NEDE-33279P

ESBWR Containment Fission Product Removal Evaluation Model.

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LOCA Scenarios Evaluated

Scenario 1: Bottom Drain Line Break with ADS. Degraded Low Pressure Makeup. ECCS Restored Just Prior to Vessel Breach.

Scenario 2: BDL Break with Degraded High Pressure Makeup and ADS Failure. ECCS Restored Just Prior to Vessel Breach.

Scenario 3: Loss of Preferred Power/Loss of FW with ADS Failure. Degraded High Pressure Makeup. ECCS Restored Just Prior to Vessel Breach.

Accident Scenario 1

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AS-1 – Injection Time Comparison

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Accident Scenario 2

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Accident Scenario 3

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Accident Scenario Comparison – CsI Released from Fuel

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Containment Airborne Mass Comparison

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Leakage Terms and Locations

NRC RAI 2.3-9:

- Containment Leakage to Reactor Building
  - Diffuse Source Assumed Over East RB Face
- Containment Leakage to PCCS Airspace
  - PCCS Releases Assume Though Vent at RB Roof
- MSIV Leakage
  - Main Condenser Determined to be the Most Conservative Release Point

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Reactor Building Release Point

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PCCS Airspace Release Point

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MSIV Release Location(s)

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Primary Containment Leakage

Total Containment Leakage Rate is 0.5 wt. % per day as specified in TS 5.5.9

Two Leakage Pathways

- 98% Assumed Released to Reactor Building (0.49 % per day)
- 2% Assumed to Leak Through PCCS (0.01 % per day)

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Reactor Building

98% of Containment Leakage Assumed to Reactor Building (0.49 % per day)

Reactor Building Assumed to Leak at 50% per day

- TS SR 3.6.3.1.4 "Verify Reactor Building exfiltration rate within limits."

40% of Building Volume Credited for Mixing

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PCCS Leakage

2% of Total Containment Leakage Assumed Through PCCS

Released to PCCS/IC Airspace which Does Not Communicate with RB Atmosphere

- Airspace Volume = 4.10E+04 ft^3

High Flow Rate Assumed

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TS 5.5.9 – Primary Containment Leakage Rate Test Program

TS 5.5.9.c Currently Wording (Based on "Option B") :

- "The maximum allowable containment leakage rate, La, at Pa, shall be 0.5% of containment air weight per day."

TS 5.5.9.c Proposed Wording:

- "The maximum allowable containment leakage rate, La, at Pa, shall be 0.5% of containment air weight per day consisting of 0.49% of containment air weight per day for Type A testing excluding Passive Containment Cooling (PCC) leakage and 0.01% of containment air weight per day for PCC leakage."

Main Steam Isolation Valve Leakage

Assumed to be 6.23E-02 m^3/min. (200 scfh) (Total per Division)

Leakage Transported Directly to Condenser

- No Credit is Taken for Holdup, Decay, or Deposition in Main Steam Lines or MSL Drain Lines

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MSIV Leakage

Technical Specification Surveillance Requirement 3.6.1.3.8 Will Be Revised

- Current (Rev. 1) Wording: "Verify the leakage rate through each MSIV is C [0.326 m^3/hour (11.5 scfh)] when tested at B [200 kPa gauge (29 psig)]."
- Proposed Wording: TBD

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Main Condenser Iodine Removal Model

Model Based on NEDC-31858P, *BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems*

Based on the “Fully Mixed Concentration Model”

Only Volume Above Condenser Tubes Credited

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Main Condenser Iodine Removal Model

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Main Condenser Iodine Removal Model

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Main Control Room Model

Assumes EBAS for 30 Days

- No operator action required for at least 72 hours
- No SAF will cause loss of bottled air inventory
- Replenishment from “off-site source” after 7 days

TS SR 3.7.1.1 will be Revised as Required

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Additional Slides

Removal Coefficient Determination

Airborne CsI Mass As a Function of Time Obtained from MELCOR Results

One Set of Removal Coefficients Determined for Each Scenario (AS-1 and AS-3)

- Due to relatively low amount of airborne CsI in AS-2 no dose calculation is warranted

$$A_t = A_{t-1} e^{-\lambda(t_2 - t_1)} \qquad A_t \propto M_t$$

$$M_t = M_{t-1} e^{-\lambda(t_2 - t_1)} \qquad \lambda = \frac{\ln\left(M_t / M_{t-1} \right)}{(t_2 - t_1)}$$

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Removal Coefficient Comparison

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Removal Coefficient Comparison

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