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Comment On: NRC-2011-0088-0003
Incorporation by Reference of American Society of Mechanical Engineers Codes and Code Cases

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General Comment

See attached file(s)

Attachments

DEI Letter L-1007-00-397 R0 (Comment on BMV Frequency)

Dominion Engineering, Inc.

December 2, 2015
L-1007-00-397, Rev. 0

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Rulemakings and Adjudications Staff

Subject: 10 CFR Part 50, Rulemaking: Docket ID NRC-2011-0088, "Incorporation by Reference of American Society of Mechanical Engineers Codes and Code Cases"

Dear Secretary:

I have supported the nuclear power industry on issues related to the basis for inspection requirements for PWR reactor vessel closure head nozzles for the last 22 years. I am respectfully submitting the comment below regarding a proposed condition on implementation of ASME Code Case N-729-4, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1." The proposed condition and section-by-section analysis discussion for this item in the proposed rulemaking are as follows [1]:

10 CFR 50.55a(g)(6)(ii)(D)(*3*) Bare Metal Visual Frequency

"The NRC proposes to revise § 50.55a(g)(6)(ii)(D)(*3*) to add a new condition which requires cold head plants (EDY<8) without PWSCC flaws to perform a bare metal visual examination (VE) each outage a volumetric exam is not performed and allows these plants to extend the bare metal visual inspection frequency from once each refueling outage, as stated in Table 1 of N-729-4, to once every 5 years only if the licensee performed a wetted surface examination of all of the partial penetration welds during the previous volumetric examination. In addition, this new condition clarifies that a bare metal visual examination is not required during refueling outages when a volumetric or surface examination is performed of the partial penetration welds. The condition that is in the current § 50.55a(g)(6)(ii)(D)(*3*) was incorporated into N-729-4 by the ASME Code committees."

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Comment

Introduction

For the reasons discussed below, the proposed 10 CFR 50.55a(g)(6)(ii)(D)(*3*) condition [1] to the inspection requirements of ASME Code Case N-729-4 for PWR reactor vessel top heads with Alloy 600 nozzles is not necessary to provide reasonable assurance of the structural integrity of the reactor coolant pressure boundary.

The EPRI Materials Reliability Program (MRP) recently performed a review of the recent operating experience and re-evaluation of the ASME Code Case N-729-1 technical basis that were documented in EPRI report MRP-395 [2] and presented at an NRC public meeting [3]. Section 5 of MRP-395 concluded that the current requirements for periodic visual examinations for evidence of pressure boundary leakage (per ASME Code Case N-729-1 as currently conditioned by 10 CFR 50.55a(g)(6)(ii)(D)) remain valid to address the concern for potential boric acid corrosion. It is concluded that, for heads with effective degradation years (EDY) < 8 (predominantly heads with Alloy 600 nozzles operating in U.S. at the reactor cold-leg operating temperature, T_{cold}, known as "cold heads") and no previously detected primary water stress corrosion cracking (PWSCC), the original technical basis for a bare metal visual examination (VE) interval of every third refueling outage or 5 calendar years, whichever is less, remains valid. The discussion below supplements the MRP-395 technical basis by addressing the specific concerns expressed in the NRC proposed rulemaking [1] that are the rationale for the proposed 10 CFR 50.55a(g)(6)(ii)(D)(*3*) condition.

NRC Concern Regarding the Susceptibility of Cold Heads to PWSCC

For the following reasons, the current VE interval requirements are adequate to address the concern expressed by NRC regarding the detections of PWSCC in cold heads:

- No through-wall cracking has been observed in the U.S. after the first in-service volumetric or surface examination was performed of all CRDM or CEDM nozzles in a given head. Additionally, there have been relatively few instances of PWSCC of leaking welds that have not been accompanied by PWSCC in the nozzle that is detectable by the periodic volumetric examinations. Compared with the frequency of PWSCC initiation and the size of flaws detected in heads operating at temperatures above T_{cold}, operating experience continues to demonstrate a relatively low susceptibility to cracking for cold heads. The operating experience for top heads clearly makes apparent the substantial relative benefit of operation at T_{cold} in terms of both initiation time and crack growth rates [2]. The MRP technical basis for the current inspection requirements does not presume that cold heads will not experience PWSCC. Nevertheless, no leakage (due to cracking in the nozzle or due to cracking in the J-groove weld) has been detected in any of the U.S. cold heads.
- The best indicator of the PWSCC susceptibility of an individual head is its own inspection results. All heads with Alloy 600 nozzles still in service have had multiple volumetric examinations. If PWSCC has been detected in a head, the VE interval must already be every refueling outage per the current requirements. The option to perform the VE every third refueling outage, or 5 calendar years, whichever is sooner, is only permitted for the currently operating cold heads in the case that the past multiple volumetric and visual examinations have not detected PWSCC. Furthermore, as discussed below a VT-2 visual

examination under the insulation through multiple access points must be performed during the refueling outages when a VE is not performed.

- In addition to temperature, the material variability is a known significant factor in PWSCC susceptibility. Only one material category of cold heads has exhibited PWSCC at this time, heads with nozzle material produced by a particular supplier of Alloy 600 nozzle material. It has been recognized since 2004 that heads with this material supplier have the highest relative incidence of PWSCC ([2], [4]). The five cold heads with reports of PWSCC are all within this material category, and under the current requirements the VE interval for these heads is already every refueling outage. There is a sixth head in this material category that has not reported indications of PWSCC. Plans have been announced for five of the six cold heads in this material category for head replacement or PWSCC mitigation by peening, including the head without previously detected PWSCC. A VE of the head without announced plans for mitigation or replacement is already being performed every refueling outage as PWSCC was previously reported for it. Thus, as a practical matter, the proposed NRC condition would have little effect on the subset of cold heads that has experienced PWSCC. The 13 U.S. cold heads not in this material category have all had multiple volumetric examinations without any reports of PWSCC. The predominant effect of the proposed NRC condition would be to require these heads, which have demonstrated a low susceptibility to PWSCC, to have a VE examination almost every refueling outage.

Moreover, there is widespread acceptance among PWSCC researchers ([5], [6]) that changes in temperature at the crack location have a consistent and well characterized effect on the PWSCC crack growth rate, with a relatively large benefit of operating near the cold-leg temperature. The expected reduction factor for the PWSCC crack growth rate using the standard thermal activation energy of 31 kcal/mole ([5], [6]) is between 4.6 and 3.1 for the range of cold leg temperatures at U.S. PWRs of about 547°F to 561°F versus a temperature of 605°F, which bounds the operating temperature for currently operating heads in the U.S. with Alloy 600 nozzles. These reduction factors result in substantially longer times for through-wall cracking to be produced, for circumferential flaws located above the weld to grow to a significant size, and for leaking cracks to grow larger and produce the leak rate magnitudes necessary for significant volumes of material loss to be produced via boric acid corrosion. As demonstrated by testing and analysis [7], the leak rate is the key parameter for determining whether relatively rapid and sustained boric acid corrosion may occur. Under current requirements, the VE interval for a head operating at a temperature of 605°F is each refueling outage regardless of whether PWSCC was previously detected. This corresponds to up to 2 calendar years of operation. Applying a reduction factor of 3.1 results in an equivalent time between examinations of 6.2 years, which is substantially greater than the 4.5 years corresponding to three 18-month cycles for a cold head. (All U.S. cold heads operate on nominal 18-month fuel cycles.) Thus, the reduction in PWSCC crack growth rate for cold heads supports the current VE interval requirements.

NRC Concern Regarding the Potential for Boric Acid Corrosion due to Leakage Through the Weld

The NRC proposed rulemaking [1] emphasizes the concern under current requirements that "leakage from a crack in the weld of a 'cold head' plant could start and continue to grow for the 5 years between the required bare metal visual examinations to detect leakage through the partial penetration weld." The NRC rulemaking discussion does not credit the current requirement that an ASME IWA-2212 VT-2 visual examination be performed of the head under the insulation

through multiple access points in refueling outages that the VE is not completed. This examination was included in the original N-729-1 requirements precisely for the purpose of addressing the boric acid corrosion concern that a leak could originate just after the time of the most recent VE. As all U.S. cold heads operate on a nominal 18-month fuel cycle, a VE or VT-2 under the insulation through multiple access points must already be performed about every 1.5 years at all cold head plants.

The PWR plant experience for PWSCC of Alloy 600 J-groove nozzles, including that for reactor vessel top head nozzles, ([8] as summarized in [9] and presented at an NRC public meeting [10]) shows that periodic visual examinations performed under the insulation at appropriate intervals are highly effective in detecting any leakage caused by PWSCC before any discernible material loss is produced via boric acid corrosion of carbon or low-alloy steel pressure boundary components. In addition to the visual indications, other indicators that leakage rates may be sufficient to cause significant boric acid corrosion are the progression of the unidentified primary system leakage rate, clogging of the containment air coolers, and plugging of the containment radiation monitor filters [4]. Mock-up testing and analyses documented in MRP-308 [7] and presented at an NRC public meeting ([11], [12]), including photographs of deposit buildup on test mockups, show that large volumes of boric acid deposits necessarily accompany cases of significant boric acid corrosion. These large volumes of deposits would be readily visible in the VT-2 examination under the insulation through multiple access points already required. Thus, the current visual examination requirements are already sufficient to address the boric acid corrosion concern for cold heads. The current VT-2 requirement limits the duration of active leakage that could cause significant material loss to occur.

Conclusions

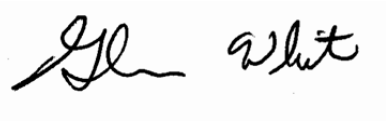
Cold heads that have not exhibited any flaws attributable to PWSCC are already subject to a visual assessment of the top head condition under the insulation every 18 months. Either a VT-2 under the insulation through multiple access points or a bare metal VE is performed every refueling outage. Operating experience and boric acid corrosion testing demonstrate that this program of periodic visual examinations would detect any leakage prior to significant material loss occurring due to boric acid corrosion.

For heads where PWSCC has previously been detected, a bare metal VE is already required each refueling outage. Heads without previously detected PWSCC have a low susceptibility to PWSCC demonstrated by multiple volumetric and visual examinations. Plant experience with Alloy 600 reactor vessel top head nozzles continues to demonstrate a low probability of pressure boundary leakage given the currently required periodic volumetric examinations. No leakage has been detected for any of the U.S. cold heads. Furthermore, plans for mitigation by peening or head replacement have been announced for five of the six heads in the one material category of cold heads for which cracking has been detected, and the remaining head in this group is already required to perform a bare metal VE each refueling outage. For these reasons, the concern for the "increasing trend" in cold head cracking cited in the proposed rulemaking is already addressed by the existing requirements.

In summary, the predominant effect of the proposed NRC condition would be to require the subset of cold heads with a demonstrated low susceptibility to PWSCC (i.e., no PWSCC detections to date) to have a VE examination most every refueling outage. This is unnecessary as the current requirement for a VE or a VT-2 under the insulation through multiple access points

about every 1.5 years ensures that any potential leakage through the partial penetration welds is identified prior to significant degradation of the low-alloy steel head material. Consequently, the imposition of the proposed 10 CFR 50.55a(g)(6)(ii)(D)(*3*) condition on ASME Code Case N-729-4 is not necessary to provide reasonable assurance of the structural integrity of the reactor coolant pressure boundary. Thus, it is respectfully commented that this condition should not be included in the final rulemaking.

Sincerely,



Glenn A. White, P.E.
Principal Engineer

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3. G. White, K. Schmitt, K. Fuhr, and C. Harrington, "Update of Technical Basis for Inspection of Alloy 600 PWR Reactor Vessel Top Head Nozzles," Presented at NRC Public Meeting, October 31, 2014. [NRC ADAMS Accession No. ML14304A076]
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