

February 8, 2000

MEMORANDUM FOR: Jack R. Strosnider, Jr., Director
Division of Engineering
Office of Nuclear Reactor Regulation

FROM: William H. Bateman, Chief */ra/*
Materials and Chemical Engineering Branch
Division of Engineering

SUBJECT: AUTHORIZATION FOR PRESENTATION OF TECHNICAL PAPER

J. A. Davis, C. L. Lauron, and A. D. Lee have authored a paper titled, "Code Cases Currently being Reviewed by the NRC Staff on Bolting and Erosion Corrosion," which will be presented at the 2001 ASME Pressure Vessel and Piping Conference. A. D. Lee will attend the meeting July 22-26, 2001, and will make the presentation. This memorandum is to request your concurrence for presentation of the subject paper which is attached together with a copy of NRC Form 390.

We believe this paper is covered by Paragraph 033a of NRC Chapter 3205, "Technical Speeches, Papers, and Technical Articles," and NRR Office Letter No. 700, Revision 1. This paper does not involve new or unresolved policy issues. We believe that the NRC staff participation in the subject meeting will be extremely useful in promoting the exchange of information among the participants concerning the use of ASME code cases.

Attached are NRC form 426 approving the abstract. Expenses for the trip are estimated to be approximately \$1300.00

Approval: */ra/* 2/19/01
Jack R. Strosnider, Jr.

Attachments: As stated

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CODE CASES CURRENTLY BEING REVIEWED BY THE NRC STAFF ON BOLTING AND EROSION CORROSION

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ABSTRACT

The NRC staff reviews and endorses code cases (sometimes with limitations) written and approved by the American Society of Mechanical Engineers (ASME). This paper will discuss the regulatory perspectives on the following three recent ASME code cases:

Code Case N-533, "Alternative Requirements for VT-2 Visual Examination of Class 1 Insulated Pressure-Retaining Bolted Connections, Section XI, Division 1," and its subsequent revision, Code Case N-533, Revision 1, "Alternative Requirements for VT-2 Visual Examination of Class 1, 2, and 3 Insulated Pressure-Retaining Bolted Connections, Section XI, Division 1," have not been endorsed by the NRC staff.

Code Case N-616, "Alternative Requirements for VT-2 Visual Examination of Classes 1, 2, and 3 Insulated Pressure Retaining Bolted Connections, Section XI, Division 1," has not been endorsed by the staff. However, the staff has granted relief with several restrictions applied.

Code Case N-597, "Requirements for Analytical Evaluation of Pipe Wall Thinning Section XI, Division 1," has not been endorsed by the staff. The staff has concerns with the implementing documents including industry standard NSAC-202L, "Recommendations for an Effective Flow Accelerated Corrosion Program."

Each code case will be discussed in detail with the staff's regulatory perspectives and concerns.

INTRODUCTION

Inservice inspection of ASME Code Class 1, 2, and 3 components shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel (B&PV) Code and applicable edition and addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(a)(3).

10CFR 50.55a(a)(3) states, in part, that alternatives to the requirements may be used provided the licensee demonstrates that (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii)

compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first ten-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein and subject to Commission Approval.

Section XI of the 1983 Edition, 1984 Addenda and later Editions of the ASME Code require the removal of all insulation from pressure-retaining bolted connections in systems borated for the purpose of controlling reactivity when performing VT-2 visual examinations during system pressure tests. These inspections determine if any wastage had occurred on steel bolts by the presence of boric acid. The code requires this examination to be performed each refueling outage for Class 1 systems, and each inspection period for Class 2 and 3 systems. Several licensees have requested relief from the code requirements to use Code Case N-533, "Alternative Requirements for VT-2 Visual Examination of Class 1 Insulated Pressure-Retaining Bolted Connections, Section XI, Division 1," or Code Case N-533, Revision 1, "Alternative Requirements for VT-2 Visual Examination of Class 1, 2, and 3 Insulated Pressure-Retaining Bolted Connections, Section XI, Division 1" and Code Case N-616, "Alternative Requirements for VT-2 Visual Examination of Class 1, 2, and 3 Insulated Pressure-Retaining Bolted Connections, Section XI, Division 1." The NRC staff reviews requests to use these code cases on a case by case basis.

The code specifies the process for the disposition of flaw examination evaluations that exceed the acceptance standards for materials and welds specified in ASME Code, Section III, edition applicable to the construction of the component. Code Case N-597, "Requirements for Analytical Evaluation of Pipe Wall Thinning Section XI, Division 1," provides an analytical evaluation of Class 1, 2, and 3 carbon and low-alloy steel piping items subjected to wall thinning as a result of flow accelerated or other corrosion phenomenon. This code case has not been endorsed by the NRC staff because the code case does not address inspection requirements and wall thinning rates. The NRC staff reviews requests to use Code Case N-597 on a case by case basis.

The NRC is engaged in action to endorse these code cases, with appropriate limitations, as part of a future revision to Regulatory Guide 1.147 and accompanying rulemaking.

NOMENCLATURE

Bolted connections, Flow accelerated Corrosion, Code Case N-533, Code Case N-616, Code Case N-597.

DISCUSSION

Alternative Requirements for VT-2 Visual Examination of Class 1, 2, and 3 Insulated Pressure-Retaining Bolted Connections

The requirements for the system leakage tests are found in ASME Section XI, IWA-5000, IWB-5000, IWC-5000, and IWD-5000. A system leakage test must be conducted prior to plant startup following each reactor refueling outage for Class 1 systems and components (ASME Section XI, Table IWB-2500-1, Examination Category B-P, Item numbers B15.10 to N15.70). For Class 2 and 3 systems and components, the system leakage tests are conducted once an period.

ASME Section XI, IWA-5242 states that for insulated systems, structures or components borated for the purpose of controlling reactivity, insulation shall be removed from pressure retaining bolted connections for VT-2 visual examination. In addition, IWA-5213 requires a 10 minute hold for non-insulated systems, structures, or components and a 4 hour hold after attaining system pressure and temperature for insulated systems, structures, or components. However, the requirement for a 4 hour hold after attaining system pressure and temperature for insulated systems, structures, or components was removed from the 1995 and later code editions. Currently, the NRC staff is requesting that this requirement be added to future editions of the code such that the 4 hour hold time is applied to insulated pressure-retaining bolted connections.

Several utilities expressed concerns about the system leak test requirements which require personnel to work in the vicinity of hot, pressurized components and systems. These concerns are related to personnel safety and radiation exposure while conducting the visual inspections. Code Case N-533 provided an alternative to the code requirements whereby Class 1 bolted connections on systems, structures or components borated for the purpose of controlling reactivity would be subject to a system pressure test at the end of each refueling outage without removal of the insulation. During the next refueling outage, while the system is not pressurized, the insulation would be removed and the area inspected. Any evidence of leakage was to be evaluated in accordance with IWA-5250. This code case is only applicable to Class 1 Systems.

On February 26, 1999, Code Case N-533-1, Revision 1, "Alternative Requirements for VT-2 Visual Examination of Class 1, 2, and 3 Insulated Pressure-Retaining Bolted Connections, Section XI, Division," was approved by the ASME. This code case revision does not affect the treatment of Class 1 bolted connections provided in Code Case N-533. This revision added Class 2 and 3 bolted connections and stated that these bolted connections would be subject to a system pressure test each period without removal of the insulation. For all three classes of insulated bolted connections, the insulation will be removed and a VT-2 visual examination will be performed at the next refueling outage. The connection does not have to be pressurized. Any evidence of leakage has to be evaluated in accordance with IWA-5250.

On May 7, 1999, Code Case N-616, "Alternative Requirements for VT-2 Visual Examination of Class 1, 2, and 3 Insulated Pressure-Retaining Bolted Connections, Section XI, Division 1," was approved by the ASME code committee. This code case states that when corrosive resistant bolting whose chromium content greater than or equal to 10 percent is used, it is permissible to perform the VT-2 examination without removal of the insulation. This code case gives the following bolting materials as examples: SA-564 Grade 630 H1100, SA-453 Grade 660, SB-637 UNS N07718, and SB-637 UNS N07750.

The staff has developed a position over the years on the use of SA-564 Grade 630 (AISI Type 17-4 PH stainless steel), AISI SA-193 Grade 6 (Type 410 stainless steel), and SA-453 Grade 660 (A-286 stainless steel) fasteners. The 17-4 PH stainless steel and the 410 stainless steel, aged at a temperature of 1100°F or higher, are suitable for use in contact with primary water. However, if these alloys are aged at a lower temperature, the microstructure produced is susceptible to primary water stress corrosion cracking. The hardness of these alloys should be below Rc 30 if properly heat treated. A-286 stainless steel is susceptible to stress corrosion cracking in primary water, particularly if preloaded above 100 ksi. There are a large number A-286 bolts and studs currently in nuclear service, both in BWRs and PWRs. Bengtsson and Korhonen [1] of ASEA-ATOM, Vasteras, Sweden, examined the behavior of A-286 in a BWR environment. Their results concluded that A-286, in comparison to other materials tested, was the most susceptible to intergranular stress corrosion cracking in BWR water but less likely to crack as the applied stress is reduced. Piascik and Moore [2] from Babcock & Wilcox reported a number of vessel internals bolt failures of A-286 bolts in PWR water. Their research correlated the bolt failures with bolt fillet peak stress and concluded that bolts preloaded below 100 ksi showed no failures.

The staff position is that any 17-4 PH stainless steel or 410 stainless steel stud or bolt aged at a temperature below 1100°F or with hardness above Rc 30 must have the thermal insulation removed for VT-2

examination during the system pressure test. For A-286 stainless steel studs or bolts, the preload must be verified to be below 100 ksi or the thermal insulation must be removed and the joint visually inspected. For nuts conforming to SA-194, experience indicates it would not be necessary to remove the thermal insulation for visual inspection. In addition, for any of these code cases, consistent with code requirements, the bolted connections have to be held at pressure and temperature for four hours before the VT-2 visual examination is performed.

Alternate Analytical Evaluation of Pipe Wall Thinning

The process for the disposition of flaw examination evaluations which exceed the acceptance standards for materials and welds specified in the code applicable to the construction of the component is provided in ASME Section XI, IWA-3100. This provision stipulates that the disposition shall be subjected to review by the regulatory and enforcement authorities having jurisdiction at the plant site.

Recently, a utility requested to implement Code Case N-597, "Requirements for Analytical Evaluation of Pipe Wall Thinning, Section XI, Division 1," as an alternate analytical evaluation of wall thinning for Class 1, 2, and 3 carbon and low-alloy steel piping items. These piping items may be subjected to wall thinning as a result of flow accelerated or other corrosion phenomenon. This code case provides an approach for determining the structural integrity of components degraded by wall thinning where the construction code minimum wall thickness has been reached. This approach is an alternative to repairing the component. Code Case N-597 stipulates that the methods of predicting the rate of wall thickness loss and the predicted remaining wall thickness shall be the responsibility of the Owner.

Code Case N-597 has not been endorsed by the NRC because it does not address inspection requirements and wall thinning rates. Therefore, the staff determined that review of the code case is needed prior to implementation.

The utility requesting use of Code Case N-597 planned to implement the code case based on industry standard NSAC-202L, "Recommendations for an Effective Flow Accelerated Corrosion Program." This industry standard provides detailed guidance for calculating remaining life, predicting remaining wall thickness, and calculating wear rates.

The staff determined that plant procedures based on this industry standard can be conservative and adequate provided that plant procedures clarify inherent ambiguities in the industry standard. In response to the staff's determination, the utility which requested the use of Code Case N-597 provided the following definitions of "should" and "shall": "shall" denotes those actions which are adhered to without exception and "should" denotes a

management expectation that is to be adhered to unless supervision determines otherwise. In addition, the utility further clarified that both terms define a management expectation that the procedural step is completed; however, the word "shall" is used as a plant-specific tracking mechanism of direct regulatory requirements.

Based on this clarifying information, the staff concluded that the utility's request to use Code Case N-597 and industry standard NSAC-202L, with clarification of the application of "shall" and "should" in this standard, provided an acceptable level of quality and safety. Therefore, the proposed alternative to use Code Case N-597 for the analytical evaluation of Class 1, 2, and 3 carbon and low-alloy steel piping items subjected to wall thinning as a result of flow accelerated or other corrosion phenomena for this utility was authorized pursuant to 10 CFR 50.55a(a)(3)(i). The staff will continue to review, on a case by case basis, additional requests for relief from the code requirements to use Code Case N-597.

The staff notes that components to which this code case is applied must be repaired or replaced in accordance with the construction code of record and owners' requirements or a later approved edition of ASME Section III prior to reaching the allowable minimum wall thickness as specified in this code case.

CONCLUSIONS

There has been interest by various utilities to use code cases that have not been formally endorsed by the NRC staff. Three code cases were discussed in this paper. The first two, Code Cases N-533 and N-616, address the requirements for removal of insulation from bolted connections for systems, structures, and components boroated for the purpose of controlling reactivity. Code Case N-597 provide an alternative approach of wall thinning carbon and low-alloy steel piping items susceptible to flow accelerated or other corrosion phenomenon. The staff has granted relief from the ASME Code requirements to use each of these code cases to several utilities on a case by case basis.

REFERENCES

1. Bengtsson and Korhonen, Proceedings of the International Symposium on Environmental Degradation of Materials in Nuclear Power Systems-Water Reactors, August 22-25, 1983, Myrtle Beach, South Carolina sponsored by National Association of Corrosion Engineers, the Metallurgical Society of AIME, and the American Nuclear Society.

2. Piascik and Moore, Nuclear Technology, Vol. 75, December, 1986
3. NSAC-202L, "Recommendations for an Effective Flow Accelerated Corrosion Program."