

NRC PROPOSED BULLETIN TO ADDRESS:

**CIRCUMFERENTIAL CRACKING OF
REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES**

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Meeting with
Advisory Committee on Reactor Safeguards

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SAFETY PERSPECTIVE

- ! Failure of a CRDM nozzle constitutes a LOCA and control rod ejection (REA)
- ! Existing PRAs indicate a level of risk requiring increased attention
- ! Worst case crack found at a high susceptibility plant had a remaining ligament factor of safety of ≈ 6 to failure
- ! No reason to conclude that cracking won't affect additional units
- ! Timely, effective inspections should provide additional information on extent of the problem and provide confidence that safety is maintained and regulatory requirements are satisfied
- ! CRDM nozzle failure not expected to challenge containment integrity

TECHNICAL ISSUES HIGHLIGHTED BY ACRS SUBCOMMITTEES

TECHNICAL ISSUE	BULLETIN APPROACH
Susceptibility Model Uncertainties	Uses rankings as basis for graded approach regarding appropriate inspection method qualification and level of information requested -- information should provide greater insights and support assessment of need for additional regulatory actions
Effectiveness of Visual Inspections	Provides qualification criteria for plant-specific evaluation (availability of deposits on head, discrimination of VHP nozzle deposits, etc.), in a graded approach appropriate to relative susceptibility ranking
Evaluation of Crack Growth Rate and Annulus Chemistry	Licensees will need to provide basis for annulus chemistry and crack growth rate if they rely on analysis for basis of no inspection or lesser inspection

INDUSTRY AND BULLETIN APPROACHES TO INSPECTION

ITEM	BULLETIN APPROACH	INDUSTRY APPROACH
Examination Method	Graded approach ^{**} : (1) volumetric for plants that have leaked, (2) plant-specific visual qualification for high susceptibility plants (< 4 EFPY from Oconee 3), (3) VT-2 visual qualification for moderate susceptibility plants (from 4 to 30 EFPY of Oconee 3)	Visual examination (“capable of detecting small amounts of boric acid deposits”) of plants < 10 EFPY of Oconee 3; continue boric acid walkdowns for other plants
Plants Affected	(1) 4, (2) 10, (3) 31 = 45	25
Timing	High susceptibility plants by end of 2001 ^{**} (6 of 14 high susceptibility plants do not have outages scheduled before 12/31/01)	Next RFO
Sample Size	100% of VHP nozzles	100% visual of VHP nozzles
Expansion Criteria	On detection of leakage, volumetric examination of 100% ^{**}	Not specified (ASME Code criteria - 1:1)

^{**} Or alternative approach justified by the licensee

RISK ASSESSMENT

- ! LOCA/reactivity insertion
 - ▶ LOCA - mitigating strategy is well understood
 - break location means operator can more readily manage coolant inventory (longer time to switch to recirculation)
 - ▶ REA - single rod ejection (hot zero power); core damage is unlikely
 - multiple rod ejection needs to be assessed

- ! Collateral issues
 - ▶ Need to assess the effect of multiple rod ejection accident
 - ▶ LOCA with multiple rod fail to insert
 - ▶ Recirculation-related issues

- ! Probabilistic fracture mechanics (PFM)

- ! Containment integrity is not challenged

ADDITIONAL WORK

- ! Complete work of RES expert group
- ! NRR user need request to RES (June 5, 2001)
 - ▶ NDE/ISI
 - ▶ Crack growth in Inconel weld metal (INCO 82/182)
 - ▶ Crack growth in Inconel base metal (Alloy 600) nozzles, considering chemistry of annulus
 - ▶ Residual stresses
 - ▶ Viability of visual leakage detection from CRDM nozzles and weld PWSCC cracks
 - ▶ Repairs and mitigation
 - ▶ Susceptibility models (base and weld metal)
- ! Risk insights and additional sequence delineation
- ! Continued review of industry activities

NRC PERFORMANCE GOALS

- ! Maintain Safety
- ! Reduce Unnecessary Burden
- ! Improve Regulatory Efficiency and Effectiveness
- ! Increase Public Confidence