

August 31, 2001

MEMORANDUM TO: William H. Bateman, Branch Chief
Materials and Chemical Engineering Branch
Division of Engineering

FROM: Jacob I. Zimmerman, Project Manager */ra/*
Structural Integrity & Metallurgy - Section A
Materials and Chemical Engineering Branch
Division of Engineering

SUBJECT: SUMMARY OF AUGUST 15, 2001, MEETING WITH NUCLEAR
ENERGY INSTITUTE AND OPERATING PRESSURIZED WATER
REACTOR LICENSEE'S ON BULLETIN 2001-01, "CIRCUMFERENTIAL
CRACKING OF REACTOR PRESSURE VESSEL HEAD PENETRATION
NOZZLES" (TAC NO.: MB2060)

On August 15, 2001, members of the U.S. Nuclear Regulatory Commission (NRC) staff participated in a public meeting held at the NRC offices in Rockville, Maryland, with representatives from the Nuclear Energy Institute (NEI), various operating nuclear reactor licensees, and members of the public. In addition, the NRC established a telephone conference bridge number, to allow interested individuals to participate in the meeting via telephone. The bridge number and meeting slides were made available prior to the meeting on the NRC web site for this issue ("Generic Activities on PWR Alloy-600 Weld Cracking," at <http://www.nrc.gov/NRC/REACTOR/ALLOY-600/index.html>). Attachment 1 is the meeting agenda, Attachment 2 provides the meeting slides, and Attachment 3 lists the meeting attendees and those participating via telephone.

The purpose of the meeting was to discuss NRC expectations regarding pressurized water reactor licensee responses to NRC's Bulletin 2001-01 on circumferential cracking of reactor pressure vessel head penetration nozzles.

Mr. Samuel Collins, Director for the Office of Nuclear Reactor Regulation (NRR), opened the meeting by reviewing its purpose and defining success as industry and external stakeholders clearly understanding the NRC's expectations with regard to what will constitute an acceptable bulletin response. He discussed the importance of industry providing credible information to support the technical bases to support their proposed actions. He indicated that the staff is prepared to review the responses in a timely manner in order to assess whether additional agency regulatory action is required.

Mr. Jack Strosnider, Director for the Division of Engineering (NRR), discussed the NRC's perspective relative to the agency's four performance goals (Maintaining Safety, Reducing Unnecessary Regulatory Burden, Improving Efficiency and Effectiveness, and Increasing Public Confidence) for the Nuclear Reactor Safety Strategic Arena and the applicable regulatory

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requirements. Mr. Strosnider stressed the importance of maintaining safety and recognized that information provided to date does not provide a sufficient technical basis to show that conditions adverse to quality are being effectively managed. Thus, the purpose of the bulletin is to collect information to determine if additional regulatory action is necessary. He recognized that managing the issue would require additional resources for both the NRC and the industry, especially in the areas of inspection, assessment, and repair method development. Mr. Strosnider indicated his support for generic approaches for addressing this issue and discussed the importance of maintaining our communications with industry and members of the public. In addition, he discussed the applicable regulatory requirements and possible long-term changes to NRC or the American Society for Mechanical Engineers Boiler and Pressure Vessel Code regulations.

Mr. Mark Caruso, Acting Licensing Section Chief, from the Licensing Section of the Probabilistic Safety Assessment Branch of the Division of Systems Safety and Analysis, discussed information to support a risk assessment. Mr. Caruso discussed the principles of risk-informed regulation contained in Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" and key technical issues, such as, accident sequence analysis, performance of equipment and operators, and treatment of uncertainties in data and methods.

Mr. Allen Hiser, the lead technical reviewer, Materials and Chemical Engineering Branch, Division of Engineering, discussed technical issues associated with probabilistic fracture mechanics evaluations with specific emphasis on the initial flaw distribution and multiple crack initiation sites, residual stresses as the crack propagates, questions on the environment for the outside diameter crack, and whether the crack would go through wall. In addition, he discussed crack progression through further understanding of the following: weld material, heat-affected-zone, and base metal cracking; annulus conditions including the leak rate; and above-the-weld cracking including the initiation time and multiple initiation sites. Mr. Hiser also discussed qualification of examination methods.

The staff will schedule further meetings with industry, as necessary, to facilitate the timely exchange of technical information and to assure that stakeholders are kept informed of the status of the issue in the regulatory process.

Attachments: As stated

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U.S. Nuclear Regulatory Commission Meeting with Nuclear Energy Institute and Material Reliability Program

**Wednesday, August 15, 2001
9:00 a.m. - 11:00 a.m.
Room: T-2B3**

Purpose: To discuss NRC expectations with regard to licensee responses to Bulletin 2001-01.

Success: NEI and MRP have a clear understanding of NRC's expectations with regard to what will constitute an acceptable bulletin response.

Introduction:	Jake Zimmerman/ Sam Collins	9:00 a.m. - 9:15 a.m.
Opening Remarks:	Jack Strosnider	9:15 a.m. - 9:35 a.m.
Discussion of Risk Assessment:	Mark Caruso	9:35 a.m. - 10:00 a.m.
Discussion of Technical Issues:	Allen Hiser	10:00 a.m. - 10:15 a.m.
Summary of Issues:	Jack Strosnider	10:15 a.m. - 10:25 a.m.
Closing Comments:	NRC/NEI/MRP	10:25 a.m. - 11:00 a.m.

Additional information on Generic Activities on PWR Alloy-600 Weld Cracking may be found on the NRC web site at <http://www.nrc.gov/NRC/REACTOR/ALLOY-600/index.html>.

The NRC staff will be available immediately following the meeting to speak with members of the public.

**NRC BULLETIN 2001-01:
CIRCUMFERENTIAL CRACKING OF RECTOR PRESSURE
VESSEL HEAD PENETRATION NOZZLES**

NRC PERSPECTIVES

August 15, 2001

**Jack Strosnider, Director
Division of Engineering
U.S. NRC**

Attachment 2

MAINTAINING SAFETY

- **ADDITIONAL INFORMATION IS NECESSARY TO ASSESS THE POTENTIAL SAFETY SIGNIFICANCE OF THIS ISSUE AND PROPOSED LICENSEE ACTIONS**
- **PURPOSE OF THE BULLETIN IS TO COLLECT INFORMATION TO DETERMINE IF ADDITIONAL REGULATORY ACTION IS NECESSARY**
- **INFORMATION PROVIDED TO DATE DOES NOT PROVIDE A SUFFICIENT TECHNICAL BASIS TO SHOW THAT CONDITIONS ADVERSE TO QUALITY ARE BEING EFFECTIVELY MANAGED**

REDUCING UNNECESSARY REGULATORY BURDEN

- **INFORMATION REQUEST IN THE BULLETIN WAS MINIMIZED**
- **MANAGING THIS ISSUE WILL REQUIRE ADDITIONAL RESOURCES**
- **ADDITIONAL CRACKING SHOULD BE ANTICIPATED**
- **INSPECTION, ASSESSMENT, AND REPAIR METHODS MUST BE DEVELOPED TO MANAGE THIS ISSUE**

IMPROVING EFFICIENCY & EFFECTIVENESS

- **WILL SUPPORT GENERIC APPROACHES**
- **COMMUNICATIONS IS THE KEY**

INCREASING PUBLIC CONFIDENCE

- **LICENSEE RESPONSES MUST PROVIDE CREDIBLE TECHNICAL BASES TO SUPPORT THEIR PROPOSED ACTIONS**
- **NRC WEB SITE**

APPLICABLE REGULATORY REQUIREMENTS

- **10 CFR 50.55a - References Section XI of ASME B&PV Code**
 - ▶
 - ▶ **Code inspections are not adequate (insulation, VT-2) to satisfy Appendix B**
 - ▶
 - ▶ **Code flaw disposition criteria are acceptable - need size and crack growth rate**
- **Plant Technical Specifications**
 - ▶
 - ▶ **Do not permit reactor coolant pressure boundary leakage**
 - ▶
 - ▶ **Because of no reasonable expectation - Exercise of Enforcement Discretion for Summer & Ocone**
 - ▶
 - ▶ **2nd occurrence of leakage at same site - may be subject to enforcement action**
 - ▶
 - ▶ **leakage at other sites - may be subject to enforcement action**
- **Criterion XVI - Corrective Action (Appendix B to 10 CFR Part 50)**
 - ▶
 - ▶ **Conditions adverse to quality are promptly identified and corrected**
 - ▶
 - ▶ **Determine cause of condition and corrective action to preclude repetition**

Mark A. Caruso
Probabilistic Safety Assessment Branch, NRR

- **Apply principles of risk-informed regulation (Regulatory Guide 1.174)**
 - continue to meet current regulations
 - maintain defense-in-depth philosophy
 - maintain sufficient safety margins
 - demonstrate that any increase in risk is small
 - monitor the change

- **Additional Guidance:**
 - Standard Review Plan Chapter 19
 - staff reviews of previous risk-informed proposals (e.g., Farley, ANO-2 steam generator tube inspections)

- **Key Technical Issues**
 - **potential for rupture**
 - **accident sequence analysis (e.g., LOCA)**
 - **availability of mitigating systems**
 - **performance of equipment and operators**
 - **containment performance**
 - **treatment of uncertainties in data and methods**

**NRC BULLETIN 2001-01:
CIRCUMFERENTIAL CRACKING OF
REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES:
TECHNICAL ISSUES**

Allen Hiser

**US Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Engineering
Materials and Chemical Engineering Branch**

Public Meeting with Industry

August 15, 2001

PROBABILISTIC FRACTURE MECHANICS EVALUATIONS

- **Initial flaw distribution**
 - ▶ **Multiple initiation sites**
- **Residual stresses as crack propagates**
- **Crack growth rate - what is the proper environment ??**
- **Through-wall or part through-wall ??**

UNDERSTANDING CRACK PROGRESSION

- **Weld/HAZ/base metal cracking**
- - ▶ **Initiation time**
 - ▶ **Controlling parameters (weld characteristics, microstructure, residual stresses, etc.)**
 - ▶ **Crack growth rate**
 - ▶
- **Annulus conditions**
Leak rate from weld/HAZ/base metal cracking
 - ▶ **Chemistry in annulus**
 - ▶ **Temperature in annulus**
 - ▶ **Ability for leakage deposits to flow up the annulus**
- **Above-the-weld cracking**
 - ▶ **Initiation time**
 - ▶ **Multiple initiation sites**
 - ▶ **Residual stress levels as crack propagates**
 - ▶ **Crack growth rate (what is the proper environment ??)**
 - ▶ **Through-wall or part-through wall ??**

QUALIFICATION OF EXAMINATION METHODS

- **VT-2 Visual Examination Qualification**
 - ▶ Capable of detecting small amounts of boric acid deposits and discriminating deposits from VHP nozzle and other sources
 - ▶ Appropriate for Moderate Susceptibility Plants (33 total) - PWSCC of nozzles not likely in short term, but could occur

- **Plant-Specific Visual Examination Qualification**
 - ▶ Plant-specific demonstration that VHP nozzle cracks will lead to deposits on the RPV head (interference fit measurements, etc.)
 - ▶ Must be capable of reliable detection and source identification of leakage (insulation, pre-existing deposits, other impediments)
 - ▶ Appropriate for High Susceptibility Plants (7 total) - PWSCC of nozzles likely to occur in the near term

- **Volumetric Examination Qualification**
 - ▶ Demonstrated capability to reliably detect cracking on the OD of VHP nozzles
 - ▶ Appropriate for plants that have identified cracking (5 total) - PWSCC of nozzles is a documented occurrence
 - ▶ Default if Visual Examination cannot be Qualified
 - ▶ Applies for any plant finding leakage

QUALIFICATION OF OTHER EXAMINATION METHODS

- **Eddy current testing**
 - ▶ **Scope of inspection (e.g., J-groove weld, nozzle OD below the weld, nozzle ID)**
 - ▶ **Detection of tight PWSCC cracks (European experience with pipe cracks)**
- **Other surface methods**
 - ▶ **Penetrant testing**
- **Qualification packages for head visual examinations**



**NRC Meeting with Nuclear Energy Institute and
Operating Pressurized Water Reactor Licensees**

**Wednesday, August 15, 2001
9:00 a.m. - 11:00 a.m.
Room: T-2B3**

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