Journal of Pressure Vessel Technology

# Guest Editorial

## Special Topic on Codes and Standards

ASME pressure technology Codes and Standards are used in the design, fabrication, examination, installation, maintenance, and in-service inspection and evaluation of pressure boundary components. The primary objective of ASME pressure technology Codes and Standards is safe operation of these components. ASME pressure technology Codes and Standards provide standardized engineering procedures that can be applied uniformly throughout a particular industry, and in some cases can support a regulatory framework. The contents of these Codes and Standards can include design criteria or in-service evaluation criteria with margins of safety to ensure a low probability of failure, analytical calculation procedures, material properties, requirements for fabrication, as well as requirements and procedures for inspection. The results of extensive research and development in pressure vessels and piping technology, as well as best engineering practices, are often incorporated into ASME pressure technology Codes and Standards. These Codes and Standards are developed, revised, and maintained by ASME Code volunteer committees comprised researchers, practicing engineers, and regulators. ASME Code committees work within a consensus process to develop the documents to ensure safe and reliable operation of pressure boundary components that benefit the public, industry, and the regulatory authorities. A number of ASME pressure technology Codes and Standards, such as the ASME Boiler and Pressure Vessel (B&PV) Code, are updated on a periodic basis.

Descriptions and technical bases for these Codes and Standards are typically published in conference proceedings, such as the *ASME Pressure Vessels and Piping Division Conference*, as well as in technical journals, such as the *ASME Journal of Pressure Vessel Technology*. This *Special Topic on Codes and Standards* contains a number of papers that provide the technical basis or supporting information for the development or revision of a cross section of a number of ASME pressure technology Codes and Standards.

Section VIII of the ASME B&PV Code contains rules for design and fabrication of non-nuclear pressure vessels. The development of new fracture toughness requirements for carbon and low alloy steels was a major part of the effort in the rewrite of Section VIII, Division 2. The paper "Technical Basis of Material Toughness Requirements in the ASME B&PV Code, Section VIII, Division 2," by D.A. Osage and M. Prager provides a technical background to the new fracture toughness rules including the development of material fracture toughness requirements and the development of impact test exemption rules. The major changes in the fracture toughness rules when compared with editions of Section VIII, Division 2 prior to 2004, as well as compared with the current edition of Section VIII, Division 1, are for carbon and low alloy steel materials excluding bolting. The new fracture toughness rules were established using the fracture mechanics assessment procedures in Part 9 of API 579-1/ASME FFS-1. The fracture toughness rules in Section VIII, Division 2 are based on a Charpy V-Notch impact requirement consistent with European practice. The beneficial effects of postweld heat treatment are included and are consistent with the procedures in API 579-1/ASME FFS-1.

Section XI of the ASME B&PV Code contains procedures for evaluation of flaws in nuclear pressure boundary components. For flaws detected during in-service inspection of ferritic steel components, such as pressure vessels, the acceptance criteria and evaluation procedures in Section XI are currently based on linear-elastic fracture mechanics only. However, elastic-plastic fracture mechanics is more appropriate for evaluation of a flaw in a ferritic steel component operating in the upper-shelf temperature range, where the fracture behavior of the material is fully ductile. A new Code Case N-749 of Section XI contains acceptance criteria and procedures for evaluation of flaws detected during in-service inspection of nuclear ferritic steel components operating in the upper-shelf temperature range. In a number of situations, the elastic-plastic fracture mechanics evaluation can be performed by calculating the applied J-integral using equations for the stress intensity factor with a plastic-zone correction to account for crack-tip plasticity. The paper "An Investigation of the Stress Intensity Factor along a Corner Crack in Pressurizer Vent Nozzle Penetration Weld," by S.-M. Lee, J.-S. Park, J.-S. Kim, Y.-H. Choi, and H.-D. Chung, describes calculations of the stress intensity factor with a plastic-zone correction for a corner crack in a pressurized water reactor pressurizer vent nozzle penetration weld under internal pressure, thermal stress, and residual stress. This work investigated the effects on a flaw evaluation of various structural (safety) factors on internal pressure, including treatment of the plastic-zone correction, and contributed to the development of the set of structural factors on internal pressure specified in the Code Case.

Appendix C of Section XI of the ASME B&PV Code contains procedures for evaluation of flaws detected during in-service inspection of nuclear piping. The flaw evaluation procedures in Appendix C are based on internal pressure and bending moments as applied loads, but do not explicitly contain provisions for torsion loads. However, in some cases, a piping item will be subjected to significant torsion loads. One potential approach for taking into account torsion loads is to combine the torsion with bending moments using the root of sum of squares (RSS) method of Section III of the ASME B&PV Code. There was a need to determine whether the RSS method for combining torsion with bending moments is applicable to a piping item containing a planar flaw. The paper "Inclusion of Torsion Loads in Section XI Flaw Evaluation Procedures for Pipes Containing Circumferential Planar Crack-Like Flaws on the Basis of Limit Load Analysis," by B. Bezensek, Y. Li, K. Hasegawa, and P.H. Hoang describes an investigation of the RSS method for combining torsion with bending moments for a piping item containing a planar flaw. The paper describes finite element analyses of limit load of straight pipes containing a circumferential planar flaw and confirms the applicability of the RSS method to planar flaw evaluation. This paper supports a proposed revision to Appendix C to take torsion loads into account.

One of the elements of the evaluation of a planar flaw is prediction of the increase in the flaw size over the evaluation period due to subcritical crack growth, including fatigue when the component is subjected to cyclic stresses. International Codes, Standards and fitness-for-service guidelines provide curves that predict the rate of fatigue crack growth for different materials in terms of the range of stress intensity factor over the load cycle, mean stress, temperature, and environment. The paper "Comparison of Fatigue Crack Growth Curves of Japan, the US and EU Code and Standards," by K. Hojo and Y. Takahashi, describes fatigue crack growth rate curves for ferritic and austenitic stainless steels in air environments that are provided in the ASME B&PV Code, the Japan Society of Mechanical Engineers (JSME) Maintenance Rule, the European FITNET "Fitness-for-Service Procedure," the FKM guideline "Fracture Mechanics Proof of Strength for Engineering Components," and the Japan Welding Engineering Society (WES) 2805 "Method of Assessment for Flaws in Fusion Welded Joints with respect to Brittle Fracture and Fatigue Crack Growth." The paper describes the features of each set of fatigue crack growth rate curves and compares the predicted crack growth rates. It was found that in general the fatigue crack growth rates for both ferritic and austenitic stainless steels in air environments differed by an order of magnitude among the various Codes, Standards, and guidelines.

Appendix G of Section XI of the ASME B&PV Code contains procedures for defining ASME Service Level A and B pressure–-temperature limits for ferritic steel components in the reactor coolant pressure boundary. The procedures are based on postulating a planar flaw in the pressure boundary component and demonstrating protection against fracture using a structural factor on internal pressure. Until recently, the evaluation procedures in Appendix G were based on deterministic methods only. The paper "A Risk-Informed Methodology for ASME Section XI, Appendix G," by R. Gamble, W. Server, B. Bishop, N. Palm, and C. Heinecke, describes the technical basis for an alternative risk-informed methodology that has been recently developed and published in Appendix G. This alternative methodology is based on probabilistic fracture mechanics analyses and provides straightforward procedures to define risk-informed pressure–temperature limits for Service Level A and B events, including leak testing and reactor start-up and shut-down. Risk-informed pressure–temperature limits provide more operational flexibility, particularly for reactor pressure vessels with relatively high irradiation levels and radiation sensitive materials.

When a degraded pressure boundary component is no longer acceptable for continued service, the component must be repaired or replaced. Section XI of the ASME B&PV Code contains requirements for repair and replacement of nuclear pressure boundary components. The paper "Changes in Section XI, Repairs and Replacements [2007 through 2009]," by R.A. Yonekawa and E.B. Gerlach, describes revisions to requirements for repairs and replacements in Section XI from the 2007 Edition through to the 2009 Addenda. Since publication of the 2007 Edition of Section XI, revisions to requirements for repairs and replacements have been in one of two categories. In the first category is a number of changes to the main body of Section XI to refine and maintain the basic Section XI requirements. The second category is revisions to Section XI Code Cases, as well as publication of new Code Cases. The paper describes both categories of revisions related to repairs and replacements in Section XI.

Ambient temperature temperbead welding employs the gas tungsten arc weld (GTAW) machine process and avoids both the elevated temperature preheat and postsoak heating operations associated with conventional temperbead welding. Code Case N-638 of Section XI of the ASME B&PV Code contains requirements for ambient temperature temperbead welding activities. However, prior versions of this Code Case limited the depth of an ambient temperature temperbead weld repair to 50% of the base material thickness. This restriction precluded use of the GTAW ambient temperature temperbead process for through-wall repairs and replacements. The paper "Through Wall Repairs Using the GTAW Ambient Temperature Temperbead Process," by B. Newton, describes the ongoing ASME Section XI activities to revise Code Case N-638-4 to permit through-wall temperbead repairs. The methodology, Code Case rules with applicable restrictions, and technical basis for this Code Case revision are described in the paper.

Hydrogen is becoming an increasingly important source of energy. As well, composite materials have been adopted to fabricate pressure vessels due to their high strength and light weight. Section X of the ASME B&PV Code contains rules for design, fabrication, and examination of composite pressure vessels for hydrogen service. In particular, in response to industry need, a new Appendix 8 to Section X has been developed that contains the Code rules for high pressure composite vessels with nonload sharing liners for stationary applications. The paper "Development of ASME Section X Code Rules for High Pressure Composite Hydrogen Pressure Vessels with Non-Load Sharing Liners," by N.L. Newhouse, G.B. Rawls, M.D. Rana, B.F. Shelley, and M. R. Gorman, describes the development and technical basis of the Section X Code rules for these composite pressure vessels for hydrogen service. The paper describes the design, fabrication, and examination requirements, as well as the Code rules for the design qualification testing of prototype vessels.

Another important topic of ASME Codes and Standards is rules for transport tanks for hazardous and nonhazardous materials. Section XII of the ASME B&PV Code contains rules for design and fabrication of transport tanks for hazardous and nonhazardous materials. One issue related to transport tanks is the potential for failure due to buckling. The paper "Buckling of Cylindrical, Thin Wall, Trailer Truck Tanks and ASME Section XII," by G.G. Karcher, M. Ward, and G. Spoelstra, which will be published in the August 2012 Issue, describes a full scale buckling test that has been performed to evaluate maximum allowable over-the-road loadings and required design details. The paper summarizes the results of the testing and provides comparisons of test results with classical ASME Code buckling criteria, the method in Code Case 2286, and other methods for buckling evaluations. The objective was to provide the ASME Section XII Committee with a basis for establishing buckling design criteria and shell stiffening details for transport tanks for hazardous and nonhazardous materials.

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