Fermi 2 License Amendment Request: Risk Informed Approach to ECCS Strainer Performance

August 2022

Agenda

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

Objectives

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

Background

- NRC inspection identified non-cited violations
  - 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
  - NCV 05000341/2016007-09, Failure to Evaluate the Acceptability of Drywell Coatings with Respect to Potential ECCS Suction Strainer Blockage

- Fermi has evaluated impact of these violations in the corrective action program

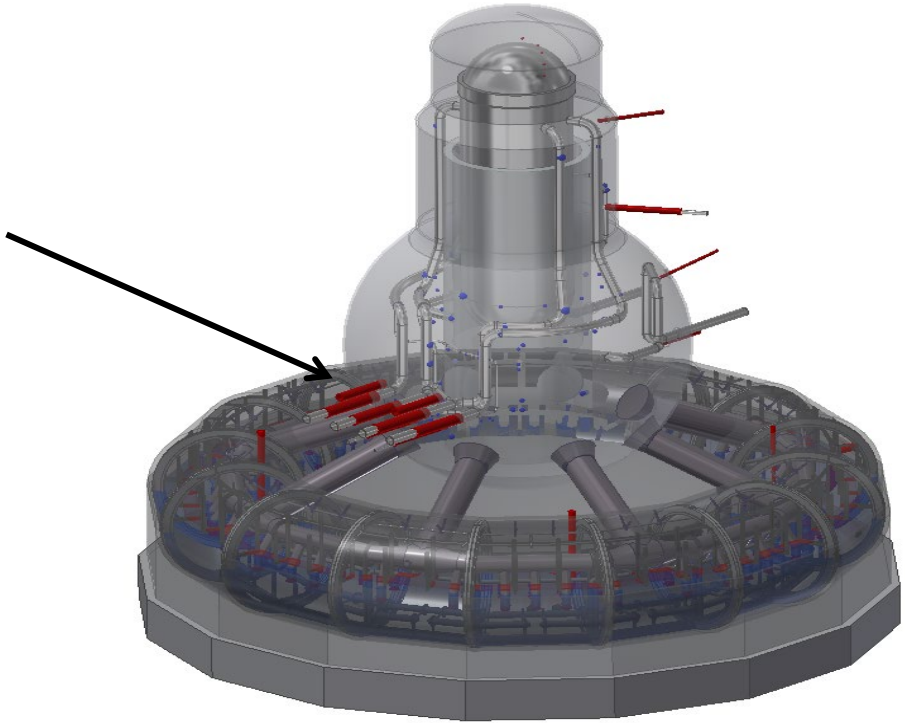
Background

- Fermi is proposing a risk-informed analysis of additional debris beyond current design basis values
  - Insulation in containment penetrations
  - Sensitivity studies for labels/tags in containment
- Results of this risk-informed analysis 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
- The Risk Informed LAR will provide an analysis of the impacts of insulation in containment penetrations and non-conforming labels/tags in containment

Fermi 2 Containment Geometry

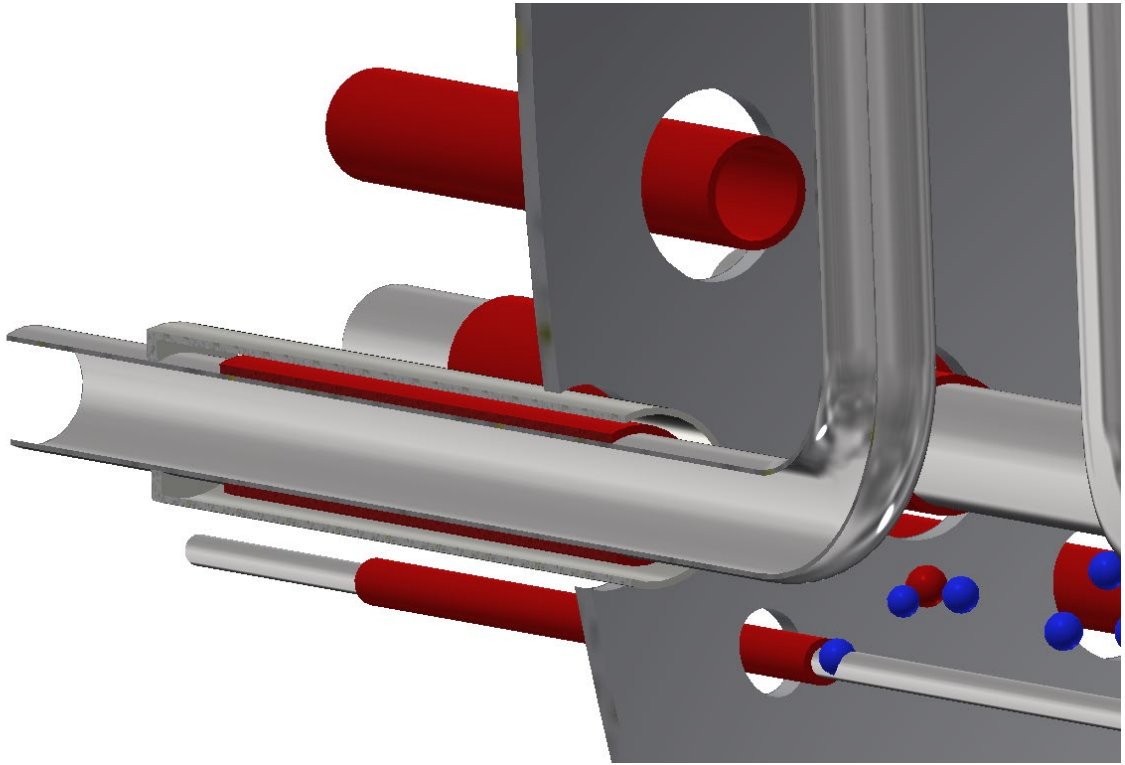
Drywell Liner
Penetrations

Feedwater x2
Main Steam x4



Penetration Photos

Penetration Cross Section

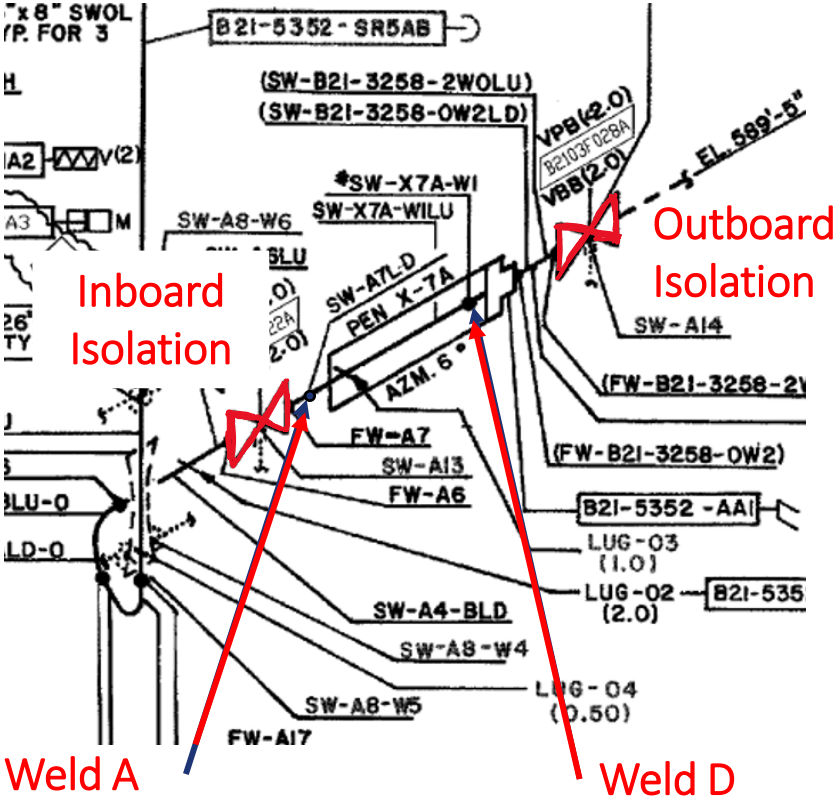


Background: Current Methodology

- Fermi replaced ECCS strainers in 1998 (RF06) in response to NRC Bulletin 96-03.
  - Strainers sized to meet requirements of Reg Guide 1.82 R2
  - Strainers are GE optimized stacked-disk (OSD) design
  - All strainers are identical in size but carry system specific flow rates
  - Strainer debris loads developed utilizing 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 an all RMI insulation plant with spot locations of NUKON/Min-K insulation at several whip restraints and Min-K in penetrations
- Fermi 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 <u>automatically</u> 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



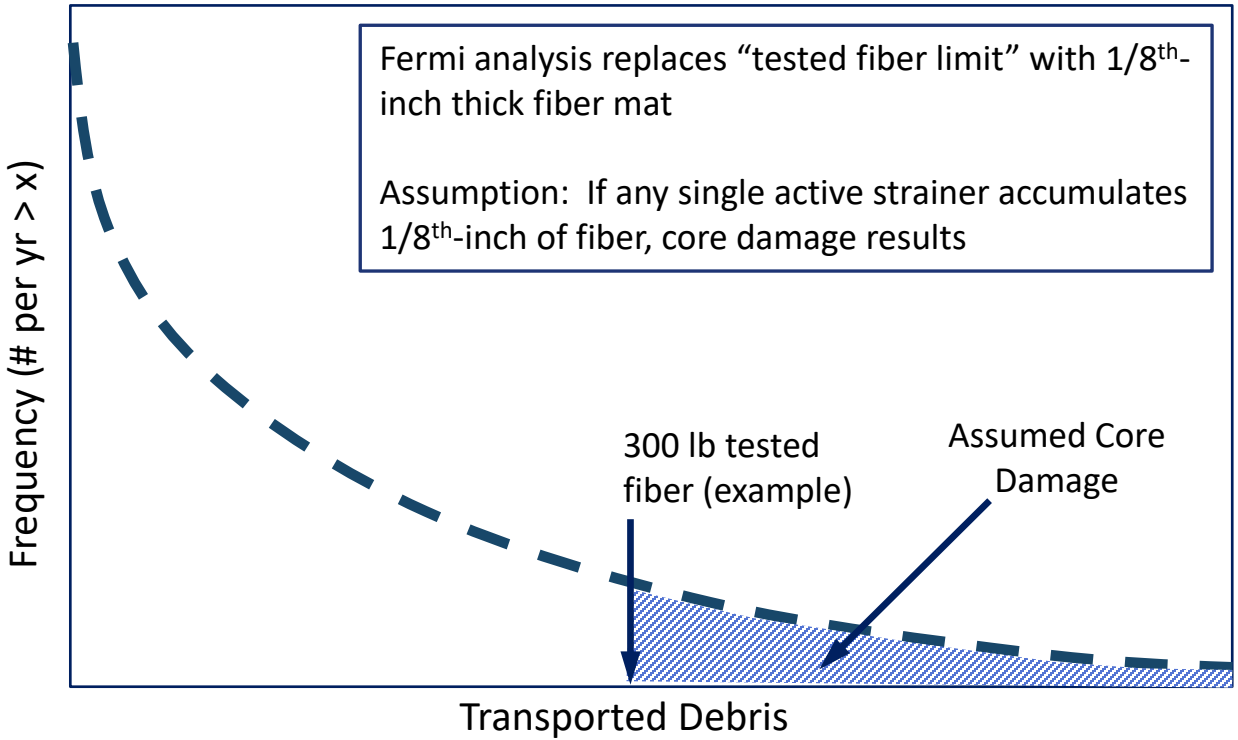
Risk Informed Analysis Approach

- 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 delta Core Damage Frequency (ΔCDF) associated with new debris loads exceeding (“over”) baseline risk of current design basis debris loads
    - Demonstrate delta Large Early Release Frequency (LERF) is not more limiting than ΔCDF
  - Utilize NUREG-1829 LOCA Frequencies consistent with recent RI LAR
  - Categorization of risk based on Regulatory Guide 1.174

PRA Interface

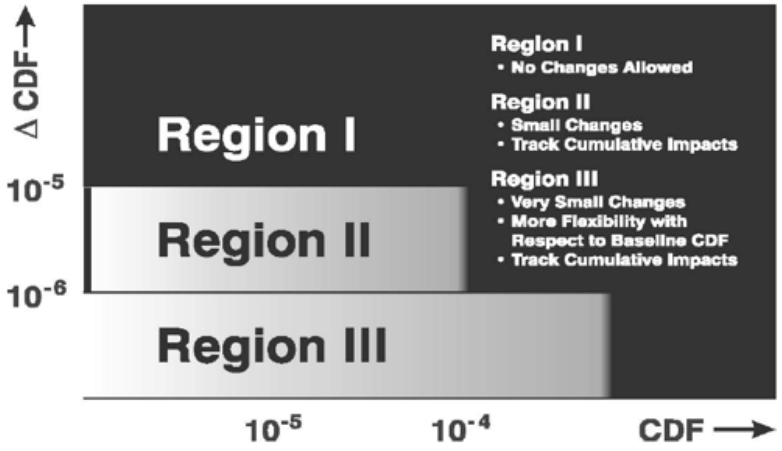
- Plant PRA provides
  - Isolation valve failure frequencies
  - Total CDF and total LERF
  - Systematic identification of recirculation sequences involving debris
  - Systematic description of defense in depth systems and operator response options

Deterministic vs Risk Informed
(Risk over Deterministic RoverD example)

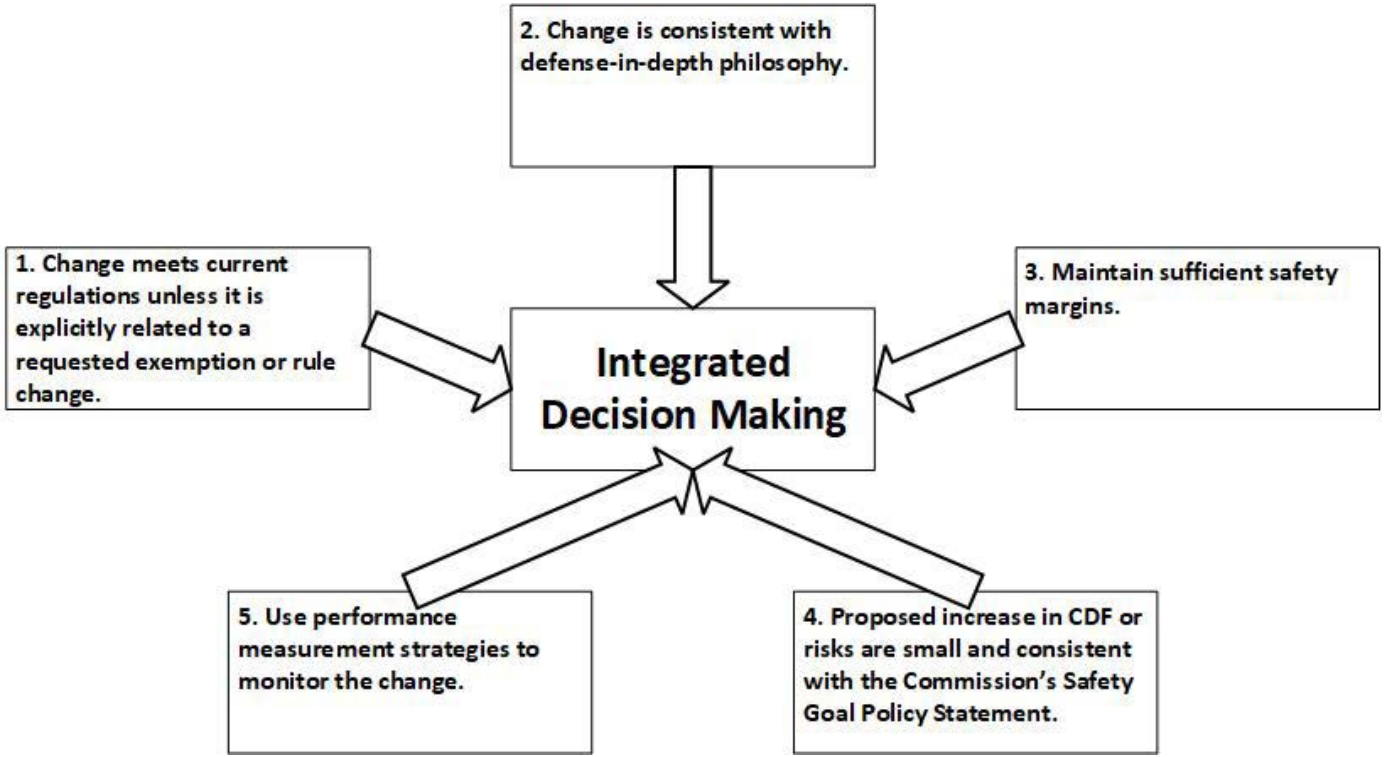


Regulatory Guide 1.174

- Impacts of debris-induced failure modes quantified by CDF, ΔCDF, LERF, and ΔLERF
- Reg Guide 1.174 establishes risk designation criteria and corresponding actions
- Total CDF and Total LERF provided by PRA
- In practice, ΔLERF is rarely bounding because debris does not pose a direct challenge to containment
  - Large Early Release Frequency regions are x10 lower on both axes



RG 1.174 Principles of Risk Informed Regulation

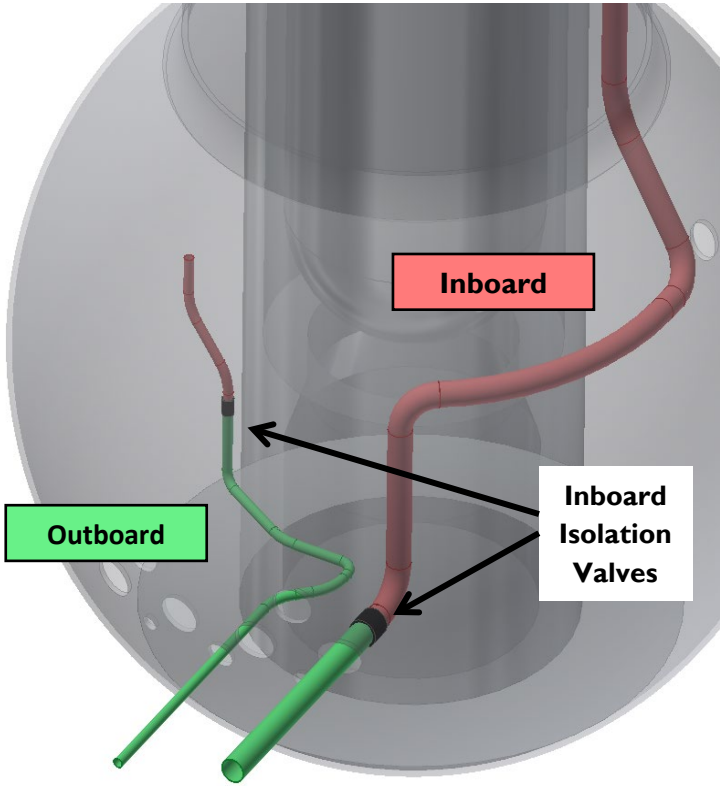


Regulatory Guide 1.174

- Regulatory Guide 1.174 – An Approach for Using Probabilistic Risk Assessment in Risk Informed Decisions On Plant-Specific Changes to the Licensing Basis
  - Proposed change to licensing basis must address RG 1.174 5 principles
    - Meet current guidance, or be associated with an exemption or rule change
    - Be consistent with defense-in-depth philosophy
    - Maintain adequate safety margins
    - Lead to small changes in CDF consistent with Commission policy
    - Impacts should be monitored using performance measurement strategies
  - Provides a “bridge” between deterministic criteria and risk-informed License Amendment Requests (LAR)
    - Must reflect as-built, as-operated and maintained plant
    - Must address all plant operating states and initiating events leading to debris generation and recirculation
    - Sensitivity Studies evaluate impact on risk figures of merit (ΔCDF, ΔLERF)

Break Locations and Risk Analysis

- Current design basis analysis utilizes a deterministic analysis for all break locations
  - conservatively assumes breaks in 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 frequency from Fermi PRA and based on generic industry data from NUREG/CR-6928
  - Adapt NUREG 1829 break frequencies and assumptions to estimate isolable break frequencies (breaks between isolation valves, i.e., in penetration)



Background Fermi PRA

- Technical adequacy of Fermi 2 PRA is consistent with requirements of Regulatory Guide 1.200, Revision 2, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities”
- 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. Fermi 2 FPIE model of record and supporting documentation has been maintained as a living program, with periodic updates to reflect as-built, as-operated plant
- Fermi 2 PRA FPIE models have been assessed (e.g., industry peer reviews) to establish 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 1 Containment CAD Model with plant specific debris locations (geometry), weld locations, and equipment configuration
- Assess strainer failure potential for each break location
  - Strainer failure is defined as any debris load greater than design basis debris load (loss of NPSH), OR, formation of a 1/8th-inch fiber bed
  - Conservatively assume core damage for every non-isolated outboard break (between isolation valves)
- For risk calculation, specific LOCA initiating event frequencies for sizes and locations leading to strainer failure are summed and conservatively assumed to lead directly to core damage

Risk Evaluation Assumptions

Inboard Weld Break Locations

- Not isolable and lead to LOCA
- URG debris generation and transport fractions are used
- Debris accumulates on strainers as a function of competing flow rates
- Assume failure of first ECCS suction strainer represents common cause failure of all ECCS suction strainers in suppression pool
- No inboard weld break locations have been found that exceed existing strainer design bases for any debris type. All presumed failures caused by 1/8th-inch fiber accumulation

Risk Evaluation Assumptions (Cont.)

Penetration Weld Break (Valves Failing to Isolate)

- Assume ECCS suction strainer failure (debris load exceedance) regardless of break size
- Apply failure to automatically isolate LOCA based on valve-specific 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 to ΔCDF
- Total annual break frequency for small population of penetration welds assumed equal to NUREG-1829 total annual LOCA frequency (6.5e-4/yr)

Risk Evaluation Assumptions (Cont.)

Penetration Weld Break (Valves Successfully Isolate)

- RPV makeup requirements for isolated LOCA events are significantly reduced such that 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.

Risk Evaluation Assumptions (Cont.)

Labels/Tags Sensitivity

- Baseline risk results include an assumption that 100 ft^2 of total active strainer area is lost to intact labels/tags that obstruct flow
- The current Engineering estimate of labels/tags in containment is as much as 87 ft^2 (CARD 15-25914)
- 100 ft^2 is comparable to strainer areas forfeited to miscellaneous debris by other plants with similar operations history, and it is a practical value that can be managed as a proactive goal at Fermi 2

Preliminary Risk Results

- Δ Core Damage Frequency (#/year) for Min-K and tags/labels

Break Location	ΔCDF
Non-Isolable Welds	3.83E-07 yr^{-1}
Isolable Welds	2.12E-07 yr^{-1}
Total	5.95E-07 yr^{-1}

- Baseline results for single-train operation and geometric mean break frequency aggregation are in Region III of RG 1.174
- Baseline results do not apply credit for probability of single-train pump state (<0.1), but sensitivity using arithmetic mean break frequency aggregation and single-train pump state probability are also in Region III
- ΔCDF initiated by external events (e.g., fire and seismic) and including the excess debris sources judged to be small or negligible and will not change the risk conclusions based on similar risk evaluations developed for BWR risk evaluation
- LERF not expected to be the bounding risk metric (x10 lower than ΔCDF), which is also consistent with BWROG risk evaluation

LAR and Changes to License Basis

- LAR explains basis of risk-informed analysis, quantifies change in risk, presents sensitivities of risk to assumptions, and describes changes in licensing basis
- Exemption request from 10CFR50.46 related GDCs (35 and 38) 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 – Q4 2022
  - Requesting NRC Approval – Q4 2023

Closing Remarks

- Penetration breaks (i.e., breaks between containment isolation valves) represent unique break locations that are designed to be automatically isolated
- Removal and replacement of insulation associated with these break locations incurs considerable dose with minimal improvement in ΔCDF
- Additional risk associated with excess Min-K and tag/label debris effects relative to RG 1.174 criteria calculated to be very small (Region III)
- Plan is to submit LAR to utilize a risk informed approach to address debris effects and resolve issues raised in referenced Fermi NCVs
- Fermi LAR is consistent with Commission's Policy Statement on "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

Questions?