October 23, 2012

MEMORANDUM TO: Sheldon D. Stuchell, Acting Chief
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: Jonathan G. Rowley, Project Manager ***/RA/***
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF AUGUST 28, 2012, PUBLIC MEETING REGARDING PRESSURE-TEMPERATURE AND EMBRITTLEMENT LIMITS ON NORMAL OPERATIONS

On August 28, 2012, a Category 2 public meeting was held by the U.S. Nuclear Regulatory Commission (NRC) staff. The purpose of this meeting was to discuss the current findings from the NRC staff evaluation of reactor pressure vessel (RPV) pressure-temperature (P-T) limits established according to the Materials Reliability Project (MRP) 250 guidelines and the current American Society of Mechanical Engineers (ASME) Code practice.

The NRC staff presented a summary of recent activities and findings associated with their probabilistic evaluation of two P-T limit curve methodologies (MRP-250 and ASME, Section XI, Appendix G limits) for normal nuclear power plant operations, including cooldown, heatup, and leak test conditions. The purpose of the NRC staff's presentation was to provide a brief review of the technical presentation associated with normal heatup, cooldown, and leak test limits presented at the ASME Section XI Working Group on Operating Plant Criteria meeting in Washington, DC on August 14, 2012, and to discuss and define the next steps to be performed by the NRC and industry on this topic. The NRC staff's list of major findings from their presentation was as follows:

1. Concerning postulated transients following risk informed (MPR-250) vs. currently allowed P-T limits
   a. Risk-informed (R-I) procedures lower the cumulative probability of failure (CPF) for cooldowns (relative to current procedures)
   b. R-I procedures often increase the CPF for heatups (relative to current procedures)
   c. R-I procedures increase the CPF for leak tests (relative to current procedures)

2. Concerning postulated transients following currently allowed P-T limits
   a. Can produce CPF greater than $1x10^{-6}$ per year
   b. The quarter thickness (1/4T) flaw does not produce the highest risk for cooldown, shallow flaws do

c. Leak tests are permitted at temperatures close to reference temperature for nil ductility transition ($RT_{NDT}$) in boiling water reactors (BWRs)
d. Actual transients usually have lower CPFs than idealized transients
    - Other P-T limits would produce different results

Following the NRC staff's presentation, representatives of the nuclear power industry made two presentations. The first presented results of recent additional FAVOR analyses of actual heatup and cooldown transient data; and also evaluated reported low temperature overpressure (LTOP) events. These results were a follow on to results presented at the ASME Section XI meeting, but included results from the most recent version of FAVOR (not yet officially released) that had been used by Oak Ridge National Laboratory to perform the CPF analysis of the P-T limits for NRC. The presentation included the following conclusions:

- Review of several plant operating pressure and temperature time histories indicate that startup and shutdown sequences do not coincide with the ASME, Section XI, Appendix G P-T limit curves.
- Protective devices provide additional assurance that normal operation does not occur on or near the ASME Section XI Appendix G P-T limits.
- The through-wall cracking frequency for LTOP event pressures up to the ASME Section XI Appendix G limits for normal reactor startup and shutdown are less than $1x10^{-7}$ per operating year.
- The conventional and R-I Appendix G allowable P-T limits provide adequate margins against RPV failure for the range of postulated flaws important to reactor safety, including 0.03T surface breaking flaws.

The second presentation provided observations regarding pressurized water reactor (PWR) P-T limits. This included the industry's understanding of the issues raised by the NRC staff's evaluation, a summary of the requirements for P-T limits, and examples of plant P-T limits and cooldown guidance. The presentation included the following conclusions:

- For a PWR, the P-T limits for the vessel are established by the ASME, Section XI, Appendix G curve and by the LTOP system.
- Other pressure temperature limits are often more limiting than the ASME, Section XI, Appendix G curve.
- Plant operating procedures guide operators to follow optimum heatup and cooldown curves that do not approach the ASME, Section XI, Appendix G curve.

Subsequent discussion identified the following action items.

<u>Industry Action Items</u>

1. Define system constraints by gathering plant data on representative transients and other P-T restraints (other than Appendix G). Obtain information regarding determination of LTOP set points and enable temperatures, and time/rate data for LTOP devices that can be used as input to FAVOR.

2. Decide if it prefers to perform analyses using Item #1 or provide data to NRC for NRC to perform analyses.

3. Consider developing the technical basis to support revision of the small flaw population.

4. Provide explanation and/or discussion of startup/cooldown plant equipment manipulations.

5. Address/resolve the boiling water reactor leak test issue (leak test temperatures are near $RT_{NDT}$).

6. Develop plan to achieve resolution and share with NRC

NRC Action Item

1. Follow-up on industry's idea that the shop hydro pre-stressed the flaws sufficiently to make CPF equal zero (approximately).

Joint Action Items

1. NRC (Al Csontos and Gary Stevens) and Electric Power Research Institute (EPRI) (Tim Hardin and Bob Carter) will remain in communication.

    a. Discuss at September 5 and 6, 2012, MRP-NRC Office of Regulatory Research technical meeting in Palo Alto. [Action Completed]

    b. Industry to get back to NRC within one month regarding feasibility of these items and industry preference for resolution (e.g., Industry will undertake or just provide data for NRC to perform the effort). [Action completed at the September Palo Alto meeting; EPRI expects to be able to further update the staff on expected schedule status at the November meeting of the ASME XI Working Group on Operating Plant Criteria]

A list of attendees is enclosed. The slide presentation presented by the NRC staff can be found in Agencywide Documents Access and Management System (ADAMS) at Accession Number ML12243A267. The presentations presented by the industry representatives can be found in the ADAMS at Accession Numbers ML12243A265 and ML12243A266.

Project Nos. 669, 689, and 694

Enclosure:
List of Attendees

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**ADAMS Accession Nos.: ML12289A035 (Summary); ML12290A153 (Package); ML12227A769 (Notice); ML12243A265; ML12243A266 & ML12243A267 (Presentations)** **NRR-106**

| **OFFICE** | PLPB/PM | PLPB/LA | PLPB/BC (A) | PLPB/PM |
|---|---|---|---|---|
| **NAME** | JRowley | DBaxley | SStuchell | JRowley |
| **DATE** | 10/15/2012 | 10/18/2012 | 10/22/2012 | 10/23/2012 |

**OFFICIAL RECORD COPY**

List of Attendees

**Public Meeting with Industry Stakeholders**
**Regarding Pressure-Temperature Limits for Normal Operations**

August 28, 2012

| Name | Organization |
|---|---|
| Asho Nana | AREVA NP, Inc. |
| Doug Killian | AREVA NP, Inc. |
| Matthew DeVan | AREVA NP, Inc. |
| Bill Server | ATI Consulting |
| Bernard Rudell | Constellation Energy |
| Robert Carter | Electric Power Research Institute |
| Tim Hardin | Electric Power Research Institute |
| Harmeet Gill | General Electric-Hitachi Nuclear Energy |
| Mark Biery | Mitsubishi Nuclear Energy Systems |
| Kailen Shores* | Omaha Public Power District |
| Kevin Holthaus* | Omaha Public Power District |
| Ron Gamble | Sartrex |
| Mike McDevitt* | Southern California Edison |
| Dennis Weakland* | Structural Integrity Associates, Inc. |
| Timothy Griesbach* | Structural Integrity Associates, Inc. |
| Al Csontos | U.S. Nuclear Regulatory Commission |
| Allen Hiser | U.S. Nuclear Regulatory Commission |
| Carolyn Fairbanks | U.S. Nuclear Regulatory Commission |
| Daniel Widrevitz | U.S. Nuclear Regulatory Commission |
| Eric Focht | U.S. Nuclear Regulatory Commission |
| Gary Stevens | U.S. Nuclear Regulatory Commission |
| Jonathan Rowley | U.S. Nuclear Regulatory Commission |
| Josh Kusnick | U.S. Nuclear Regulatory Commission |
| Mark Kirk | U.S. Nuclear Regulatory Commission |
| Michael Benson | U.S. Nuclear Regulatory Commission |
| Patrick Purtscher | U.S. Nuclear Regulatory Commission |
| Rob Tregoning | U.S. Nuclear Regulatory Commission |
| Robert Hardies | U.S. Nuclear Regulatory Commission |
| Simon Sheng | U.S. Nuclear Regulatory Commission |
| Carol Heinecke | Westinghouse Electric Company |
| Nathan Palm | Westinghouse Electric Company |

*via telephone conferencing

ENCLOSURE