opening to distort, resulting in a leak that terminated the test.

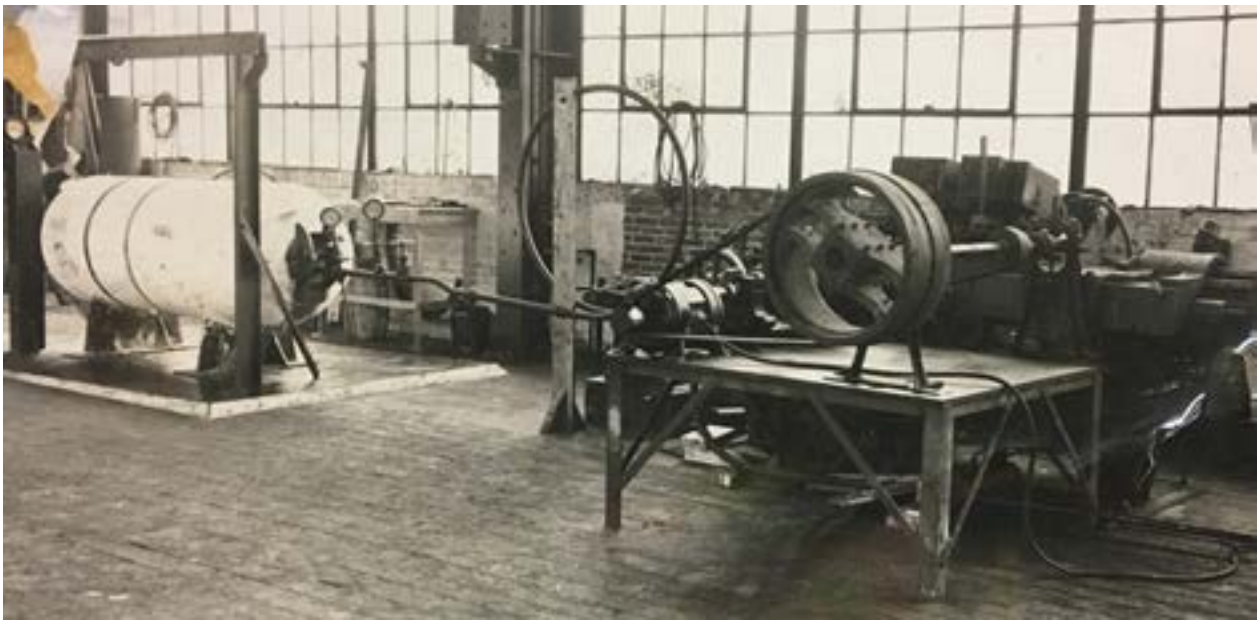

Fig. 3. Gilston, P. (1930). Under test. Combustion Engineering, USA

While the process of a welded joint using the forging process, which was outlined in one paragraph for a total of 83 words in two sentences, was included in the 1924 edition of the Code, it was in 1931 that the first rules permitting the fabrication of drums or shells for power boilers using fusion welding were introduced.

Paragraph P-101 a through h, which we would recognize as PW-53 in the 2023 edition of the Code, laid out the requirements for qualification coupons, and testing, as well as providing some welding definitions. It also included subparagraph i that addressed nondestructive testing using X-rays. The acceptability of welds was to be judged by comparison with a reference set of standard radiographs available from the Boiler Code Committee. When the Code was first printed, it was noted that "These sample films were not available before going to press. Fig. P-4 will be used until the new films are available." (ASME Power Boiler Code, 1933)

In addition to the longitudinal welded seams, rules for welded head attachments and fusion welded nozzle construction were also described.

Stress relieving was to be performed:

> *".. by heating uniformly to at least 1100 deg. fahr., and up to 1200 deg. fahr., or higher, if this can be done without distortion. The structure or parts of the structure shall be brought slowly up to the specified temperature and held at that temperature for a period of time proportioned on the basis of at least one hour per inch of thickness, and shall be allowed to cool slowly in a still atmosphere." (ASME Power Boiler Code, 1933)*

The path to these new rules was presented and discussed at the National Board of Boiler and Pressure Vessel Inspectors 8th Annual meeting in 1930, which was held on June 17, 18, and 19 at the Patten Hotel in Chattanooga, Tennessee.

Fig. 4. Matt L. Brown & Co. Hotel Patten. Chattanooga Public Library. (1940) https://collections.chattlibrary.org (2024)

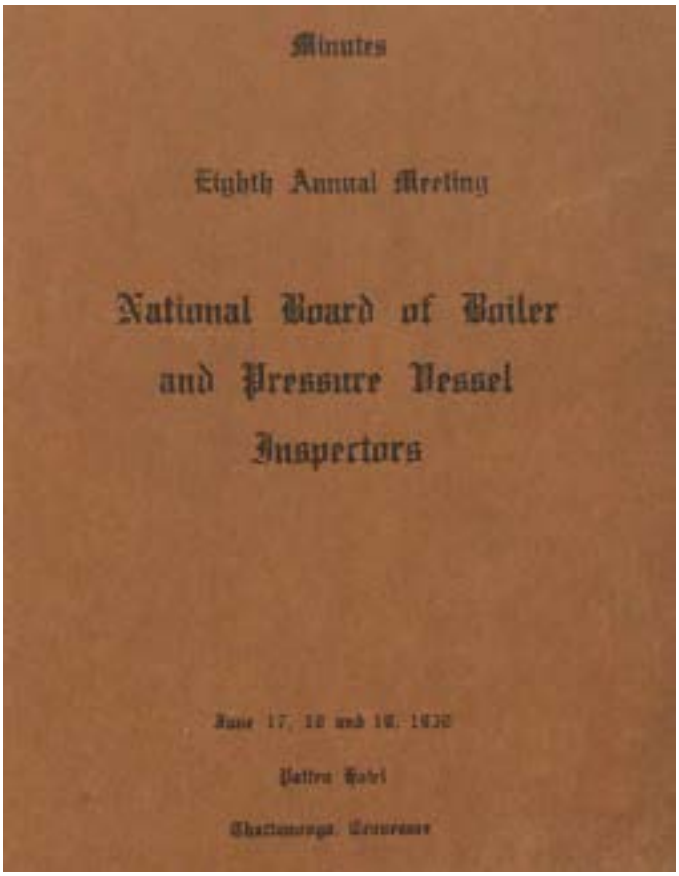

Fig. 5. The National Board of Boiler and Pressure Vessel Inspectors (2024). Minutes of 8th Annual NBBI meeting. NBBI Columbus, OH/USA

At this meeting, A.J. Moses, the shop superintendent of Hedges-Walsh-Wiedner (the subsidiary of Combustion Engineering) in Chattanooga, presented a paper titled "Development of Proposed Specifications for Fusion Welding of Drums or Shells of Power Boilers."

The urgent need for welded construction was driven by the inadequacy of forged and riveted parts to operate at pressures from 900 to 1500 lbs. unless the diameters of those parts were restricted to impractical limits.

The paper reviewed rules that the ASME Committee was developing, noting Combustion Engineering agreements with some and offering alternate opinions on others.

As well as the tests previously described, the presentation also addressed pressure testing. The initial part of the discussion debated the proposal for "Fatigue Testing" of the annealed vessel, by subjecting it to 10,000 cycles between zero and 1 1/2 times the working pressure in 10 to 12 cycles per minute. However, the preferred method discussed by the presenter was to test the vessel near the elastic limit at 2 1/2 times the safe working pressure. In the end, the published requirements called for a test pressure of twice the allowable working pressure to be held for sufficient time to inspect all joints and connections.

Manufacturers and inspectors

One of the recommendations made by Moses in his presentation was that to eliminate any responsibility for hazardous structures, it would be necessary to ensure proper equipment and trained organizations. It was deemed essential that a governing body such as, he suggested, the National Board, license those manufacturers who wished to use this type of

construction. The minutes published from the National Board of Boiler and Pressure Vessel Inspectors 8th Annual meeting in 1930 provide an interesting read on this subject.

Further, it was recognized there was a need for a system of checking the required testing to ensure that such licensed manufacturers met their demonstrated ability and that this should be performed by specially trained Inspectors to "...function under special orders." (National Board of Boiler and Pressure Vessel Inspectors, 1930) It was suggested that the Code specify the inspection and manufacturing requirements to obtain permission to build welded drums and shells for Power Boilers. The Code also addressed inspection, stating that the Inspector may designate the work they wished to inspect and that the manufacturer should submit the drum for such inspection.

The code put into practice

In early June 1931, The Hartford Steam Boiler Inspection and Insurance Company gave Combustion Engineering Company the approval to construct fusion welded unfired pressure vessels. Soon after, the first commercial land boiler fabricated by fusion welding to the ASME Code requirements was shipped to the Fisher Body Division of General Motors Corporation.

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Phil joined Hartford Steam Boiler in February 2022. He holds a bachelor's degree in metallurgy and a master's degree in welding technology. He is a Chartered Engineer registered with the UK Engineering Council and holds an International Welding Engineer diploma.

Prior to joining HSB, Phil worked for a major power company providing welding and materials support for large industrial boiler projects, as well as QA management for Code Certification of Authorization. Within Codes and Standards, Phil provides technical support and training in the areas of welding and fabrication for boilers and pressure vessels.

Phil is also very active on ASME Boiler and Pressure Vessel Committees. He currently serves as the vice chair for Subgroup Fabrication & Examination of Section I, Member SG Materials – BPV I, Member Section I Executive Committee, Member of Section IX SG General Requirements and BPV IX Committee. Phil is also a member of two NBIC committees, Subcommittee Repairs & Alterations and Task Group Interpretations.

Modification of data reports

Author: Paul Coco, Senior Engineer, Codes & Standards

With pressure equipment, the accuracy and integrity of data reports are paramount. However, situations may arise where modifications are necessary, raising questions about the recertification process. Specifically, when a data report, previously certified during a prior Certificate of Authorization period, requires modifications, should recertification be based on the current or original Certificate of Authorization period?

The NBIC Guide for Completing Data Report and Repair Forms (NB-11) addresses how corrections should be handled. This guidance delineates distinct approaches depending on whether the report has already been registered with the National Board or not.

The Guide can be obtained at: https://www.nationalboard.org/SiteDocuments/Registration/NB-11.pdf

One may interpret the Guide to include two options for a Certificate Holder to follow depending on whether the data report has been registered or not. These options are:

1. Correcting reports that *have not been* registered with the National Board:

   - Corrections made by whiteouts, markups, or other changes shall be legibly initialed and dated by both the Manufacturer's representative and the Authorized Inspector (AI) at the point(s) of correction.
   - The Data Report *should not* be marked "Corrected Copy."

2. Correcting data reports *that have been* registered with the National Board:

   Two options could be followed, but in both cases, it is required to mark the report with "Corrected Copy," noting the date of correction in the top right-hand corner.

   - Option one for correcting the report is to mark up a clear legible copy of the original report and certify in the same manner as described above for reports not yet registered. This option can only be used if an original report is already on file with the National Board.
   - Alternatively, a new original report can be prepared. The date of the Manufacturer's Certificate of Authorization and the date of inspection will be the same as the original report, but the dates of signature certifying the report should be the current date.

In both scenarios:

a. If the Inspector initialing the changes is not the same Inspector who originally signed the report, the new Inspector shall sign, date, and indicate their National Board commission number below the certification block.

b. In the case where a Certificate Holder has changed their Authorized Inspection Agency (AIA), then a clear legible copy of the original data report (not a new original report) shall be marked up, and the new AI shall initial and date the changes along with the Manufacturer's representative. Further, in the remarks section of the report, the name of the new AIA and the Inspector's information shall be listed, signed, and dated by the AI. The words "For Documentation Purposes Only" shall also be added to the remarks section.

In all cases, the recertification process should involve close collaboration between the entity responsible for the data report and the relevant regulatory authorities. Clear communication and adherence to procedural guidelines are crucial in ensuring a smooth and compliant recertification process.

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Paul joined HSB in January 2014. Paul is a graduate of the United States Naval Academy where he earned a Bachelor of Science in aeronautical engineering. Paul also holds a Master of Engineering Management and a Master of Science in Mechanical Engineering. Paul served in the U.S. Navy from 2002 through 2010. During this time, one of his many responsibilities included the role of Reactor Mechanical Division Officer and Training Officer, where Paul was responsible for the safe operation of a nuclear power plant onboard a Nuclear Powered Aircraft Carrier. From 2007 through 2010, Paul joined the Mechanical Engineering Department at the U.S. Naval Academy, where he taught Applied Engineering Thermodynamics for Naval Applications as a Military Professor. After Military Service, Paul then joined the U.S. Nuclear Regulatory Commission (NRC) as a reactor operations engineer, where he conducted detailed technical reviews of nuclear licenses in accordance with federal codes and standards, and performed quality assurance inspections on domestic and international nuclear vendors for nuclear safety related components. Within the HSB Codes and Standards group, Paul is responsible for providing code technical support to internal and external clients with a focus on nuclear construction to ASME Section III and the associated nuclear conformity assessment programs. He is responsible for the development, maintenance, and delivery of technical training related to nuclear construction, as well as supporting the HSB NQA Services Program. Paul is also responsible for the development of HSB's remote inspection program and is the technical lead on emerging renewable technologies. He holds a Professional Engineer License in the state of Maryland, National Board Endorsements as an AI and ANI, and is a member of various ASME Section III committees.

Ask the engineer

Author: Julie Hoskinson, Senior Engineer, Codes & Standards

In the June 2024 edition of Pressure Points, we published a piece in Ask the Engineer regarding SA-105 custom flanges (Click here to read the original.) The following questions came in response to that piece. All references below are from ASME Section VIII, Division 1, 2023 Edition.

Q: A standard B16.5 flange is made of SA-105 as forged. According to Section VIII, Division 1, may this flange have an MDMT of 0 deg. F (-18 deg. C) without impact testing?

A: Yes. Paragraph UCS-66(c)(1)(-a) provides an impact testing exemption for ASME B16.5 flanges in the as forged condition down to an MDMT of 0 deg. F (-18 deg. C).

Q: Can this same flange MDMT be further reduced from 0 deg. F (-18 deg. C) by applying the coincident ratio as defined in paragraph UCS-66(b) and Figure UCS-66.1?

A: Possibly. The flange would need to have a coincident ratio of less than 1 as defined by Figure UCS-66.1. Paragraph UCS-66(b)(1)(-b) states, "Figure UCS-66.1 (Figure UCS-66.1M) may also be used for components not stressed in general primary membrane tensile stress, such as flat heads, covers, tubesheets, and flanges." (© American Society of Mechanical Engineers. All rights reserved.) It is important to read the rest of the paragraph UCS-66(b)(1)(-b), which gives more details on how to determine the ratio and limits this impact exemption to an MDMT of -55 deg. F (-48 deg. C).

Q: In a similar situation, a flange is made of SA-105 as forged, but it is a custom Appendix 2 designed flange. Is the answer the same?

A: No. UCS-66(c) only applies to ASME B16.5, ASME B16.47, and long weld neck forged flanges. A custom SA-105 flange as forged would need to follow UCS-66(a) and be assigned to Curve A. Once that minimum exemption temperature is established using Figure UCS-66, the MDMT may be further reduced by using Paragraphs UCS-66(b)(1)(-b) or UCS-66(b)(1)(-c) as applicable.

Q: Is it possible to use UG-20(f) to exempt either of these flanges [Custom SA-105 flange as forged or standard B16.5, SA-105 flange as forged] to an MDMT of -20 deg. F (-29 deg. C)?

A: Possibly. All the provisions of UG-20(f) would need to be met in order to apply this impact testing exemption to the pressure vessel that includes either/both of these flanges.

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Julie joined HSB in 2006 and has been part of the Codes & Standards group since 2014. She has been successful in several different roles within the company, starting as a project manager serving several of HSB's largest customers and supporting their international pressure equipment inspection and certification needs. In 2009, Julie completed a temporary assignment as the design manager for the HSB International design office in Socx, France. Beginning in August 2011, Julie worked as a program manager responsible for DOT/Transport Canada Cylinder and Cargo Tank Inspections and European Pressure Equipment Directive (PED) Services, including managing two major transitions of the HSB Notified Body.

Julie is a graduate of the University of Minnesota with a Bachelor of Science in chemical engineering and is pursuing an M.S. in material science and engineering from University of Florida. She is a National Board of Boiler and Pressure Vessel Commissioned Inspector, holding an "AI" and "IS" Commission. Julie is currently chair of ASME BPV VIII Subgroup on General Requirements and chair of Task Group Fired Pressure Vessels. She provides technical support and training on ASME Boiler and Pressure Vessels Codes and other international pressure equipment regulations/standards, including the Pressure Equipment Directive.

Take note!

Malaysia DOSH compliance changes

The Malaysia Department of Occupational Safety and Health (DOSH) has repealed the Factories and Machinery Act of 1967 replacing it with the Occupational Safety and Health (Plant Requiring Certificate of Fitness) Regulations (OSH) 2024. The new regulation will affect your DOSH compliance, but HSB is here to support you in making the necessary adjustments to ensure compliance.

HSB is authorized to conduct design reviews and inspections of boilers and pressure vessels installed in Malaysia. Our program complies with the new regulation, and we are ready to assist you in meeting this challenge.

June 1, 2024, brought significant changes. Design reviews and inspections are no longer covered by the Factories and Machinery Act. Our design reviews and inspections will now be covered by the Occupational Safety and Health (Plant Requiring Certificate of Fitness) Regulations (OSH) 2024. Some critical changes that you may see as a result of the new regulation will be:

- A revised design verification document.
  - Our Design Verification Certificate (DVC) has been updated to reflect the OSH 2024.
- OSH 2024 regulations have implemented test report requirements.
  - During our inspections, a new Pressure Test Report has been implemented to meet the new OSH requirements.
- The Fifth Schedule form has been removed from the regulation.
  - We will provide you with an Inspection Certificate certifying your pressure equipment has been reviewed and inspected.

DOSH has made changes that may impact your operations. HSB, with over 150 years of serving the boiler and pressure vessel industry, is ready to help meet these new compliance requirements and minimize any disruption to your operations. Our experienced staff is pleased to assist with your company's compliance.

If you have any questions, please contact us at GetInfo@hsb.com.

Carriage of dangerous goods (CDG) accreditation scope expansion

HSB is pleased to announce the successful expansion of our CDG accreditation scope. This significant enhancement enables HSB to provide a global, one-stop-shop inspection service for both new construction and in-service equipment under ADR, RID, IMDG, CSC, TPED, and UK TPE regulations.

Key terms	
CDG	Carriage of Dangerous Goods Directive 2008/68/EC
ADR	Transport by Road
RID	Transport by Rail
IMDG	International Maritime Dangerous Goods Code
CSC	International Convention for Safe Containers
TPED	Transportable Pressure Equipment Directive 2010/35/EU
UK TPE	Transportable Pressure Equipment (GB)
MEGCs	Multiple Element Gas Containers

The new scope covers:

- **Pressure receptacles:** providing comprehensive conformity assessment services, including type approval, initial inspection, testing, reassessment of conformity, in-house inspection service surveillance, and periodic inspection for both UN and non-UN pressure receptacles. Our expertise spans 40 ISO standards, covering cryogenic vessels, seamless and welded steel gas cylinders, aluminum alloy cylinders, composite cylinders, cylinder bundles, service equipment, and more, all under the latest ISO and EN standards.
- **UN MEGCs, non-UN MEGCs, and offshore tanks:** full-service inspection and conformity assessment for MEGCs and offshore tanks. This includes type approval, supervision of manufacture, and all necessary in-service inspections as required by RID, ADR, and IMDG Code chapters 6.7.5 and 6.8.
- **In-service inspections:** the newly extended scope includes comprehensive in-service inspection services, such as periodic, intermediate, and exceptional checks, under ADR chapters 6.2, 6.7, and 6.8. These inspections help ensure all equipment remains compliant throughout its operational lifecycle.
- **TPED and UK TPE compliance:** HSB now offers full conformity assessments for TPED and UK TPE marked equipment, ensuring compliance with the highest standards for transportable pressure equipment in both European and Great Britain markets.

For further information, please email GetInfo@hsb.com, or visit us online at HSB | Global Inspection and Engineering Services to request a quote.

Events calendar

2024 virtual technical training seminars – click here to register

October 8&9	NBIC Repairs and Alterations (E23)
October 15-17	ASME Section III, Division 1 - Overview and Nuclear Certification Process (E23)
November 13&14	ASME Section IX - Welding Requirements (E23)
November 19-21	ASME Section VIII, Division 1 - Boilers & Pressure Vessels (E23)

2024 on-site technical training seminars

October 9&10	ASME Section VIII, Division 1 | ASME Section IX (E23)	United Arab Emirates	faisal_veeran@hsb.com
October 12&13	ASME Section IX - Welding Requirements (E23)	Kingdom of Saudi Arabia	nader_alyousef@hsb.com
October 16&17	ASME Section VIII, Division 1 | ASME Section IX (E23)	Kuwait	faisal_veeran@hsb.com
November 11-13	ASME Section VIII, Division 1 (E23)	Mexico	luis_carreiro@hsb.com
November 14&15	ASME Section IX (E23)	Mexico	luis_carreiro@hsb.com

For more information on HSB training and events, please email us at GetInfo@hsb.com. New topics may also be added throughout the year. Click here to visit the HSB Bookstore.

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