

PRESSURE POINTS

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ASME CODE NEWS

By Codes and Standards Group

Questions & Answers

Q When designing flat heads and covers, bending stresses at the edge or in the center of the cover typically control the design thickness. Per UG-23(c), when loads subject a component to a combination of primary membrane stress plus primary bending stress, the stress in the component shall not exceed 1-1/2 times the maximum allowable stress value in tension from Section II, Part D. Does this mean that I can use 1.5S for the allowable stress when calculating the required thickness?

A No. When you look at the thickness equations for welded and bolted flat heads given in UG-34, S represents the maximum allowable stress value in tension as given in the allowable stress tables from Section II, Part D. However for the case of welded covers [Eq. (1) of UG-34(c)], an adjustment is made to this allowable stress within the C factor, effectively increasing the allowable stress to 1.5S. The C factor also accounts for the edge condition (from simply supported to fixed). But in the case of bolted covers, this adjustment is not made since the Code takes a very conservative design approach for bolted components to minimize the chance of leakage in service. So, in summary, the allowable stress used in the UG-34 thickness equations should be taken directly from the allowable stress tables given in Section II, Part D, since any necessary adjustments related to a higher allowable stress for a bending condition is automatically built into the C factors.

Q Is it required that the pressure vessel Manufacturer perform product analysis chemistry and/or mechanical tests as permitted by the material specification in order to determine that the material and Material Test Report (if required) provided by a material supplier or manufacturer meet the material specification?

A No, per UG-90(b)(1) and UG-93(a)(1) the Manufacturer and Inspector shall verify that all material used for construction is properly marked, and the Inspector shall examine the MTR to determine that it represents the material and meets the requirements of the material specification.

Product analysis can be performed for additional quality verification if desired by the Manufacturer. [See the August 2003, Vol 6 No. 1 issue on this topic on our website.]

THE 2007 EDITION OF THE BOILER AND PRESSURE VESSEL CODE WILL BE PUBLISHED JULY 1, 2007

The 2007 Edition will contain hundreds of changes approved over the past year, and the Codes and Standards staff will be issuing their annual Synopsis of code changes later this summer. For a preview of some of the upcoming 2007 revisions, log on to our website (www.hsbglobalstandards.com), navigate to the Synopsis page and look up E07 Pending. As in past years, the complete Synopsis document will be finalized and posted on our website late in August.

OVERVIEW OF ASME 2007 SECTION VIII, DIVISION 2

By Thomas P. Pastor, P.E., Vice President
Codes and Standards Group

ABSTRACT

In 1998, ASME decided to undertake a project to completely rewrite the Section VIII, Division 2 pressure vessel code. Significant advances in pressure vessel design and related sciences such as materials, welding and NDE highlighted the need for a complete updating and modernization of this "design by analysis" standard. A survey of code users was conducted at the beginning of this project to identify subject matter in the standard that were of primary interest to the petrochemical industry, and every effort has been made to meet their needs. The project is nearing completion, and this paper will highlight the significant features of the new standard, and provide the latest status on remaining tasks and the publication schedule.

BACKGROUND

In 1998, the ASME Boiler and Pressure Vessel Committee authorized a project to rewrite the Section VIII, Division 2 pressure vessel code. This decision was made shortly after the design margin on ultimate tensile strength (UTS) was revised from 4.0 to 3.5 in Section I and Section VIII, Division 1. ASME saw the need to update Section VIII, Division 2 to be more competitive with other international standards, and in lieu of revising the existing standard, the decision was made to perform

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a clean sheet rewrite. By doing so it was felt that not only could the standard be modernized with regard to the latest technical advances in pressure vessel construction, but it could be structured in a way to make it more user-friendly for both users and the committees that maintain it.

ORGANIZATION OF NEW CODE

The organization of the new VIII-2 is very different from the current standard, utilizing a flat modular structure to facilitate future revisions and additions. The standard is made up of nine parts as follows:

- Part 1 - General Requirements
- Part 2 - Responsibilities and Duties
- Part 3 - Material Requirements
- Part 4 - Design by Rule Requirements
- Part 5 - Design by Analysis Requirements
- Part 6 - Fabrication Requirements
- Part 7 - Inspection and Examination Requirements
- Part 8 - Pressure Testing Requirements
- Part 9 - Pressure Vessel Overpressure Protection

In addition to these nine parts, normative and informative annexes are utilized within each Part, eliminating the use of mandatory and nonmandatory appendices that are traditionally placed in the back of the standard.

Part 1 - General Requirements

This Part addresses the scope of this standard with respect to the types of pressure vessels covered, as well as the definition of the geometric boundary for the stamped item. In addition this Part covers unit of measurement, reference standards, technical inquiries, and global definitions. Similar to other ASME B&PV standards, either US Customary, SI or local customary units may be used to demonstrate compliance with the standard. Annex 1.C provides guidance for the use of US Customary and SI Units within this standard.

Part 2 - Responsibilities and Duties

Part 2 consolidates responsibilities and duties of the User, Manufacturer, and Authorized Inspector. The most significant change in this area has to do with Registered Professional Engineer (RPE) certification of the Manufacturers Design Report (MDR) and the Users Design Specification (UDS). An alternative to RPE certification is provided which will facilitate the use of the new VIII-2 outside of North America. This alternative will require that the engineer certifying either the UDS or MDR has the requisite technical and legal stature, and jurisdictional authority to certify such a document.

One other significant change concerns maintenance of records. The Manufacturer needs to supply to the User the complete technical file containing all pertinent documentation related to the construction of the vessel, as well as retain these records for a minimum period of three years after stamping of the vessel. Some of the items required to be retained are:

- Users design specification
- Manufacturers design report
- Manufacturers data report
- Manufacturers construction records, including welding procedure specifications, procedure qualification records, records of all heat treatments, results of all production test plates, NDE procedures, results of all NDE examination, etc.

Part 3 - Material Requirements

Part 3 contains several significant enhancements relative to the existing VIII-2:

- The allowable stress basis is set to $UTS/2.4$ at room temperature and $2/3S_y$ at design temperature. This aligns the new VIII-2 with current European pressure vessel standards and VIII-3.
- The toughness rules were updated and the minimum Charpy VNotch impact test requirement was increased to 20 ft-lb (27 J). In addition, impact test exemption curves for carbon and low alloy steel are now provided with and without the influence of PWHT. Finally, the option to establish the design MDMT using fracture mechanics methodology (similar to VIII-3) has been added.
- A master stress-strain curve has been developed which utilizes S_y , UTS, and elastic modulus functions to introduce temperature dependence. This calculated stress-strain curve is used when applying the design by analysis rules of Part 5, as well as when performing buckling calculations when it is necessary to determine the tangent modulus.
- Two sets of design fatigue curves are provided; 1. Smooth bar design fatigue curves using the same design methodology as presented in Appendix 5 of the current VIII-2; 2. Welded joint design fatigue curves utilizing the new Master S/N Curve and the Structural Stress Method for determining the equivalent structural stress.

Part 4 - Design By Rule Requirements

The VIII-2 rewrite will contain both design by rule (DBR) and design by analysis (DBA) options. Numerous enhancements were made to the design by rule section, several of which are highlighted below:

- A new format was introduced to present the design rules in a manner to enhance readability and facilitate computer implementation of the required calculations.
- Weld joint efficiencies are introduced in the VIII-2 rewrite permitting for the first time less than 100% volumetric examination for main vessel welds, with various limitations.
- Introduction of explicit design rules for combined loadings (i.e. pressure, weight, wind and earthquake), as well as adoption of the ASCE 7-2002 Load Combination Methodology
- New design rules for ellipsoidal and torispherical heads.
- External pressure rules based on Code Case 2286 and utilizing the tangent modulus derived from the master stress strain curve given in Part 3.
- New opening reinforcement rules based on pressure-area stress calculation.
- New rules for conical transition subject to internal/external pressure.

- Inclusion of bellows and tubesheet design rules based on Part UHX from VIII-1.
- Inclusion of design rules for jacketed vessels, noncircular vessels, and vessel supports.

Part 5 - Design by Analysis Requirements

The design by analysis section was reorganized based on the mode of failure:

- Protection against plastic collapse
- Protection against local failure
- Protection against collapse from buckling
- Protection against failure due to cyclic loading

Another significant change is that the minimum wall thickness can be established using DBA rules in lieu of following DBR requirements. This is a significant departure from the philosophy that exists in the current VIII-2.

Some other enhancements to Part 5 are:

- Continued use of stress classification and the Hopper Diagram.
- Introduction of Structural Stress concepts that provide a new fundamental method to compute membrane and bending stresses using FEA that is mesh insensitive. This structural stress method is used when performing a fatigue analysis of welded joints.
- New requirements for design based on local failure strain, replacing the existing limits on triaxiality.
- New procedure for elastic plastic design using FEA and the Master Stress Strain curve.
- New method for fatigue assessment based on Structural Stress concepts for assessment of welded joints.
- Explicit DBA rules for evaluating collapse from buckling
- Recommendations for linearization of stress results from FEA for stress classification.
- Normative annexes are provided for the design of perforated plates based on elastic stress analysis, and rules are provided for experimental stress analysis.

Part 6 - Fabrication Requirements

Part 6 contains a consolidation of fabrication requirements from the original VIII-2 Part AM and Part AF, as well as some fabrication rules from VIII-1. Similar PWHT requirements are planned for the initial release; however, new time-temperature-thickness criterion for PWHT is under development.

Part 7 - Examination Requirements

Rules for examination of welded joints have been completely rewritten in Part 7. The concept of defining "examination groups" for pressure vessels, based on the practice used in several European standards has been utilized. Also with the introduction of weld joint efficiencies in the new VIII-2, the option for partial radiography is now available. However unlike the spot RT rules of VIII-1 where 1% of a weld joint is examined, when permitted in Part 7 partial radiography will

require between 10 and 25% of the weld to be examined. Other significant features of Part 7 include:

- Provision for UT in lieu of RT; requirements are given regarding when manual versus automated UT shall be performed.
- More extensive visual examination requirements, similar to the British standard procedure PD 5500.
- For vessels for which the fatigue analysis as mandatory, all surfaces of pressure boundary components (internal and external) shall be examined by MT or PT following a hydrostatic pressure test. This requirement is taken from Section VIII, Division 3, KE-400.
- Part 7 also contains a normative Annex outlining Inspector and Manufacturer duties for inspection and examination.

Part 8 - Pressure Testing Requirements

The hydrostatic test pressure factors are now set to the greater of $1.43 \times \text{MAWP}$ or $1.25 \times \text{MAWP}(\text{ST/S})$, bringing them in alignment with the PED. The pneumatic pressure test option is retained, however when used the vessel must be monitored by acoustic emission examination during the test. Finally the Manufacturer must maintain complete records of the final pressure test.

Part 9 - Overpressure Protection

Basic rules for overpressure protection will be virtually identical to that currently published in VIII-1. For that reason, most rules for overpressure protection will be referenced to VIII-1 instead of publishing again in this new VIII-2. Rules not covered in VIII-1, such as Overpressure Protection by Design (Code Case 2211), will be presented in Part 9. Annex 9.A contains best practices for the installation and operation of pressure relief devices, which is based on the latest revision to Appendix M of VIII-1.

SUMMARY

The majority of the goals outlined in 1999 for the rewrite of Section VIII, Division 2 have been satisfied in the draft approved by the ASME B&PV Standards Committee in February 2007. A completely new and more user-friendly organizational structure to the book coupled with adoption of the latest technology available for construction of pressure vessels will hopefully result in a standard that will serve the petrochemical and refinery industry for decades to come. Ongoing activities related to the project include beta testing by existing VIII-2 Certificate Holders, addressing accreditation issues, and preparation of a separate Examples Manual.

The new Section VIII, Division 2 (2007 Edition) will be published on July 1, 2007, and will become mandatory January 1, 2008. A code case has been approved (Code Case 2575) that will allow for an 18 month transition period during which VIII-2 Certificate Holders will be able to construct to either the old VIII-2 (2004 Edition through 2006 Addenda) or the new VIII-2.

A more detailed explanation of each of the nine Parts of the new standard will be published in future editions of Pressure Points.

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HSB Global Standards
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Hartford, CT 06141-0299

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