

NRC Bulletin 2001-01,
**“Circumferential Cracking of Reactor
Pressure Vessel Head Penetration
Nozzles”**



Presenters:

Guy G. Campbell, Vice President - FENOC

Steven P. Moffitt, Director - Technical Services

David C. Geisen, Manager - Design Basis Engineering

David H. Lockwood, Manager - Regulatory Affairs

Steve Fyfitch, Framatome Engineering

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Nuclear Operating Companies



Why We're Here:

- ★ NRC Bulletin 2001-01 response provided
- ★ Telephone call received on September 28
- ★ Teleconference on October 3



Today's Objective:

Provide reasonable basis for assurance that Davis-Besse is safe to operate until next refueling outage (March 2002) and should continue 24 month operating cycles



NRC Bulletin 2001-01

Titled, "***Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles,***" dated August 3, 2001

★ Requests that plants provide design information, previous inspection results, and future inspection plans

★ Response requirements were based upon plant ranking in Susceptibility Model as published in EPRI MRP-48.



Susceptibility Model

EPRI - PWR Materials Reliability Program Response to NRC Bulletin 2001-01 (MPR-48), 1006284, dated August 2001

- ★ Ranked Davis-Besse as 7th out of 69 plants.
- ★ 6.6 actual EFPY away from Oconee 3 but 3.1 EFPY away after normalizing on head temperatures down to 600 degrees.
- ★ Model is purposely simplistic in that PWSCC is influenced by *Environment* (Chemistry & Temperature), *Stress*, and *Time*. The model does not account for Stress, Chemistry, or specific plant as-built conditions.



Davis-Besse's NRC Bulletin Response

- ★ Conducted and recorded video inspections of the head during 11 RFO (April 1998) and 12 RFO (April 2000)
- ★ Re-reviewed video inspections of head in light of boron leakage seen at Oconee and Arkansas Nuclear.
- ★ No head penetration leakage was identified.
- ★ Committed to submit follow-up response on January 29, 2002 based upon further industry developments.
- ★ Committed to perform a qualified visual of Reactor Pressure Vessel head in 13RFO currently scheduled for April 2002.



Facts

- ☆ All CRDM penetrations were verified to be free from “popcorn” type boron deposits using video recordings from 11RFO or 12RFO.
- ☆ All through wall cracks in the industry have been identified by visual inspection.
- ☆ Plant specific finite element analysis shows that 65 out of 69 will open up sufficiently to provide visual indication.
- ☆ Remaining 4 CRDMs located in lowest stress area where there have been no circumferential cracks found in the industry.
- ☆ Critical crack size is 273 degrees which is still a safety factor of 3 (aligns with ASME code).



Assumptions

★ Initial conservative crack size of 180° at beginning of Cycle 12 (1998)

★ Crack propagates in two directions

★ Industry accepted crack growth rates for Alloy 600 are applied

★ Does not credit decreasing stresses as crack grows which would also decrease crack growth rate.



Reasonable Assurance

Results of Analysis:

This conservative analysis shows that a potential crack would not grow to critical crack size before the 13th refueling outage.



Additional Supporting Information

- ★ Continuing industry effort to refine crack propagation
- ★ Continuing industry effort to define effects of chemical environment
- ★ Plant specific fracture mechanics evaluation and crack growth analysis by SIA (Structural Integrity Associates).
- ★ Plant specific leakage analysis for critical crack size by SIA.



Risk-Informed Evaluation

★ NSSS vendor-specific risk assessment provides estimated core damage frequency of 3.4 E-7

★ Per RG 1.174 this is categorized as a “very small” increase in risk



Summary:

★ There is a reasonable basis for assurance that Davis-Besse is safe to operate based on deterministic and probabilistic assessments until next refueling outage (March 2002)

★ We want to have the opportunity to continue dialog



Industry References

Electric Power Research Institute (EPRI) - PWR Materials Reliability Program Interim Alloy 600 Safety Assessments for U.S. PWR Plants (MRP-44), TP-1001491, Part 2, dated May 2001.

EPRI - PWR Materials Reliability Program Response to NRC Review Comments Transmitted by Letter Dated June 22, 2001, to the NEI Relating to MRP-44, dated June 29, 2001

EPRI - PWR Materials Reliability Program Response to NRC Bulletin 2001-01 (MRP-48), 1006284, dated August 2001



CRDM NOZZLE CRACKING TIMELINE

1991 - Originally CRDM cracking was identified at Bugey Unit 3 in France

June, 1993 - Safety Assessment Written by all three NSSS Owners Group (NUMARC)

October, 1994 - NUREG/CR-6245, "Assessment of Pressurized Water Reactor Control Rod Drive Mechanism Nozzle Cracking"

April, 1997 - NRC Generic Letter 97-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations", was issued. Industry Responded with Probabilistic Rankings and head inspection plans.

1997 - Electric Power Research Institute (EPRI) - Crack Growth and Microstructural Characterization of Alloy 600 Vessel Head Penetration Materials, TR-109136 (Proprietary)

June, 2000 - Electric Power Research Institute (EPRI) - Crack Growth of Alloy 182 Weld Metal in PWR Environments (MRP-21)

December, 2000 - One Leaking Nozzle Oconee 1

February, 2001 - Nine Leaking Nozzles at Oconee 3

March, 2001 - One Leaking Nozzle at ANO 1

April, 2001 - Four Leaking Nozzles at Oconee 2

April, 2001 - Framatome ANP - RV Head Nozzle and Weld Safety Assessment, 51-5011603-01 (FTI ANP Proprietary) and 51-5012567-00 (Non-proprietary)

April 30, 2001 - NRC IN 2001-05, "Through-wall Circumferential Cracking of Reactor Pressure Vessel Head Control Rod Drive Mechanism Penetration Nozzles at Oconee Nuclear Station, Unit 3"

May, 2001 - Electric Power Research Institute (EPRI) - PWR Materials Reliability Program Interim Alloy 600 Safety Assessments for U.S. PWR Plants (MRP-44), TP-1001491, Part 2



CRDM NOZZLE CRACKING TIMELINE, CONT.

June 29, 2001 - EPRI - PWR Materials Reliability Program Response to NRC Review Comments Transmitted by Letter Dated June 22, 2001, to the NEI Relating to MRP-44 (MRP-50)

August 3, 2001 - NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles.

August 19, 2001 - EPRI - PWR Materials Reliability Program Response to NRC Bulletin 2001-01 (MRP-48), 1006284

August 24, 2001 - Davis-Besse enters contract with SIA.

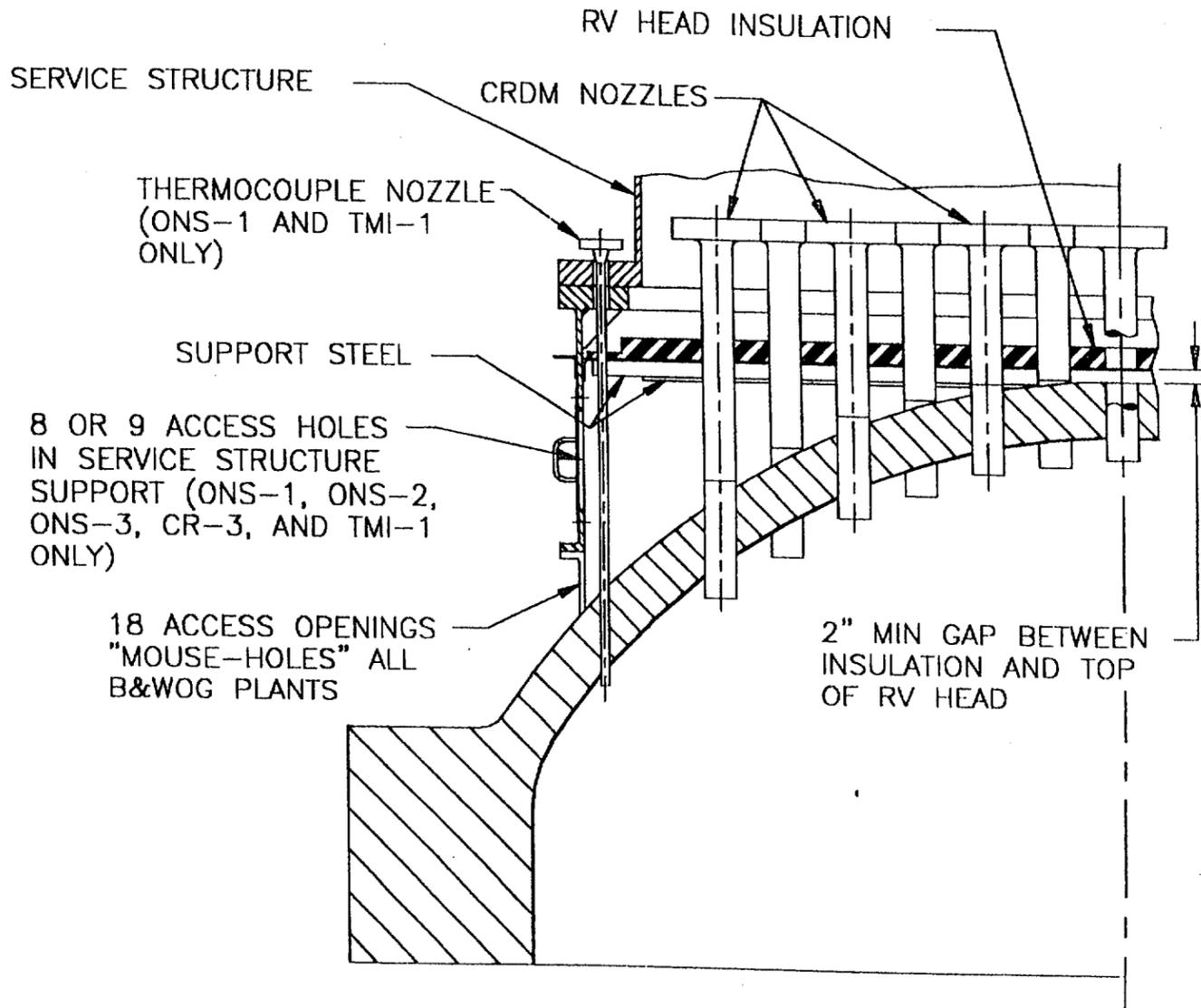
September 4, 2001 - Davis-Besse responds to NRC Bulletin 2001-01

September 24, 2001 - NRR transmits via letter Flaw Evaluation Criteria to NEI.

September 28, 2001 - Dr. Brian Sheron telecon with FENOC CNO Robert Saunders urging fall inspection at Davis-Besse

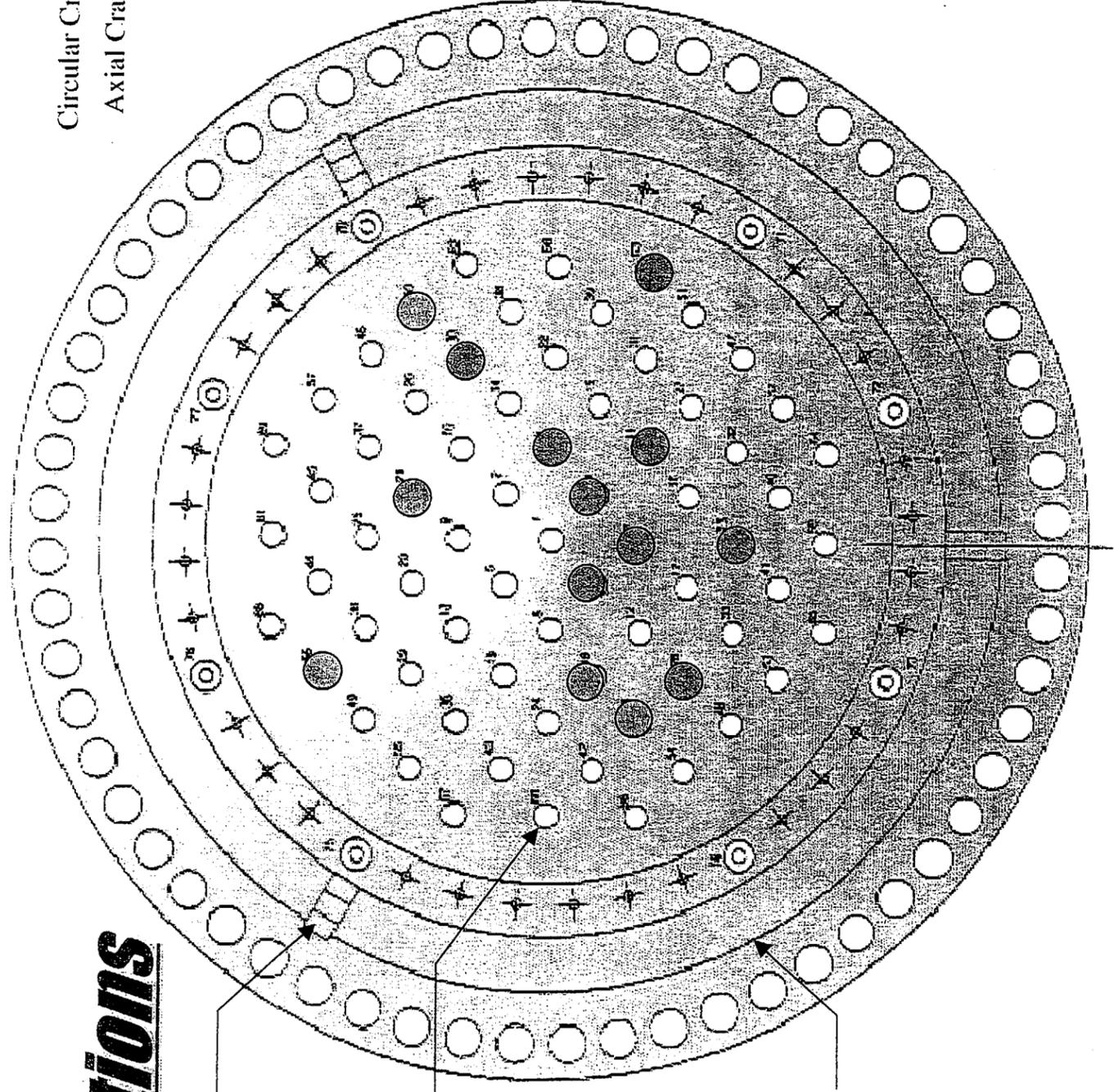
October 3, 2001 - NRR conference call with Davis-Besse technical personnel to understand NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles.





Leak **Locations**

Circular Cracks - 
Axial Cracks - 



Lifting Lug
(3 Total)

CRDM Nozzles
(69 Total)

Service Structure
Support Flange



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