PRESSURE BUILDS for user-friendliness

Both new technology and major format changes modernize an old pressure vessel code. By David A. Osage and Steven J. Rossi

Standards organizations historically use a consensus approach to develop new technologies. But in the modernization of a key pressure vessel code, the objective of consensus-building took on an expanded scope.

The newest version of one of ASME's pressure vessel codes, known as Section VIII, Division 2, has been updated not only in its content, but also in the organization and presentation of the information it contains. What's more, the method by which the new edition was developed differed in many ways from earlier practice. The new VIII-2, which becomes mandatory on July 1, may serve as a model for future standards development.

Before the project to rewrite the Section VIII, Division 2 pressure vessel code began, an ASME committee of industry veterans surveyed potential users in the petrochemical and manufacturing industries to build consensus on what these target users wanted. "Make the code more user-friendly" was one of the top requests.

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In a business environment where modern technology serves up an abundance of information on illuminated screens, industry experts increasingly believe that user-friendly presentation and organization of new codes and standards is key to their active use. The survey results confirmed that not only do users demand the latest technology innovation, but also a structure that makes the standard easy to use and understand.

"We had no choice if we were to develop a world-class pressure vessel design code that would exceed our customers' needs," said Louis Hayden, ASME's vice president of Pressure Technology Codes and Standards, who served as project manager for the rewrite. "To be blunt, [the standard] was difficult to use, particularly for early-career engineers. We needed to start from scratch after reviewing pressure vessel codes from around the world."

The ASME Boiler and Pressure Vessel Code was first published in 1915, and the initial edition of the Unfired Pressure Vessel Code, Division 1, was distributed in 1925. As far back as the 1960s, it was recognized that the special requirements for design of pressure vessels operating at pressures over 2,000 psi (13.7 MPa) called for special rules, and ASME issued Section VIII, Division 2, *Alternative Rules for Pressure Vessels* in 1968.

These codes have been actively maintained and updated by a dedicated group of volunteers, but it was becoming difficult to work within the older format. The increased understanding of failure mechanisms and advances in material science, nondestructive testing, and computer-aided design have progressed to the stage where a new approach was needed not only in the content of design codes, but in the way they are presented and organized.

By doing a clean-sheet rewrite, the standard has been modernized not only with the latest technical advances in pressure vessel construction, but also in a structure that is friendly for both users and the committees that maintain it.

International Pressure

International codes and corporate engineering practices had demonstrated with over 30 years of operating experience that a lower design margin, along with advanced engineering practices, resulted in safe pressure vessel construction. With a design margin of 3.0, the old Section VIII, Division 2 was not commercially competitive with European standards. In the new edition of VIII-2, the design margin value is 2.4.

What's more, the old VIII-2 required a lot of extra and unnecessary analysis, and was not very cost effective.

According to Tom Pastor, Hartford Steam Boiler vice president and chair of the ASME Subcommittee on Pressure Vessels that authorized the rewrite, "Senior volunteers felt it was time to turn our attention to VIII-2. VIII-2 was not a heavily used standard, and thus it was not kept up to date at the same pace as VIII-1."

Traditionally, the development of new standards by ASME is carried out by volunteer committees. The ASME Boiler and Pressure Vessel Committee consists of a volunteer manpower base of about 800 engineers. But experience with previous new code or rewrite activities demonstrated that the volunteer manpower base did not have enough industry-sponsored time to finish the project quickly and efficiently. The last major standard developed completely by volunteers was Section VIII, Division 3, for vessels operating at pressures above 10,000 psi, which took nearly 15 years to complete.

JAPAN STEEL WORKS

▲ The Section VIII, Division 2 code applies to vessels like this hydro-desulfurization reactor, built by Japan Steel Works.

"Accomplishing this using only the volunteer manpower base would have detracted significantly from the quality of the new code and added significantly to the required development costs and time by a factor of two or more," said Guido Karcher, who chaired the Board on Pressure Technology Codes and Standards from 2005 to 2008, the ASME board responsible for the rewrite process. "Even with such a resource, it would have

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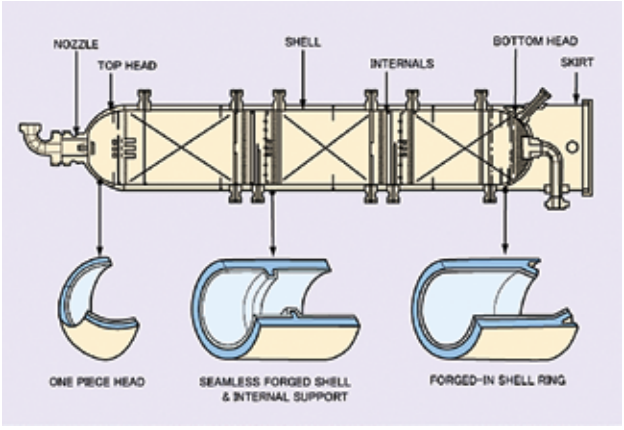
been necessary to provide an overall project management activity to coordinate volunteer reviews and consistency between the reviewing efforts."

With the development of a European pressure code, waiting 15 or more years for a needed update to Section VIII, Division 2 was not an option, so ASME decided to use an outside organization to develop the first draft of the new standard. The project was awarded to the Pressure Vessel Research Council (PVRC), which in turn formed the Task Group on Continued Modernization of Codes to oversee development. PVRC then engaged the Equity Engineering Group as the lead investigator, editor, and publisher for the new code.



JAPAN STEEL WORKS

▲ Schematic from Japan Steel Works' Web site shows the plan of construction for a pressure vessel built at its Muroran Plant.

A steering committee made up of ASME Section VIII members was formed to provide technical oversight and direction to the development team, with the goal of facilitating the eventual balloting and approval process. ASME also hired a project manager to coordinate the activities required to bring the new standard to publication.

Numerous international groups have written standards covering pressure equipment. The most important are the European Committee for Standardization, or CEN, which has 30 national members, and the International Standards Organization, a non-government organization that builds consensus through a network of national standards from more than 150 countries. The developers of the new Division 2 code believe it enables ASME to maintain a pre-eminent position in pressure vessel technology globally, because it advances design practices beyond standing CEN and ISO codes.

"The new Division 2 provides for many of the longstanding accreditation and design practices that are not in the CEN or other international codes," Karcher said. "It also provides for a more efficient and adaptable code for international use via the new recognitions of engineering certifications outside of the U.S.A. and Canada."

Feedback Before Publication

The rewrite of Section VIII, Division 2 broke new ground for ASME in several areas, from hiring a project manager to publishing the document in single columns and formatting it to satisfy ISO guidelines. Also, the project team initiated two other activities to ensure both high quality and acceptance of the Division 2 rewrite: a validation of all design rules, and beta testing of the document.

The new Division 2 contains hundreds of equations and polynomial expressions for curve fits used in the design rules. Even where rules were taken from Section VIII, Division 1, they were rewritten in most cases to facilitate computerization. The net result was that to check each equation, figure, and polynomial expression would have been a major undertaking. If volunteers were asked to perform this work, it would have delayed publication of the document.

Instead, an independent organization experienced in writing pressure vessel design software was contracted to assure the quality of the design rules. It performed this work by programming all the design rules in Mathcad and running numerous examples. Whenever possible, examples from the old VIII-2 and VIII-1 were used for the validation work. In all, over a thousand pages of calculations were performed and the process did identify some errors, mostly in the equations used to model design curves. This validation work will serve as the starting point for an examples manual to be developed for future publication.

Everyone on the Division 2 project team was interested in receiving feedback from users, and normally this feedback is received once a standard is published and used for production vessels. This time, however, it was decided to test the standard prior to publication, during the last stages of approval. Invitations to participate were sent to several Division 2 certificate holders, who were asked to select a recently completed Division 2 vessel

and re-execute the project on paper using the new standard. A large number of interested users responded to the invitation with a description of a vessel to be used in the evaluation.

The beta test provided validation of many of the goals set forth when the project was initiated. As expected, significant cost savings were reported due to the increase in allowable stress for many carbon and low-alloy steels. Of equal importance, most of the testers also reported a reduced amount of reinforcement required for openings resulting in a reduction in forged nozzle thickness.

All the beta testers reported the standard was easy to use and that the design rules were clear and concise. Many said they prefer the new format of the document.

Early in the project, developers surveyed code users, including vessel users, manufacturers, and regulatory organizations. According to Karcher, "These responses were used as building blocks in the new Division 2. Some resulting examples are the use of non-North American professional engineers, a more comprehensive and better focused user design specification, single column ISO numbering and format."

After publication, surveys were conducted to assess the new code at seminars and training sessions in Italy, Japan, Canada, and the U.S. According to Hayden, "Attendees were surveyed as to their likes and dislikes of the new code. Their input has been factored into addenda and plans for continued publication of this code in its current format."

Extended Transition

Originally published in 2007, the new Section VIII, Division 2 was to become mandatory Jan. 1, 2008. A code case was approved (Code Case 2575) that allows 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. The transition period ends July 1 this year, when the new edition will become the only one in effect.

ASME is offering training seminars for the new code at locations around the world. As user communities are identified, ASME has also set up international interest groups that can nominate engineers for delegate membership in the ASME code committees of interest. These delegates may participate by attending meetings, teleconferencing, or correspondence on code development and issues. Interested engineers can visit the ASME Web site at www.asme.org for more details on these programs.

From the first polling of users to its publication in July 2007, the revamping of VIII-2 took six years.

Would ASME use this development process again? "I believe the answer is yes," Pastor said. "Times have changed such that the number of volunteers, and more importantly, the number of volunteer hours donated to ASME continue to reduce each year, so that large projects such as the Division 2 rewrite will need to be directly funded as R&D."

And what may be the next step? Karcher said, "Looking to the future, the predicted evolutionary process would be a rewrite of Division 1 to address so-called simple pressure vessels, and a merging of Division 2 and Division 3 to benefit from the advanced technologies and to avoid the burdening of the small and mass produced pressure vessel industries with unnecessarily complex and tedious construction requirements."

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This might take some time and more pressure from users. According to Pastor, "The users want one pressure vessel code, and ASME would be more than happy to give it to them, but it is not that easy. Pressure equipment is ordered based on regulatory requirements, price, manufacturer's experience with a standard, and the like."

Hayden sees the new document setting a standard for code development. "I believe that the development of the 2007 edition of Section VIII, Division 2 is a bellwether of things to come from ASME," he said. "The development process, leading edge technical content, and use of user input/feedback in developing this code have set the standard for new code development activities at ASME. The staff and volunteers have seen what can be accomplished and are willing and ready to use this model for future codes and standards development."

The developers believe that a completely new and more user-friendly organizational structure to the Section VIII, Division 2 pressure vessel code, coupled with adoption of the latest technology available for the construction of pressure vessels, will result in a standard that will serve the petrochemical and other industries for decades to come. ■

Kathy Powers, marketing and communication director for The Equity Engineering Group, contributed to this article.