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Fermi-2 Risk Assessment of ECCS Strainer Performance

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Agenda

- Objectives
- Background
- Risk Discussion
- LAR Overview
- Schedule
- Summary / Questions / Feedback

Objectives

- Provide the NRC with an overview of the proposed license amendment request (LAR):
  - Scope and content for LAR
    - Intended role of probabilistic risk assessment (PRA)
    - Changes to licensing basis for ECCS suction strainers
  - Methodology
  - Submittal schedule
- Obtain NRC feedback
  - Content for LAR
  - Approval schedule
  - Lessons learned

Background

- NRC inspections identified non-cited violations[1]
  - NCV 05000341/2016007-09, Failure to Evaluate the Acceptability of Drywell Coatings with Respect to Potential ECCS Suction Strainer Blockage
  - NCV 05000341/2016007-10, Non-Conservative ECCS Suction Strainer Min-K Combined Generation and Transport Factors
  - NCV 05000341/2016007-15, Failure to Identify that a Non-Conservative Min-K Insulation Volume Calculation Error Was Nonconforming to the ECCS Suction Strainer Licensing Basis
- Fermi has evaluated the impact of these violations in the corrective action program

1. INSPECTION REPORT 05000341/2016007

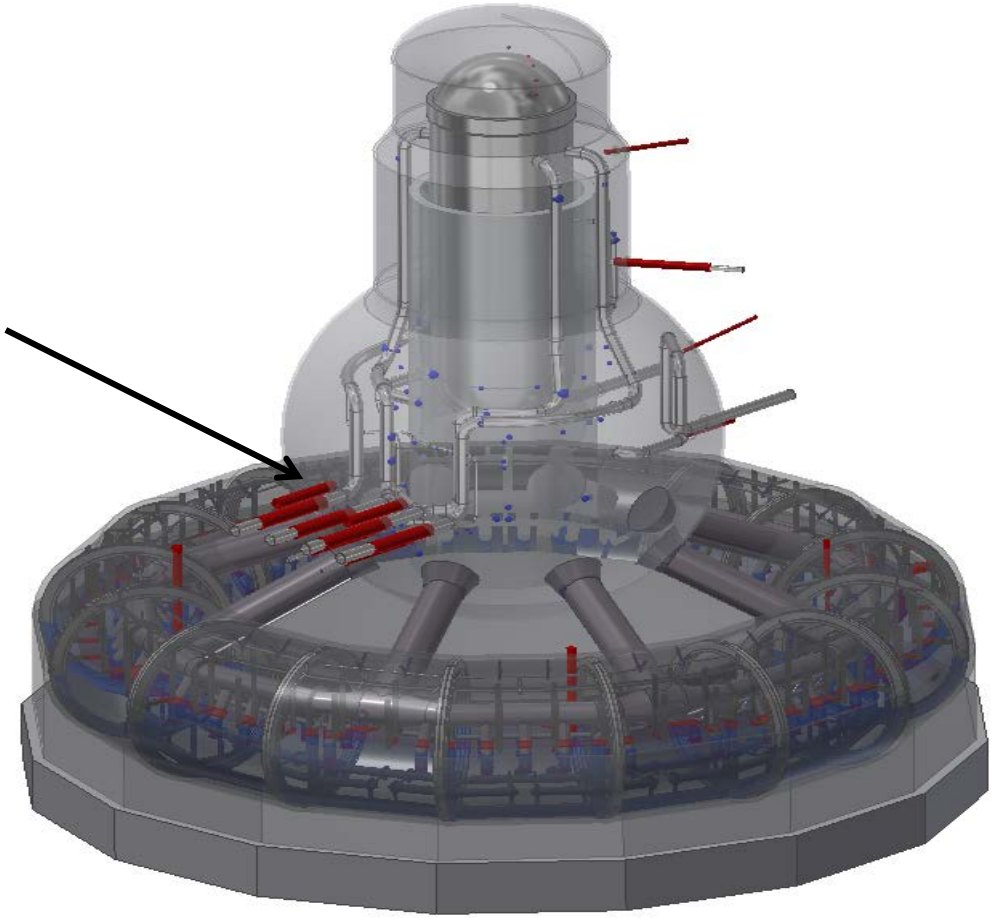
Background

- Fermi is proposing a risk-informed analysis of additional debris beyond current design basis values
  - Insulation in containment penetrations
  - Sensitivity studies for coatings / labeling
- Results of this risk-informed analysis will form the basis of a request to amend the license basis to accept the additional debris sources based on low risk following the guidance in Reg. Guide 1.174
- This will provide an analysis of the impacts of insulation in containment penetrations and additional margin to support emergent analysis

Fermi-2 Containment Geometry

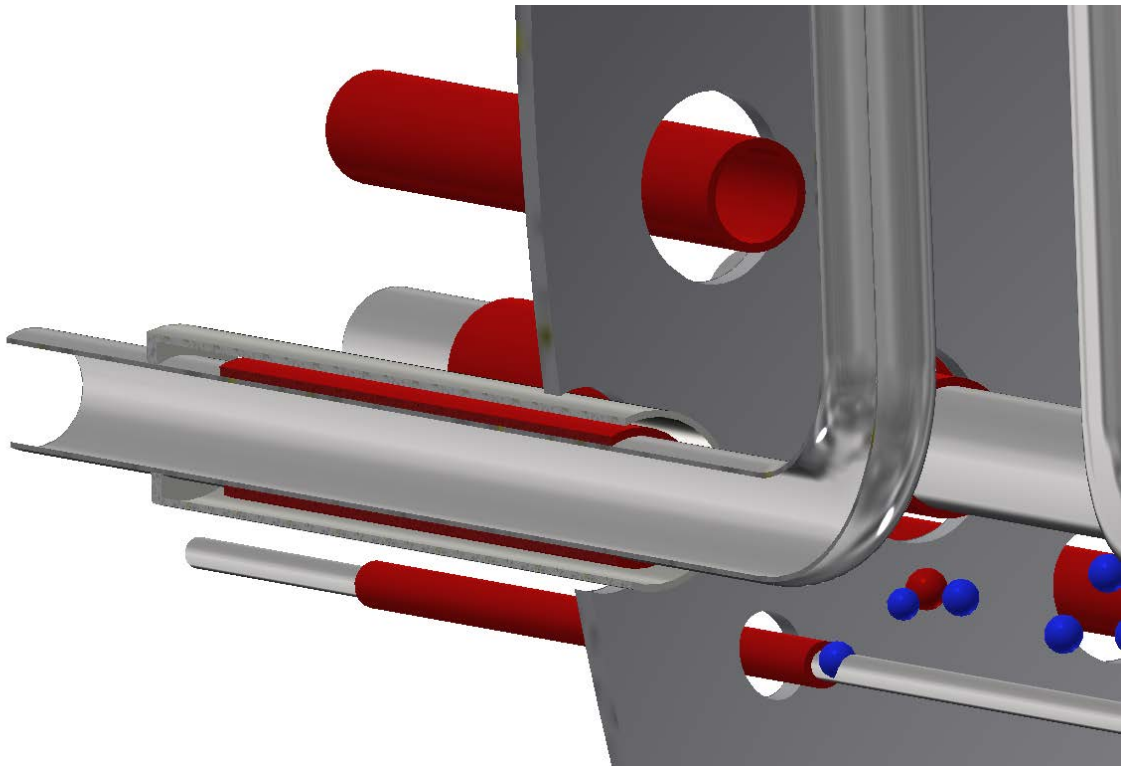
Drywell Liner
Penetrations

Feedwater x2
Main Steam x4



Penetration Photos

Penetration Cross Section

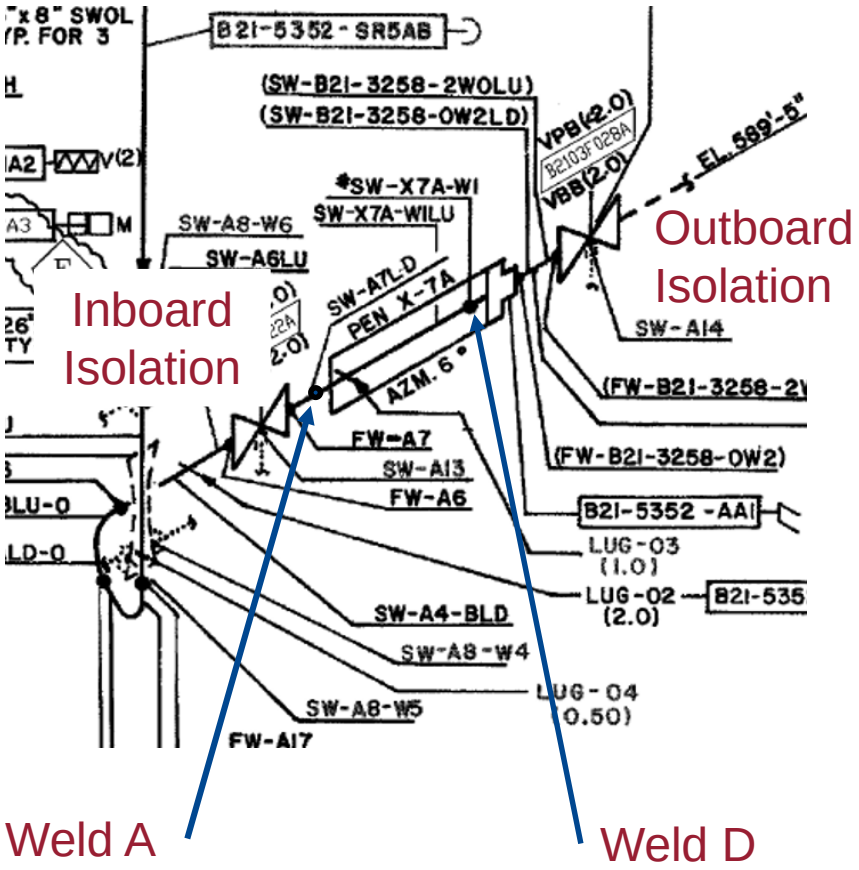


Background: Current Methodology

- Fermi replaced ECCS strainers in 1998 in response to NRC Bulletin 96-03
  - Strainers were sized to meet the requirements of Reg Guide 1.82 R2
  - Strainers were designed and installed in RF06 are of the GE optimized stacked-disk (OSD) design
  - Strainer debris loads were developed utilizing the methodology provided in NEDO-32686, BWROG Utility Resolution Guidance (URG)
  - Strainer head loss uses GE LTR Methodology (NEDO-32721P-A) as modified by GE SC 08-02 corrections
- Fermi is predominately a Reflective Metal Insulation plant with spot locations of NUKON/Min-K insulation at several whip restraints and Min-K in penetrations
- Participated fully in BWROG studies regarding NRC twelve issues

Penetration Min-K Debris Loads

- There is no specific guidance in the URG methodology regarding a ZOI for a break inside a penetration
- A break in the penetration is unique in that it is highly restrained, directed and becomes automatically isolated as part of the containment isolation system
- All breaks at the penetration (Weld A and Weld D) are between the inboard and outboard containment isolation valves and part of the Containment Isolation System

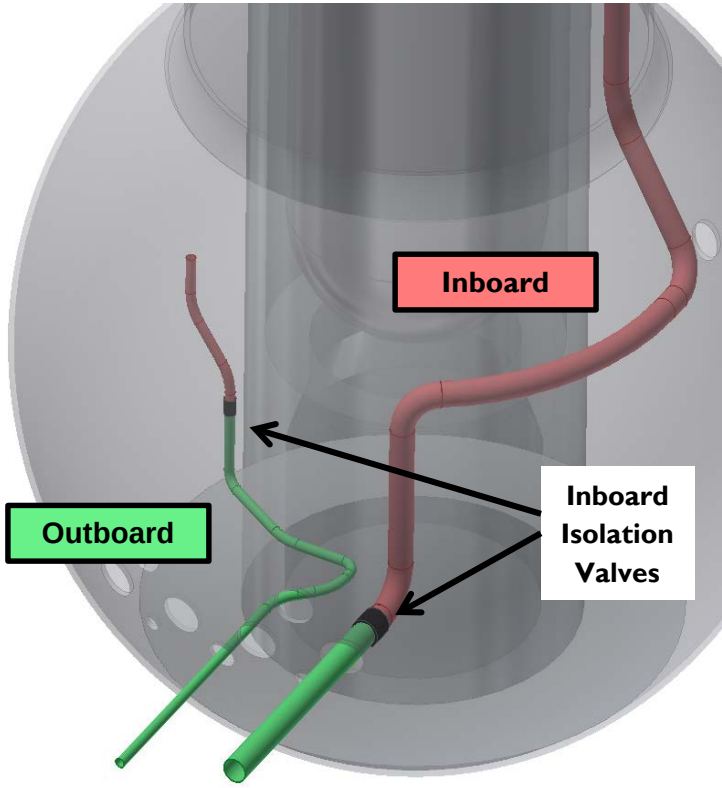


Risk Informed Analysis Approach

- Leverage industry precedent including NRC SE for South Texas Project (PWR) GSI-191 LAR and recent BWROG ECCS Risk Informed Resolution studies
- Risk over Deterministic (RoverD) Approach
  - Maintain current design basis deterministic methods for existing debris loads
  - Calculate the delta risk associated with the new debris loads over the baseline risk of the current design basis debris loads
  - Utilize NUREG-1829 LOCA Frequencies
  - Categorization of risk based on Regulatory Guide 1.174
- Interface with plant PRA
  - Provides isolation valve failure probabilities

Break Locations and Risk Analysis

- Current design basis analysis utilizes a deterministic analysis for all break locations
  - Conservatively assumes those in the penetrations are non-isolated
- New risk analysis takes into consideration isolation of breaks between inboard and outboard isolation valve and valve failure probability
  - Utilize NUREG-1829 break frequencies and assumptions for inboard welds
  - Valve failure probability from Fermi PRA based on generic industry data from NUREG/CR-6928
  - Adapt NUREG-1829 break frequencies and assumptions to estimate isolable break frequencies (breaks between the isolation valves, i.e., in the penetration)



Background Fermi PRA

- The technical adequacy of the Fermi 2 PRA is consistent with the requirements of Regulatory Guide 1.200, Revision 2, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities.”
- The Fermi 2 PRA Full Power Internal Events (FPIE) models are highly detailed and include a wide variety of initiating events, modeled systems, operator actions, and common cause events. The Fermi 2 FPIE model of record and supporting documentation has been maintained as a living program, with periodic updates to reflect the as-built, as-operated plant
- The Fermi 2 PRA FPIE models have been the subject of several assessments (e.g., industry peer reviews) to establish the technical adequacy of the PRA
- Fermi 2 has used the F&O Closure process and Focused Scope Peer Reviews to close all open findings and currently meets all supporting requirements to at least Capability Category II

Risk Evaluation

- Utilize Fermi Mark I Containment CAD Model with plant specific debris locations (geometry), weld locations, and equipment configuration
- Develop strainer failure probabilities for all break locations
  - Strainer failure is defined as any debris load greater than the design basis debris load (loss of NPSH)
  - Conservatively assume core damage for every non-isolated outboard break (between isolation valves)
- For risk calculation, the specific LOCA initiating event frequency for size and location is multiplied by the associated ECCS suction strainer failure probability and conservatively assumed to lead directly to core damage

Risk Evaluation Assumptions

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Inboard Weld Break Locations (Between Vessel and Isolation Valve)

- Not isolable and lead to LOCA
- Use URG debris generation and transport fractions
- Debris accumulates on strainer as a function of flow
- Assume failure of the first ECCS suction strainer represents common cause failure of all ECCS suction strainers in the suppression pool

Risk Evaluation Assumptions (Cont.)

Penetration Weld Break (Valves Failing to Isolate)

- Assume ECCS suction strainer failure (debris load exceedance)
- Apply failure to automatically isolate LOCA based on valve isolation failure probabilities from Fermi-2 PRA
- LOCA frequency x valve isolation failure probability x ECCS suction strainer probability (1.0) assumed to lead directly to core damage and contribute directly ΔCDF

Risk Evaluation Assumptions (Cont.)

Penetration Weld Break (Valves Successfully Isolate)

- RPV makeup requirements for isolated LOCA events are significantly reduced such that the risk impact of these scenarios is judged to be very small
- RPV makeup can be provided automatically from clean water sources such as HPCI, RCIC, and CRD. Standby Feedwater System (two high pressure motor driven pumps with 600 gpm/pump from CST) can be manually aligned from the Control Room with a high reliability

Preliminary Min-K Results

- ∆ Core Damage Frequency (#/year) for Min-K

Break Location	∆CDF
Inboard Breaks	0
Penetration Breaks	7.22E-07
Total	7.22E-07

- Results are in Region III of R.G. 1.174
- ∆CDF due to external events (e.g., fire and seismic) judged to be small or negligible and will not change the risk conclusions based on similar risk evaluations developed for the BWR risk evaluation
- LERF not expected to be the bounding risk metric, which would also be consistent with BWROG risk evaluation

Sensitivity Studies and Operational Margin

- Goal is to support additional operational margin and evaluation of potential debris sources
- Sensitivities performed to address potential debris sources (e.g., non-conforming coatings or labeling) identified during plant walkdowns or vendor safety communications that may exceed the current design limits
- Sensitivity #1 – impact of degraded or failed coatings
- Sensitivity #2 – impact of reduced strainer area due to labels, tags, or foreign material

Sensitivity Studies and Operational Margin

- Sensitivity #1 – impact of failed coatings (particulate)
  - Strainer failure criteria is development of 1/8” of fibrous debris; sufficient to filter coatings particulate
    - Preliminary results indicate this will be in Region II/III
- Sensitivity #2 – impact of reduced strainer area of 80 sqft with and without thin-bed strainer failure criteria
  - Preliminary results indicate that limited credit for operator actions may be required to remain in Region II/III for thin-bed criteria

Change to License Basis

- LAR explains basis of risk-informed analysis, quantifies change in risk, and describes changes in licensing basis
- Exemption request from 10CFR50.46 related GDCs (35 & 38) to permit use of a risk-informed approach to evaluate the residual risk associated with those effects that have not been explicitly addressed using deterministic methods
- Schedule
  - Planned LAR Submittal – Spring/Summer 2019
  - Requesting NRC Approval – 2020

Closing Remarks

- Penetration breaks (i.e., breaks between containment isolation valves) represent unique break locations that are designed to be automatically isolated
- Removal of the insulation associated with these break locations incurs considerable dose with minimal improvement in safety
- Additional risk associated with debris effects relative to RG 1.174 criteria calculated to be small (Region II/III) based on preliminary analyses
- Plan is to submit LAR to utilize a risk informed approach to address the debris effects and resolve the issues raised in the referenced Fermi NCVs and provide operational margin
- Consistent with the Commission's Policy Statement on the "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities" that "…the use of PRA technology in NRC regulatory activities should be increased to the extent supported by state of the art in PRA methods and data and in a manner that complements the NRC's deterministic approach" and consistent with defense in depth concepts

NRC Feedback

- Comments / Feedback
- Lessons Learned from recent submittals