Ex. 5

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

John: Sensitivity Study (bounding analysis)

Attendees:

Steven Moffitt, Director - Technical Services
David Geisen, Manager - Design Basis Engineering
David Lockwood, Manager - Regulatory Affairs
Kendall Byrd, Supervisor - Nuclear Engineering
Gerald Wolf, Senior Engineer - Regulatory Affairs
Mike Dowling, Vice President - First Energy Services
Alvin McKim, Framatome
Steve Fyfitch, Framatome
Stanley Levinson, Framatome
Peter Scott, Framatome
Bob Enzinna, Framatome
Dick Mattson, Structural Integrity Associates
Roy Lessy, Akin, Gump, Strauss, Hauer & Feld, L.L.P.

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OPERATIONAL EXCELLENCE

Why We're Here:

☆ NRC Bulletin 2001-01 response provided

☆ Telephone call received on September 28

☆ Teleconference on October 3

☆ Brief drop by on October 11

Today's Objective:

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

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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, Material Variability, or specific plant as-built conditions.

Davis-Besse's NRC Bulletin Response

- ☆ Referenced 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 One.
- ☆ 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 inspection of Reactor Pressure Vessel head in 13RFO currently scheduled to begin in March 2002.

Analyses

Ex 5

DBNPS's evaluation is based on our visual inspections performed in 10, 11, and 12 RFO (May 1996, April 1998, and April 2000 respectively)

The inspection results afford us assurance that all but 4 nozzle penetrations were inspected in 1996. All but 19 penetrations were inspected in 1998. And all but 24 penetrations were inspected in 2000.

The limiting nozzle population is those nozzles that could not be inspected in 1998 or 2000.

It is conservatively assumed that for these penetrations, an axial through weld flaw occurs immediately upon startup from 10 RFO (May 1996) Ex 5

Analyses, cont.

Assuming flaw initiation at the beginning of cycle 11, a circumferential through wall flaw will not reach the allowable flaw size before November 2003.

Clearly, operating to March 2002 is acceptable given that we have analyzed conservatively at each step of our evaluation.

Facts

All CRDM penetrations were verified to be free from "popcorn" type boron deposits using video recordings from 10RFO, 11RFO or 12RFO.

☆ *A review of visual recordings as well as eye-witness accounts served as the means of the inspection.*

☆ *The original VHS format was transferred to .avi file format to allow a frame by frame review.*

Facts

All through wall flaws in the US industry reported to date have been identified by visual inspection.

☆ *There have been no through wall circumferential flaws above the J-weld region that have not exhibited visual leakage on the OD of the reactor vessel head.*

☆ *The sampling of CRDM nozzles that underwent NDE type inspections as part of an extent of condition did not exhibit circumferential flaws above the J-weld.*

Facts

A conservative plant specific finite element analysis shows that at least 65 out of 69 penetrations will open up sufficiently to provide visual indication.

☆ *Structural Integrity Associates (SIA) performed the finite element analysis.*

☆ *Drive penetrations 1, 2, 3, and 4 did not relax their interference fits sufficiently enough to claim that an unimpeded path exists from the top of the J-weld to the OD of the head. The minimum interference fit is only 0.00002".*

☆ *These drives did not necessarily have the highest interference fits. Their location exhibited the lowest differential stress and that limited their penetration elongation. This absence of high differential stress may also explain why no circumferential flaws have been found in the industry at these locations.*

☆ *A detailed Framatome analysis of B&W plants shows all penetrations opening up.*

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Facts

Maximum allowable flaw size is at least 273 degrees which is still a safety factor of 3 (aligns with ASME code)

☆ *Preliminary Davis-Besse specific SIA analysis indicates that the maximum allowable flaw size to still achieve a safety factor of 3 may be as high as 302 degrees.*

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Assumptions

Initial flaw depth of 0.5 mm, 172° around the nozzle, is assumed to exist immediately upon achieving a full penetration axial flaw.

BASIS:

- ☆ This is a conservative flaw initiation site size.
- ☆ It is further conservatively assumed that multiple starting flaws could exist and that these would eventually link together.
- ☆ It is conservative in that by assuming this starting point, we also are assuming that we have already had several years of flaw propagation axially through the Alloy 182 weld material.

Assumptions

It takes at least 3.5 years to grow circumferentially through wall to a flaw size of 180°

BASIS:

☆ 180° was used by Framatome in their Safety Assessment.

☆ It is conservative in that the Framatome analysis showed that a single initiation site would take 10 years to grow to this point but that multiple initiating flaws could link up to shorten the flaw growth timeframe to 3.5 years.

Assumptions

Industry accepted crack growth rate models for Alloy 600 are applied.

BASIS:

☆ The crack propagation rate used in the Framatome analysis was derived from applying the Peter Scott model which is K (stress intensity factor) dependent.

☆ The model is a materials based model developed from steam generator empirical data and is applied conservatively to CRDM material database. Ex5

☆ The environment is equivalent to primary water chemistry.

Ex5

Assumptions

It takes at least 4 years to grow from the flaw size of 180° to a maximum allowable flaw size of 270°

BASIS:

☆ Modeled by Framatome in their Safety Assessment.

☆ Applying an alternative method we see that the Framatome method is conservative. For example, using mean radius of nozzle which equates to a circumference of 10.62, to flaw from 180 to 270 degrees would equate to 45 degrees in each direction for a circumferential distance of 1.33 inches. Then applying an accepted linearized growth rate of 0.2 inches/year through Alloy 600 material yields 6.6 years to propagate the 1.33 inches in each direction.

Ex5

Reasonable Assurance

Results of Analysis:

This conservative analysis shows that a potential flaw would not grow to maximum allowable flaw size before the 13th refueling outage.

Ex5

Risk-Informed Evaluation

- ☆ NSSS vendor-specific risk assessment provides estimated incremental core damage frequency of 3.4 E-7 Ex5

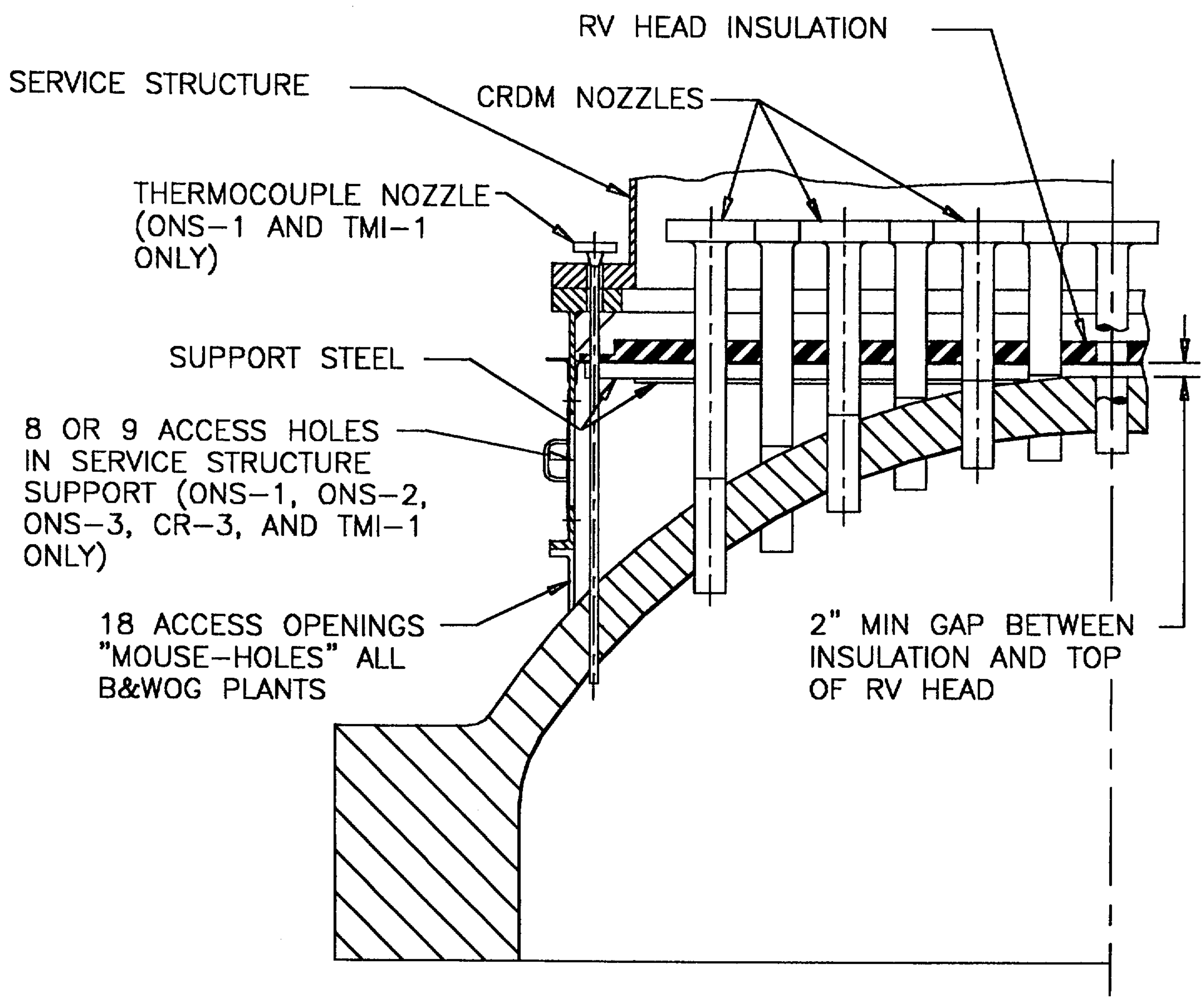
- ☆ Preliminary plant specific risk assessment conservatively estimates incremental core damage frequency as 6.7 E-6, which is categorized as "small" per RG 1.174.

- ☆ Preliminary plant specific risk assessment conservatively estimates incremental large early release frequency as 1.0 E-8, which is categorized as "very small" per RG 1.174.

Ex.5

Summary:

There is Reasonable Assurance that Davis-Besse is safe to operate based on deterministic and probabilistic assessments until the next refueling outage (March 2002) and continue on 24-month operating cycles.


RV HEAD INSULATION
SERVICE STRUCTURE
CRDM NOZZLES
THERMOCOUPLE NOZZLE (ONS–1 AND TMI–1 ONLY)
SUPPORT STEEL
8 OR 9 ACCESS HOLES IN SERVICE STRUCTURE SUPPORT (ONS–1, ONS–2, ONS–3, CR–3, AND TMI–1 ONLY)
18 ACCESS OPENINGS "MOUSE–HOLES" ALL B&WOG PLANTS
2" MIN GAP BETWEEN INSULATION AND TOP OF RV HEAD