# Calvert Cliffs GSI-191 Program

## Zone of Influence, Debris Size Distribution, Option 2b Closure Approach, and LAR Exemption Request

July 18, 2016

Exelon Generation®

# Agenda

- Introductions
- Objectives for Meeting
  - Option 2b Simplified Risk-Informed Closure Plan
    - Strainer Performance Criteria
    - LOCA Frequency Allocation
    - LAR Exemption Request
  - Zone of Influence and Debris Size Distribution
- Staff Questions & Concerns
- Schedule for Future Periodic Meetings

# CCNPP Attendees

- Doug Lauver– Senior Engineering Manager
- Andre Drake – Lead Responsible Engineer GSI-191
- Jim Landale – Lead PRA Engineer
- Ken Greene – Licensing Engineer
- Craig Sellers – Project Manager GSI-191
- Eric Federline – Project Support

# Objectives of this Meeting

- Discussion of Calvert Cliffs Simplified Risk-Informed Approach
  - Strainer Performance Criteria
  - LOCA Frequency Allocation
  - LAR Exemption Request
- Discussion of Revised ZOIs and Debris Size Distributions
- Capture Staff Issues and Concerns
- Discuss Next Steps

# Simplified Risk-Informed Approach
# Strainer Performance Criteria

- Strainer Failure Modes:
  - Pump NPSH
  - Structural Failure
  - Deaeration – Limiting Failure Mode

- Strainer Performance Criteria
  - 1) Mass of Fine Fiber Debris
  - 2) Mass of Particulate Debris
  - 3) Mass of WCAP-16530 Chemical Precipitate Debris*
    - * Provided sufficient fiber to cover strainer ≥ $^{1}/_{16}$”

- Preliminary Results
  - 19 of 62 Welds ≥ 30” ID Exceed Criteria of Fiber and/or Precipitate Mass
    - 7 of 19 Exceed only Precipitate Criterion
  - 2 of 72 12” ID Welds Exceed Precipitate Criterion
    - Equivalent Uniform Fiber Bed Thickness ~$^{1}/_{23}$” and $^{1}/_{28}$”
    - Insufficient Debris Bed to Capture Precipitate
    - No Threat to Strainer Performance

# Simplified Risk-Informed Approach (continued)
# Calculate ΔCDF – Preliminary Results

- Use Conservative Approach
  - Smallest break that threatens strainer performance – 30” DEGB
  - NUREG-1829 LOCA Frequencies
  - Equally Apportion LOCA Frequency Across RCS Welds
    - Degradation mechanisms are Design and Construction for all 62 RCS welds
    - PWSCC also on 8 RCS welds

- NUREG-1829 LOCA Frequencies

| LOCA Category | Break Size (in.) | Geometric Mean[1] | Arithmetic Mean[2] |
|---|---|---|---|
| 1 | ≥ 0.5 | 1.90E-03 | 1.00E-02 |
| 2 | ≥ 1.625 | 4.20E-04 | 3.00E-03 |
| 3 | ≥ 3 | 1.60E-05 | 7.30E-05 |
| 4 | ≥ 7 | 1.60E-06 | 9.40E-06 |
| 5 | ≥ 14 | 2.00E-07 | 2.40E-06 |
| 6 | ≥ 31 | 2.90E-08 | 1.50E-06 |
| Notes: | | | |
| [1] Taken from Table 7-19 of NUREG-1829<br>[2] Taken from Table 7-13 of NUREG-1829 | | | |

- Log-Linear Interpolation

| LOCA Category | Break Size (>in.) | Geometric Mean | Arithmetic Mean |
|---|---|---|---|
| 1 | ≥ 0.5 | 1.90E-03 | 1.00E-02 |
| 2 | ≥ 1.625 | 4.20E-04 | 3.00E-03 |
| 3 | ≥ 3 | 1.60E-05 | 7.30E-05 |
| 4 | ≥ 7 | 1.60E-06 | 9.40E-06 |
| 5 | ≥ 14 | 2.00E-07 | 2.40E-06 |
| 5.5 | ≥30 | 3.25E-08 | 1.54E-06 |
| 6 | ≥ 31 | 2.90E-08 | 1.50E-06 |
| | | | |
| # Welds | #Failed | ΔCDF GM | ΔCDF AM |
| 62 | 22 | 1.15E-08 | 5.47E-07 |

  - 62 Butt Welds ≥ 30”
  - 19 Welds ≥ 30” Threaten Strainer Performance
  - 3 are DM Welds – Double Counted

# Simplified Risk-Informed Approach (continued)
# License Amendment Request

- Calvert Cliffs Planning to Request Exemption from 10CFR50.46(a)(1.)
  - Similar to South Texas Project

- Calvert Cliffs not licensed to 10CFR50 Appendix A General Design Criteria
  - Do not need exemption from GDC

# Zone of Influence & Debris Size Distribution

- CCNPP Submitted Supplemental Response to GL 2004-02 on June 8, 2016
  - Addressed Revised ZOI and Debris Size Distributions for:
    - NUKON & Thermal Wrap Blanket Insulation
    - Mineral Wool Insulation in Stainless Steel Cassettes
    - Generic Fiberglass Insulation
    - Lead Wool Shielding Blankets
  - Based on data accepted at other plants

# ZOI & Debris Size Distribution – NUKON & Thermal Wrap

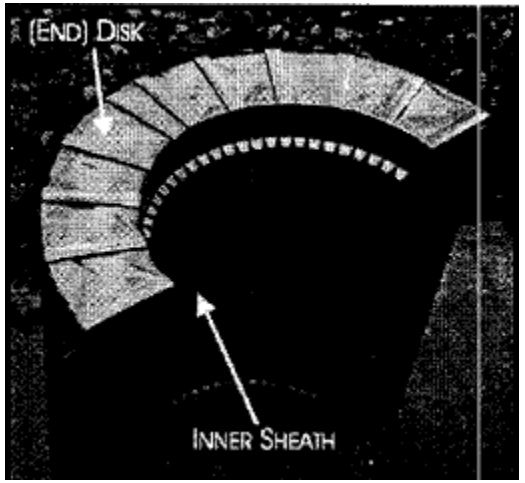
- 3 Zones of Influence, 4 Debris Size Distribution
- ENERCON Approach using Insulation Centroid
- Based on NEI 04-07 Safety Evaluation Guidance
- Accepted at Other Plants

| Debris Size | Average (Centroid) Distance from Break Location to Target | | |
|---|---|---|---|
| | 0D – 4D ZOI | 4D – 15D ZOI | 15D – 17D ZOI |
| Fines Fraction ($F_{fines}$) | $F_{fines} = 0.2$ | $F_{fines} = -0.01364 \times C + 0.2546$ | $F_{fines} = -0.025 \times C + 0.425$ |
| Small Pieces Fraction ($F_{smalls}$) | $F_{smalls} = 0.8$ | $F_{smalls} = -0.0682 \times C + 1.0724$ | $F_{smalls} = -0.025 \times C + 0.425$ |
| Large Pieces Fraction ($F_{large}$) | $F_{large} = 0$ | $F_{large} = 0.0393 \times C - 0.157$ | $F_{large} = -0.215 \times C + 3.655$ |
| Intact Pieces Fraction ($F_{intact}$) | $F_{intact} = 0$ | $F_{intact} = 0.0425 \times C - 0.170$ | $F_{intact} = 0.265 \times C - 3.505$ |

# ZOI & Debris Size Distribution – Mineral Wool

- Mineral Wool at CCNPP is Transco Stainless Steel Cassette Design
- 0.024" SS Sheath with Slotted End Panels
  - Installed in Plant


Tested at CEESI, Tests 22-1 to 22-3




- Tested cassettes contained metal foil and produced none or very little transportable debris.
- The contained material contributes no strength to the cassettes.
- Therefore, the destruction pressure for the Transco mineral wool cassettes and RMI cassettes are considered equal.
- To account for the difference in filler material, the ZOI for the mineral wool cassettes will be conservatively increased by a factor of 2 from 2.0D to 4.0D.
- The debris size for the mineral wool will be conservatively assumed to be 100% fine fibers.

# ZOI & Debris Size Distribution – Generic Fiberglass

- Anti-Sweat Insulation on Unit 1 CCW piping
- Molded of heavy density resin bonded inorganic glass fibers
- Jacketed with 0.010” riveted stainless steel
- Bulk density generally greater than Nukon and Thermal Wrap.
  - 3.5 to 5.5 lbm/ft$^3$ verses 2.4 lbm/ft$^3$
- The mass percentage of generic fiberglass relative to total fibrous debris load is <20% for the bounding break at Calvert Cliffs.
- Calvert Cliffs assumes that the ZOI and debris size distribution for generic fiberglass is that used for Nukon and Thermal Wrap based on the insulation density.

| Debris Size | Average (Centroid) Distance from Break Location to Target | | |
|---|---|---|---|
| | 0D – 4D ZOI | 4D – 15D ZOI | 15D – 17D ZOI |
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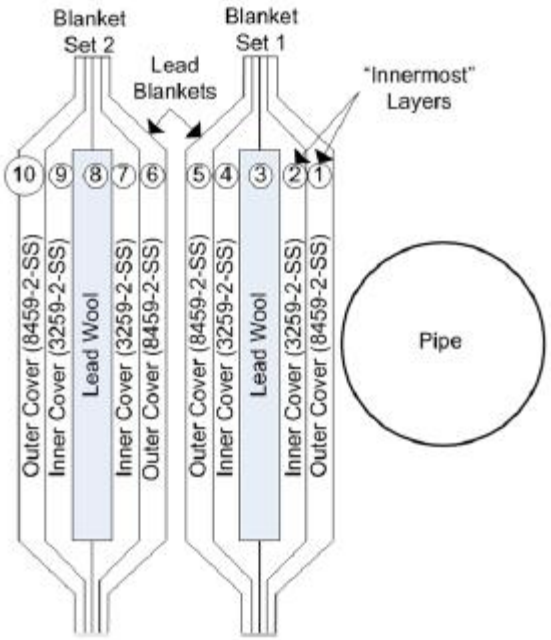
# ZOI & Debris Size Distribution – Lead Wool Shielding Blankets

- Two Zones of Influence, 3 Debris Size Distribution
- ZOI based on CESSI Air Jet Impact Tests
- Typical Installed Configuration




| Debris Type | Size | Size Distribution | |
|---|---|---|---|
| | | 2.1D ZOI | 2.1D – 5.4D ZOI |
| Lead Blanket Cover Layers Closest to Pipe Break (Open Back Configuration) | Fines | 20% | 0% |
| | Small Pieces | 80% | 0% |
| | Large/Intact Pieces | 0% | 100% |
| Remaining Lead Blanket Cover Layers (Open Back Configuration) | Fines | 0% | 0% |
| | Small Pieces | 0% | 0% |
| | Large/Intact Pieces | 100% | 100% |
| Wrapped Lead Blanket Cover Layers (Strong Back Configuration) | Fines | 0% | 0% |
| | Small Pieces | 0% | 0% |
| | Large/Intact Pieces | 100% | 100% |

# Questions/Concerns

- Jointly Review Issues, Questions, and Concerns for Future Communication

# Next Steps

- Finalize Update of Deterministic Calculations
- Present Formal Risk-Informed GSI-191 Analysis and Results
- Desire Next Meeting – 4Q 2016