UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 18, 2025

Peter Dietrich
Senior Vice President
and Chief Nuclear Officer
DTE Electric Company
Fermi 2 – 260 NOC
6400 North Dixie Highway
Newport, MI 48166

SUBJECT: FERMI-2 - ISSUANCE OF AMENDMENT NO. 230 REGARDING REVISION OF FINAL SAFETY ANALYSIS REPORT TO ALLOW USE OF RISK-INFORMED APPROACH FOR EVALUATING EMERGENCY CORE COOLING SYSTEM STRAINERS (EPID L-2023-LLA-0092)

Dear Peter Dietrich:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 230 to Renewed Facility Operating License No. NPF-43, for Fermi-2 (Fermi). This amendment includes changes to the Final Safety Analysis Report (FSAR) in response to your amendment request dated June 13, 2023 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23164A232), as supplemented by letters dated April 24, 2024 (ML24115A095), May 30, 2024 (ML24151A173), and October 31, 2024 (ML24305A147), respectively.

The amendment modifies the Fermi licensing bases, including the affected portions of the FSAR. Specifically, the amendment allows the use of a risk-informed approach to address the effects of potential debris sources, beyond those currently deterministically evaluated, on the emergency core cooling system strainers.

A copy of the related Safety Evaluation is also enclosed. A Notice of Issuance will be included in the Commission's monthly *Federal Register* notice.

Sincerely,

/RA/

Surinder S. Arora, Project Manager
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-341

Enclosures:
1. Amendment No. 230 to NPF-43
2. Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

DTE ELECTRIC COMPANY

DOCKET NO. 50-341

FERMI-2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 230
Renewed License No. NPF-43

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:

A. The application for amendment by DTE Electric Company dated June 13, 2023, as supplemented by letters dated April 24, 2024, May 30, 2024, and October 31, 2024, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

C. There is reasonable assurance: (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No. 230, Renewed Facility Operating License No. NPF-43 is amended to authorize revision to Fermi-2 Final Safety Analysis Report as set forth in the licensee's application dated June 13, 2023, and its supplements and evaluated in the NRC staff's evaluation enclosed with this amendment.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

ILKA BERRIOS

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Date: 2025.02.18 13:56:10 -05'00'

Ilka Berrios, Acting Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating License

Date of Issuance: February 18, 2025

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 230 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-43

DTE ELECTRIC COMPANY

FERMI-2

DOCKET NO. 50-341

1.0 INTRODUCTION

1.1 Application

By letter dated June 13, 2023 (Reference 1), as supplemented by letters dated April 24, 2024 (Reference 2), May 30, 2024 (Reference 3), and October 31, 2024 (Reference 4), DTE Electric Company (the licensee) submitted a License Amendment Request (LAR) and exemption request for Fermi-2 (Fermi). The amendment would modify the Fermi licensing bases, including the affected portions of the final safety analysis report (FSAR). Specifically, the amendment would allow the use of a risk-informed approach to address the effects of potential debris sources, beyond those currently deterministically evaluated, on the emergency core cooling system (ECCS) strainers. The letter dated June 13, 2023 (Reference 1), and supplements and revisions (Reference 2,3,4) constitute the licensee's request.

1.2 Background

1.2.1 Challenges to Safety Systems Function from Debris in Containment

The function of the ECCS is to ensure cooling of the reactor core following a loss-of-coolant accident (LOCA). The ECCS is made up of the high-pressure coolant injection system (HPCI), the automatic depressurization system (ADS), the core spray system (CSS), and the residual heat removal (RHR) system. HPCI, CSS, and RHR take suction from the suppression pool through strainers that limit the amount of foreign material that can enter these systems and the reactor. The HPCI system is a single train system that provides high-pressure injection to the reactor for LOCAs that do not result in rapid depressurization of the reactor. In the event that the HPCI system cannot provide adequate makeup to the reactor, the ADS actuates safety relief valves to reduce pressure in order to allow the higher capacity low-pressure injection systems (RHR and core spray) to inject water into the reactor. The CSS is a redundant two-train system that sprays water into the volume above the core via spray headers. The RHR system, operating in the low-pressure coolant injection (LPCI) mode is a low-pressure, high-volume system that injects water into the reactor to prevent fuel cladding from reaching its temperature limit for large breaks. The LPCI system is a redundant system that also provides cooling to the suppression pool via heat exchangers in its flow path. The ECCS functions are automatically initiated by instrumentation depending on the conditions sensed in the reactor and the containment.

The RHR system can also be operated in the containment cooling mode. Containment spray and suppression pool cooling are non-ECCS functions that are manually initiated by operators if the conditions in containment require cooling or pressure control. These systems use the RHR pumps to inject the water via the RHR heat exchangers and spray nozzles in the drywell or torus (i.e., suppression pool).

Nuclear power plants are designed and licensed based upon analysis demonstrating the capability to shut down and remove reactor decay heat to prevent core damage and containment failure for a spectrum of break sizes and location, from small leaks up to and including a double-ended guillotine break (DEGB) of the largest coolant pipe. A key difference between pressurized-water reactors (PWRs) and boiling water reactors (BWRs) is that PWR emergency core cooling water sources originate from a relatively larger Refueling Water Storage Tank (RWST), external to the containment, that is not susceptible to threats from suction strainer inoperability. The ECCS suction strainer issue only becomes important in the long-term ECCS recirculation phase, after the RWST is exhausted. BWRs, on the other hand, rely upon ECCS water sources inside the containment, which are susceptible to early threat from suction strainer inoperability. Fermi is a BWR-3 with a Mark I containment. Its design utilizes a combination high-pressure and low-pressure makeup as well as ECCS to handle different break sizes and locations.

Coolant makeup for smaller leaks is provided by an automatic reactor trip and a steam driven HPCI system taking suction from the condensate storage tank (CST). This is supplemented by internal control rod drive (CRD) pump flows taking suction from the CST. If injection from the suppression pool is needed and fails, procedures exist to manually depressurize the reactor using main feedwater and to remove long-term decay heat by manually reopening main steam isolation valves and passing steam to the Main Condenser; thus, bypassing issues of suppression pool suction strainer inoperability. Unique to Fermi is a gas turbine powered two-train standby feedwater (SBFW) system, which is manually initiated from outside the control room and takes suction from the CST. Provisions exist for manually refilling the CST from several possible demineralized water sources, if needed.

The high-pressure makeup systems, if unable to restore reactor water levels, are backed up by an ADS which opens selected safety relief valves to allow low-pressure ECCS systems to inject. In the event of a large LOCA the reactor would become depressurized on its own. The low-pressure ECCS systems include a two-division core spray (CS) system (i.e., four pumps total), and a two-division LPCI system (also with four pumps). The CS system electric motor driven pumps inject spray water directly at the top of the core by taking suction from the containment suppression pool through dedicated suction strainers. If the suction strainers become inoperable, there is a provision to connect the Division II CS pumps directly to the CST via 16-inch header, which requires opening a local manual valve outside the control room.

Similarly, the LPCI system electric motor driven pumps inject ECCS water directly into the recirculation piping by taking suction from the containment suppression pool through dedicated LPCI suction strainers. Long-term cooling of the reactor core and containment is accomplished via the RHR mode of LPCI operation. In the RHR mode of operation, essential service water (ESW) is passed through the redundant RHR heat exchangers to cool the LPCI makeup flow. In the event the LPCI/RHR suction strainers become inoperable, provisions exist in the Division II LPCI/RHR to cross connect a train of ESW directly into the pump suction by opening a motor operated valve in the control room. This provides core and containment cooling without reliance on the suppression pool suction strainers.

If a LOCA occurs, piping thermal insulation and other materials located in containment may be dislodged by the two-phase (i.e., steam and liquid) coolant jet emanating from the broken reactor coolant system (RCS) pipe. This debris may transport by the flow of water and/or steam from the break to the suppression pool and be recirculated though the ECCS systems. Once transported to the suppression pool, the debris could be drawn toward the ECCS strainers, which are designed to prevent debris from entering the ECCS. If this debris clogs the strainers, the ECCS could fail, resulting in core damage or the inability to control containment pressure. It is also possible that some debris could bypass the strainers and get lodged in the reactor core, which could result in reduced core cooling and potential core damage.

1.2.2 History of the Effects of Debris on the ECCS

Industry and the U.S. Nuclear Regulatory Commission (NRC) have recognized the potential for debris to adversely affect ECCS performance for many years. NUREG/CR-7172, "Knowledge Base Report on Emergency Core Cooling Sump Performance in Operating Light Water Reactors," (Reference 5) contains a history of performance issues involving debris and the ECCS, operating experiences, evaluations conducted, and actions taken to address issues. The ECCS debris interaction issue was closed out for BWRs in 2001 when the NRC issued a memo (Reference 6) acknowledging the completion of staff reviews under NRC bulletins NRCB 95-02, "Unexpected Clogging of a Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode" (Reference 7), and NRCB 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling Water Reactors" (Reference 8). In response to these bulletins, BWR licensees developed updated design basis for the effects of debris on the strainers for each plant.

One of the technical documents used to address issues associated with debris developed by the BWR Owner's Group (BWROG) is titled "Utility Resolution Guide for ECCS Suction Strainer Blockage" as well as the associated NRC safety evaluation (SE) dated August 28, 1998. Both documents were issued in October 1998 as NEDO-32686-A (Reference 9). This BWROG guidance and the NRC SE are referred to in brief as the Utility Resolution Guide (URG). Most BWR licensees, including DTE Energy Company as the operator of Fermi, committed to use this guidance to evaluate the effects of debris at their plants. Based on the review and URG guidance, Fermi upgraded its strainers from relatively small cone shaped strainers (with analyses assuming 50 percent of the strainer area was blocked) to a General Electric (GE) optimized stacked disk design. The new (and current) strainer design accounts for plant-specific flow rates, debris loads, and head loss to assure adequate net positive suction head (NPSH) is maintained for operation of the pumps. The new strainers have a significantly larger filtering area than the original strainers. The HPCI and reactor core isolation cooling (RCIC) strainers were not replaced because the expected duration of pump operation is short compared to the high-volume, low-pressure injection pumps. Therefore, the HPCI strainer was not predicted to accumulate significant debris during a large-break LOCA (LBLOCA) response.

After the issue was resolved for BWRs, the NRC determined that similar issues should be evaluated for PWRs. This led the NRC to open Generic Safety Issue (GSI) 191 to study the potential effects of debris on PWRs. Based on the evaluations conducted for GSI-191, the NRC issued NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized Water Reactors," dated June 9, 2003 (Reference 10). As a follow up to the bulletin, on September 13, 2004, the NRC issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," (Reference 11) to holders of operating licenses for PWRs. Most PWRs have responded adequately to the GL, but a few are still working to ensure that their designs adequately account for potential effects of debris interaction with the ECCS. The guidance used by PWRs was based on the BWR URG but was updated to account for knowledge gained with the studies to address GSI-191 and the PWR resolution.

Some of the PWR licensee's that were having difficulty using NRC accepted deterministic methods to resolve GL 2004-02 used risk-informed analyses to demonstrate that the risk of debris interacting with the ECCS was low. The basis for the use of risk-informed analyses was the NRC Commission's staff-requirements memorandum (SRM) associated with SECY-10-113, "Closure Options for Generic Safety Issue 191, Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance," dated December 23, 2010 (Reference 12). This SRM directed the NRC staff to consider a risk-informed approach for resolution of GL 04-02 for PWR licensees. The licensee's LAR referred to the South Texas Project pilot study that issued precedent license amendments (Reference 13) and exemptions (Reference 14).

During the resolution of GL 04-02, the NRC staff recognized that a significant increase in knowledge regarding the potential for debris effects had occurred since the closure of the issue for BWRs. Much of the PWR guidance and NRC staff SE are contained in (Reference 15) and (Reference 16). Together these documents are known as the Guidance Report (GR)/SE. The GR/SE contains updated guidance based on some of the lessons learned since the strainer issue was closed for the BWRs. Therefore, the NRC requested that BWR licensees, via the BWROG, address potential non-conservative treatment of debris at BWRs considering the lessons learned during PWR evaluations of the issue. The BWR licensees agreed to conduct a voluntary evaluation of the increase in knowledge since the BWR guidance was finalized. The NRC summarized the differences in treatment between PWR and BWR designs in NUREG/CR-7011, "Evaluation of Treatment of Effects of Debris in Coolant on ECCS and CSS Performance in Pressurized Water Reactors and Boiling Water Reactors" (Reference 17).

The BWR licensee voluntary review was initiated by a letter from the NRC to the BWROG on April 10, 2008 (Reference 18). The BWROG and NRC conducted several meetings to discuss the areas identified as requiring review. Ultimately, the BWROG provided responses to all of the areas in a letter dated November 20, 2017 (Reference 19). The NRC provided its conclusions on the review to the BWROG in a letter dated June 29, 2018 (Reference 20) and provided its technical evaluation in a letter dated May 2018 (Reference 21). The NRC concluded that no additional regulatory action was necessary to assure the safety of the BWR fleet with respect to the effects of debris on the ECCS. The licensee cited these analyses to justify that evaluations beyond those for the added debris were not required.

Specifically for Fermi, the licensee identified potential debris sources that are not included in the existing design basis. The licensee evaluated these newly identified debris sources in its current LAR. The NRC staff reviewed Fermi's existing licensing basis and finds it is consistent with the licensee's initial evaluation of the ECCS strainer issue and with BWR guidance as approved by the NRC. The proposed change in the licensing basis is based on a risk-informed analysis concluding very low risk to justify leaving the potential debris sources in place.

1.2.3 Proposed Final Safety Analysis Report Changes

In the letter dated June 13, 2023 (Reference 1), Attachment 2, the licensee proposed changes to the Fermi FSAR. In its letter dated April 24, 2024 (Reference 2), the licensee made revisions to the changes proposed in its initial LAR (Reference 1) to address NRC staff comments made during a regulatory audit. The changes are described in the response to requests for additional information (RAIs) STSB-RAI-2, 3, 4, and 5 (Reference 2). These changes describe the treatment of debris with respect to operation of the ECCS and CSS taking suction from the suppression pool. In the letter dated October 31, 2014 (Reference 4), the licensee revised its FSAR changes to clarify that the design basis debris values apply to the plant conditions described in the LAR and also allow up to 100 square feet (ft^2) of miscellaneous debris in the containment. The FSAR values may provide margin beyond the current potential debris sources, but they are not intended to allow the installation of further debris sources of any type in containment. The NRC staff reviewed these changes and concluded that they provide an adequate description of the proposed change.

The licensee also requested exemptions from Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46(d), General Design Criteria (GDC) 35 and GDC 38. In the letter dated May 30, 2024 (Reference 3), the licensee changed its proposed exemptions to include 10 CFR 50.46(a)(1), instead of 10 CFR 50.46(d). In its letter dated October 31, 2014 (Reference 4), the licensee revised its proposed exemptions to clarify that the complete three key elements of the exemption request are present for the exemptions to be applied. The licensee revised the exemptions to reflect that the analysis in the LAR considered DEGBs instead of the full spectrum of breaks. The licensee also removed its request for the exemptions to be completed within one year because of delays in the review of the LAR.

1.3 Licensee's Approach

The licensee for Fermi applied a risk-informed approach, similar to that used by PWRs, to evaluate the effects of the debris amounts greater than those examined in response to NRCB 95-02 (Reference 7) and 96-03 (Reference 8). Attachment 3 to the licensee's LAR (Reference 1) provides the detailed description and evaluation of the acceptability of the risk-informed approach. The licensee's evaluation benefits from lessons learned during the PWR resolution and uses relevant assumptions from the URG and the licensee's initial strainer design program. The licensee's approach maintains the existing design basis limits, or qualified load, for all of the debris types except for Min-K (i.e., an insulating material that when rendered into debris can have a significant effect on strainer performance) and miscellaneous debris (e.g., tags and labels that may block the strainer surface that would cause an increase in the amount of debris on the open strainer and an increase in the flow rate through the remaining strainer area).

The licensee also updated the amounts of reflective metal insulation (RMI) during its evaluation of debris amounts and found that the RMI amounts remain bounded by the initial strainer design limits. For BWRs, RMI is treated separately from other debris types in the head loss analysis; therefore, it does not affect the evaluation of increased amounts of other debris types.

The licensee's risk-informed analysis considered LOCAs initiated by pipe breaks. The analysis assigned some break scenarios to success and some to strainer failure based on threshold debris loads on strainers. During their design, the licensee estimated maximum loads for different types of debris based on debris sources. Following the original design, the qualified debris amounts were adjusted to account for changes in the plant or assumptions regarding the debris sources and insulation characteristics. The licensee tested strainer performance considering simultaneous loads of the different debris types. The tested or qualified debris amounts were referred to by the licensee as design bases (DB) or qualified debris loads. After the qualified debris loads were established, the licensee identified that the amounts of Min-K and tags and labels that could become debris were not bounded by the analysis. In the risk-informed analysis, break scenarios producing strainer debris loads less than the qualified loads are considered successfully mitigated. Break scenarios that generate Min-K debris loads on the strainer exceeding the qualified load limit are conservatively assumed to cause strainer failure and core damage. Similarly, break scenarios generating debris on strainers from low-density fiberglass (LDFG) insulation exceeding a debris bed thickness threshold are conservatively assumed to cause strainer failure and core damage. The debris bed thickness computations account for tags and labels debris potentially accumulating on strainers and reducing the active strainer area, consequently increasing the LDFG debris bed thickness on the active strainer area. On the other hand, the licensee directly compared the DB load limits to the computed strainer loads, independently of the active strainer area, to identify core damage scenarios. The NRC staff verified that the licensee appropriately applied the failure criteria in the analysis.

To evaluate the change in core damage frequency (ΔCDF) and change in large early release frequency (ΔLERF), the licensee implemented simplified analyses, independently of the probabilistic risk assessment (PRA) model of record, to estimate ΔCDF and ΔLERF. The licensee estimated the change in risk considering DEGB at specific locations of pipes of the ECCS, computing debris amounts generated by the break, and comparing debris loads on strainers to the DB limits (including a postulated threshold for formation of a thin bed of LDFG debris). Break scenarios exceeding the DB limits were conservatively associated with core damage. The CDF was computed based on all breaks generating debris exceeding the DB limits, and LOCA break exceedance frequencies published in NUREG-1829 (Reference 22). The licensee compared the ΔCDF and ΔLERF to metrics in NRC guidance to conclude very low risk of effects of debris interacting with the ECCS.

The licensee stated that its LAR is consistent with the guidance of Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Reference 23). The licensee concluded that the risk associated with the excess Min-K and miscellaneous debris was very low so that leaving these potential debris sources in place is justified.

The licensee's overall evaluation of risk attributable to debris for Fermi is based on physical models, test results, and conservative assumptions that have been used in the past in similar risk-informed and deterministic assessments. These methods have been accepted by the NRC staff for resolution of the effects of debris on the ECCS. The licensee provided a summary of the plant-specific conditions and models related to the analysis, as well as a description of the risk quantification using a method similar to the one used in the South Texas Project (STP) pilot GSI-191 evaluation (Reference 13), relying on the Containment Accident Stochastic Analysis GSI Resolution and Evaluation (CASA Grande) software to compute debris amounts as a function of potential break locations, DEGB size, and LOCA break exceedance frequencies from NUREG-1829 (Reference 22).

The licensee identified debris sources as coatings, insulation, dirt/dust, rust, suppression pool sludge, and latent debris. The insulation types at Fermi include reflective metal, NUKON (i.e., low-density fiberglass), and Min-K. Min-K is a microporous insulation that has the potential to cause significant head loss across strainers if accumulated as debris. The original strainer replacement design accounted for approximately 9.5 pounds (lb) of Min-K installed mostly at pipe-whip-restraints and a similar amount associated with containment penetrations. The potential debris from the Min-K at the penetration locations was evaluated in the DB qualified load analysis to be bounded by the Min-K installed at other locations within the drywell.

The updated risk-informed analysis accounts for additional Min-K that could be generated from penetration locations as well as the effects of miscellaneous debris blocking part of the active strainer areas. Considering these two changes to the debris source term, the licensee determined that most break scenarios would be mitigated successfully when evaluated using deterministic methods. Any scenario that was not predicted to be mitigated was assumed to result in a core damage event. These failures, accounting for their frequency, were assumed to contribute to the change in plant risk and were compared against the RG 1.174 acceptance guidelines. The approach of deterministically evaluating some breaks and considering other breaks that contribute to the plant risk was referred by the licensee as RoverD (for risk over deterministic), as in the STP pilot evaluation (Reference 13). The RoverD analysis was applied to evaluate the risk of the additional Min-K and miscellaneous debris that was discovered by the licensee, as well as the risk of scenarios causing formation of a thin bed of debris of LDFG insulation. Scenarios that are bounded by the DB qualified debris strainer loads, and without sufficient LDFG debris strainer loads to exceed a threshold thickness, are assumed to be mitigated by the ECCS. The licensee concluded that the change in risk due to loads of debris on strainers is very small.

The licensee submitted its Baseline analysis in its initial LAR submittal. In its letter dated May 30, 2024 (Reference 3), the licensee submitted a Modified Baseline analysis that: (1) addressed some errors affecting the amount of insulation in the computer-aided design (CAD) model, (2) included Min-K in penetrations, and (3) changed some of the assumptions in the analysis. The Modified Baseline Case provided the Baseline risk values associated with the proposed change. In its letter dated October 31, 2024 (Reference 4), the licensee addressed minor computational errors to compute the overall risk and renamed the risk values to clarify the discussions regarding their evolution due to analysis changes made by the licensee. In the October 31, 2024, letter (Reference 4), the licensee also used the following designations for risk values as they evolved:

- **ATTACHMENT 3 RISKS** are those that were provided in the initial submittal (Reference 1); these risk estimates did not include penetration Min-K.
- **REVISED ATTACHMENT 3 RISKS** include penetration Min-K, but do not include risk mitigating assumptions such as 25 percent reduction in penetration Min-K, system flow changes, and operator actions. The sensitivity studies are based on this case.
- **ATTACHMENT 4 RISKS** are the final risk values, including crediting 25 percent reduction of penetration Min-K debris and operator credit to mitigate effects of strainer clogging. The Attachment 4 risks provided in (Reference 4) are the baseline risk values, which are sometimes called final baseline values.

The NRC staff considers the final risk values to be the baseline risk values and uses this terminology for simplicity. The NRC staff finds that the licensee’s discussions of the evolution of the risk values appropriately describe earlier baseline risk values.

1.4 Method of NRC Staff Review

The purpose of the NRC staff’s SE review was to evaluate the licensee’s assessment of the impact of debris on ECCS functions following postulated LOCAs at Fermi. The NRC staff evaluated the licensee’s LAR (Reference 1). The NRC staff also conducted a regulatory audit (Reference 24,25) and performed confirmatory calculations in areas deemed appropriate by the NRC staff. Based on the feedback from the audit, the licensee revised and updated its request (Reference 2,3,4).

In areas where the licensee used its current licensing basis and NRC-approved or widely accepted methods, the NRC staff reviewed relevant material to ensure that the licensee used methods consistent with the limitations and conditions placed on those methods. Details of the NRC staff review, audit, and verification calculations are provided in Section 3.0, "Technical Evaluation: Risk-Informed Methodology," of this SE.

The NRC staff's review, documented below, integrates several disciplines (e.g., mechanical, structural, thermal-hydraulic, risk) and this SE is organized using the five key principles of risk-informed decision-making as listed in Section 3.0 of this SE.

2.0 REGULATORY EVALUATION

2.1 Description of Affected Structures, Systems, and Components

A fundamental function of the ECCS is to inject and recirculate water from the suppression pool to the RCS following a break in the RCS piping to ensure long-term removal of decay heat from the reactor fuel. Leaks from the RCS in excess of the plant's normal makeup capability (scenarios known as LOCAs) are part of a nuclear power plant's design basis. Hence, nuclear plants are designed and licensed with the expectation that they can remove reactor decay heat following a LOCA to prevent core damage. Long-term cooling following a LOCA is also a basic safety function for nuclear reactors.

One of the barriers to the release of radiation in the event of an LOCA is the primary containment. The primary containment at Fermi consists of a drywell, which encapsulates the reactor, and the torus which contains the suppression pool. The torus is a large doughnut shaped structure that is below the drywell and connected to it via very large pipes. The suppression pool provides the water source to the ECCS at Fermi. The suppression pool is also designed to receive the steam and hot water that blow down from the drywell. The blowdown is routed by the large pipes to under the surface of the suppression pool so that the steam is condensed and the pressure inside the containment is controlled. All BWRs have suppression pools. Most BWRs are designed with a torus, but a few newer BWRs have an alternate design for the suppression pool.

The strainers for the ECCS pumps are located in the suppression pool inside the torus.

ECCS and CSS

Fermi has two independent trains of RHR and two independent trains of CS equipment. Fermi also has a single train of HPCI that is mainly designed for small break LOCA mitigation. During a large-break LOCA (LBLOCA), depressurization of the RCS causes pressure to decrease in the reactor, pressure to increase in the drywell (and torus), and reactor water level to decrease.

Following a LOCA, the reactor SCRAMs. An increase in drywell pressure or decrease in reactor level will initiate a start of the HPCI system. HPCI can also be manually operated from the control room. The HPCI pump is driven by a steam driven turbine that uses reactor steam for power. HPCI can operate without any AC power, relying only on batteries. Initially, HPCI takes suction from the CST. When the CST water supply is exhausted the pump suction transfers to the suppression pool.

If the HPCI system does not restore reactor water level, the ADS activates to reduce reactor pressure so that the higher capacity, lower pressure ECCS systems (RHR and CS) can inject.

The ADS logic incorporates a time delay to allow HPCI to recover level and actuates only if low-pressure injection is available.

The CSS has two individual and independent loops that each have two pumps. The pumps take suction from the suppression pool and inject it via spray headers above the reactor core. A high drywell pressure or low reactor level signal will start the CSS.

The RHR system consists of two redundant loops. The LPCI mode of RHR injects water from the suppression pool into the reactor. Each LPCI loop has two RHR pumps and a heat exchanger. The LPCI system also initiates on high drywell pressure or low reactor level. The LPCI system is sized with adequate capacity to mitigate a DEGB of the largest piping in the RCS. The LPCI system injects into the RCS via the recirculation loop discharge piping and the system has loop select logic to isolate flow to the broken loop and inject into the intact loop from either of the independent LPCI loops. This ensures that the water is delivered to the reactor.

The containment cooling mode of RHR includes containment spray for the drywell and suppression pool cooling mode for the torus. These modes are manually initiated to control containment pressure. Water is taken from the suppression pool by the RHR pumps, routed through a heat exchanger for cooling, and sprayed into the drywell and/or torus to control pressure as needed. The containment cooling function is not aligned until between 10 and 20 minutes following the initiation of the event.

2.3 Applicable Regulatory Requirements

The NRC staff's acceptance criteria for ECCS performance following a LOCA are based on 10 CFR 50.46. LOCAs are postulated accidents that would result in the loss of reactor coolant from piping breaks in the reactor coolant pressure boundary at a rate exceeding the capability of the normal reactor coolant makeup system to replenish it. Loss of significant quantities of reactor coolant would prevent heat removal from the reactor core unless the water is replenished. The reactor protection and ECCS systems are provided to mitigate these accidents. The NRC staff's review of the licensee's LAR covered the acceptance criteria based on 10 CFR 50.46, insofar as it establishes standards for the calculation of ECCS performance and acceptance criteria, while also considering the effects of debris.

The following regulatory requirements are applicable to the NRC staff's review of the LAR attached to DTE Energy Company's letter dated June 13, 2023:

- Section 50.46(a)(i) of 10 CFR requires, in part, that each BWR must be provided with an ECCS, and the ECCS performance must be calculated with an acceptable evaluation model. The performance must be calculated for a number of postulated LOCAs of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated LOCAs are calculated.

- Section 50.46(b)(5) of 10 CFR requires licensees of domestic nuclear power plants to provide long-term cooling of the reactor core. That is, after any calculated successful initial operation, the ECCS must be able to remove decay heat so that the core temperature is maintained at an acceptably low value for the extended period of time required by the long-lived radioactivity remaining in the core.

- Section 50.46(c)(2) of 10 CFR defines an evaluation model as the calculational framework for evaluating the behavior of the reactor system during a postulated LOCA.

An evaluation model includes one or more computer programs and all other information necessary for applying the calculational framework to a specific LOCA (e.g., the mathematical models used, the assumptions included in the programs, the procedure for treating the program input and output information, the parts of the analysis not included in the computer programs, the values of parameters, and all other information necessary to specify the calculational procedure). Although not traditionally considered as a component of the 10 CFR 50.46 ECCS evaluation model, the calculation of sump performance is necessary to determine if the sumps and the ECCS are predicted to provide enough flow to ensure long-term cooling (LTCC). The NRC staff notes that these passages were developed as part of the regulatory basis during the resolution of PWR strainer issues. For BWRs the same concepts are applied to the strainers taking suction from the suppression pool which may affect both early and later LOCA response, not just LTCC.

- GDC 35 provides design requirements for the ECCS. It requires the system to provide abundant emergency core cooling. GDC 35 also defines required suitable redundancy for the system and defines assumptions to be made regarding single failures and power source availability. Regulatory precedent requires that licensees comply with GDC 35 using deterministic methods.

- GDC 38 provides design requirements for the containment heat removal systems. It requires the system to have the capability to rapidly reduce containment pressure and temperature following any LOCA and maintain them at acceptably low levels, consistent with the requirements of other systems. GDC 38 also defines required suitable redundancy for the system, and assumptions to be made regarding single failures and power source availability. Regulatory precedent requires that licensees comply with GDC 38 using deterministic methods.

2.4 Applicable Regulatory Guides, Review Plans, and Guidance Documents

The BWROG evaluation guidance document, NEDO-32686-A, entitled “Utility Resolution Guide for ECCS Suction Strainer Blockage” which included the associated NRC SE was issued as an approved topical report (TR) in October 1998 (Reference 9). The NRC SE found the BWROG TR provided an acceptable overall guidance methodology, but that portions were not adequately justified. The final approved URG includes descriptions of the areas that the NRC found to need additional justification. The BWROG did not address all of the areas because they were not generic to all plants. However, these areas are identified in the final document, NEDO-32686-A. The final TR, including the NRC SE, provides a method acceptable to the NRC staff, with limitations and conditions for performing the evaluations necessary to assure that the ECCS strainers will function to support core cooling, including LTCC, following a LOCA. The URG provides the technical basis and methodology for evaluating and quantifying the generation and transport of debris within the drywell and to the strainers in the torus/suppression pool. It also provides guidance for determining whether the pumps will retain adequate NPSH considering the effects of the maximum amounts of debris that may reach the strainers.

In addition to the evaluation guidance of the URG, Fermi’s licensing basis for strainer head loss is based on a GE TR (Reference 26,25). This TR provides the maximum allowable debris amounts for the various debris types that may transport to the suppression pool while maintaining adequate NPSH for the ECCS pumps. The specific strainer debris load limits were calculated using a proprietary methodology (Reference 27).

The reports listed above, subject to the limitations and conditions contained in the NRC SEs for those TRs, describe methods acceptable to the NRC staff for performing the evaluations and analyses within the scope stated in those documents.

RG 1.82, Revision 4, “Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident,” dated March 2012 (Reference 28), provides guidance for an evaluation of the effects of debris on ECCS strainers and, more generally, guidance for the evaluation of water sources for long-term recirculation following a LOCA.

RG 1.174, Revision 3, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” dated January 2018 (Reference 23), provides guidance on the use of probabilistic risk assessment (PRA) findings and risk insights in support of licensee requests for changes to a plant’s licensing basis. This RG provides risk acceptance guidelines for evaluating the results of such evaluations. RG 1.174 also provides the five key principles of risk-informed integrated decision-making.

RG 1.200, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk Informed Activities” (Reference 29), endorses, with clarifications, the American Society of Mechanical Engineers (ASME) and the American Nuclear Society (ANS) PRA Standard ASME/ANS RA-Sa-2009, “Addenda to ASME/ANS RA-S 2008, Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications” (Reference 30). The ASME/ANS RA-Sa-2009 Standard addresses PRAs for internal events and other hazards. RG 1.200 describes one acceptable approach for determining whether the PRA, in total, or the parts that are used to support an application, is acceptable for use in regulatory decision-making for light-water reactors.

Guidance on evaluating PRA acceptability is also provided in Standard Review Plan (SRP) Chapter 15, Section 15.0.2 (Reference 31), and SRP Chapter 19, Section 19.1, Revision 3, “Determining the Technical Adequacy of Probabilistic Risk Assessment for Risk-Informed License Amendment Requests After Initial Fuel Load” (Reference 32). General guidance for evaluating the technical basis for proposed risk-informed changes is provided in SRP Section 19.2, “Review of Risk Information Used to Support Permanent Plant-Specific Changes to the Licensing Basis: General Guidance” (Reference 33). Section 19.2 of this SRP references the same criteria as RG 1.174, and states that a risk-informed application should be evaluated to ensure that the proposed changes meet the five key principles of risk-informed decision-making.

3.0 TECHNICAL EVALUATION: RISK-INFORMED METHODOLOGY

For this safety analysis, the NRC staff used the format developed for PWR plant risk-informed analysis for the resolution of GL 2004-02. For example, see the SE for the Callaway Plant LAR on this topic (Reference 34). The format is also based on draft RG 1.229 (Reference 35) which was used for the PWR reviews. The BWR guidance is significantly simplified and is not required to cover all the topics that were evaluated for PWRs. Additionally, the Fermi review is limited to evaluating changes in only two of the debris type source terms, compared to evaluating all the potential debris types. For these reasons, many sections of this SE are abbreviated or eliminated compared to PWR risk-informed SEs. As discussed in Section 1.2.2 of this SE, the lessons learned during the PWR resolution of the debris issue were considered and the NRC staff determined which items needed to be applied to BWRs. Based on these considerations, and the limited changes evaluated in the licensee’s LAR, areas are appropriately abbreviated or omitted as required for this SE.

The NRC staff performed an integrated review of the proposed risk-informed approach, considering the five key principles of risk-informed decision-making set forth in RG 1.174, Revision 3 (Reference 23). The five key principles are:

1. The proposed change meets the current regulations, unless it explicitly relates to a requested exemption or rule change.

2. The proposed change is consistent with the defense-in-depth (DID) philosophy.

3. The proposed change maintains sufficient safety margins.

4. When proposed changes result in an increase in risk, the increase(s) should be small and consistent with the intent of the Commission's Safety Goal Policy Statement – 51 FR 30028 (Reference 36).

5. The impact of the proposed change should be monitored using performance measurement strategies.

3.1 Key Principle 1: The Proposed Change Meets Current Regulations, Unless it is Explicitly Related to a Requested Exemption or Rule Change

The licensee's proposed change requested to modify the Fermi licensing basis to show compliance with 10 CFR 50.46 considering the effects of debris using both deterministic and risk-informed methodologies. The deterministic basis is unchanged. However, the licensee demonstrated that the effects that could be caused by the debris identified in the LAR that are not bounded by the deterministic debris amounts would result in acceptably low risk.

The URG and the associated strainer analyses, RG 1.82, and the SRP (NUREG-0800) are the primary guidance documents used to show regulatory compliance with 10 CFR 50.46, considering the effects of debris using deterministic criteria. As described above, the RoverD method uses both deterministic and risk-informed criteria. Most of the break scenarios are shown to meet deterministic acceptance criteria. For scenarios where deterministic acceptance criteria are not satisfied, the licensee proposed an exemption to 10 CFR 50.46, and GDCs 35 and 38. The requested exemptions were evaluated by the NRC staff against the criteria of 10 CFR 50.12 and were found to be acceptable. A successful demonstration that all break scenarios are bounded by the deterministic criteria, or fall within the bounds of the exemption, demonstrates that the regulations have been met, and thus, the proposed change meets the first key safety principle of RG 1.174.

The criteria to evaluate compliance with 10 CFR 50.46 using a risk-informed methodology are provided in the SRP, Section 19; RG 1.200; and RG 1.174. However, the NRC's position has historically interpreted and applied the current regulations in 10 CFR 50.46 as requiring a deterministic approach and bounding calculations to show compliance. Thus, the NRC's longstanding practice may be regarded as a legally binding requirement from which an exemption is the appropriate means of granting dispensation from compliance.

The NRC staff recognizes, as discussed SRM-SECY-12-0093 (Reference 37), that the Commission allowed PWRs to use risk-informed methods to resolve issues related to debris and ECCS performance in their responses to GL 2004-02 (Reference 11). Based on the similarity between the PWR situation and that at Fermi, the NRC staff concluded that the SRM was applicable to the licensee's LAR. In accordance with 10 CFR 50.12, the licensee requested exemptions from 10 CFR 50.46(d), and exemptions from GDC 35 and 38 of Appendix A to 10 CFR Part 50 (Reference 1). In supplemental letters dated May 30, 2024 (Reference 3) and October 31, 2024 (Reference 4), the licensee revised its exemption from 10 CFR 50.46(d) to an exemption from CFR 50.46(a)(1) and clarified the conditions for which the exemption is applicable. The licensee concluded for Fermi that the risk for the effects of debris is less than the threshold for Region III, Very Small Changes, of RG 1.174 (Reference 23), and that no additional physical changes to the facility or changes to the operation of the facility were proposed.

The NRC staff determined that special circumstances exist to grant the proposed exemption and that granting the exemption would not result in a violation of the Atomic Energy Act of 1954, as amended. Therefore, since the staff has granted the exemptions and the change explicitly relates to these requested exemptions, the proposed change to use the risk-informed methodology meets the first key safety principle of RG 1.174.

3.2 Key Principle 2: The Proposed Change is Consistent with the Defense-in-Depth Philosophy

Section C.2.1.1 of RG 1.174, Revision 3 (Reference 23), states that the DID philosophy consists of a number of considerations, and consistency with the DID philosophy is maintained if the following occurs:

- A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.
- Over-reliance on programmatic activities as compensatory measures associated with the change in the licensing basis is avoided.
- System redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences or challenges to the system, and uncertainties (e.g., no risk outliers).
- Defenses against potential common-cause failures are preserved, and the potential for the introduction of new common-cause failure mechanisms is assessed.
- Independence of barriers is not degraded.
- Defenses against human errors are preserved.
- The intent of the plant's design criteria is maintained.

In its initial LAR (Reference 1), the licensee discussed mitigative measures that provide DID for issues that could be caused by the effects of debris on the ECCS. The following actions that were not credited in the calculated risk values were identified by the licensee:

- Reduce flow through the strainer to reduce flow losses through debris.
- Backflush strainer to remove debris.
- Align core spray suction to the CST which does not take suction through the strainer.
- Use of clean alternate injection sources from the hotwell, CST, RHR, and fire protection systems, as well as Diverse and Flexible Coping Strategies (FLEX) equipment.
- Flooding the reactor pressure vessel (RPV) to above the Steam Separator Return (for core inlet blockage).

In its RAI responses dated May 30, 2024 (Reference 3), the licensee explicitly addressed DID and the seven considerations from RG 1.174 (listed above) for Fermi. Items associated with DID that were included in the licensee's analysis are evaluated in Sections 3.2.1 to 3.2.7 of this SE.

3.2.1 A Reasonable Balance is Preserved Among Prevention of Core Damage, Prevention of Containment Failure, and Consequence Mitigation

The licensee highlighted the independent components of the LOCA response systems, including two independent trains of ECCS equipment that include the ability to assure containment heat removal.

The licensee noted that the proposed license change does not involve any change to the design and design requirements of the current plant equipment, or changes to strategies for core damage prevention, containment failure prevention, and consequence mitigation (Reference 1,3).

The NRC staff reviewed the licensee's rationale and concluded that a reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation because of the following:

1. There is a robust plant design to survive hazards and minimize challenges that could result in the occurrence of an event, and the change to adopt a risk-informed approach for assessing the effects of debris does not increase the likelihood of initiating events or create new significant initiating events;

2. Prevention measures are in place with adequate availability and reliability of structures, systems, and components (SSCs), providing the safety functions that prevent plant challenges from progressing to core damage;

3. Existing measures are in place to contain a source term if a severe accident occurs, since the change does not impact the containment function or SSCs supporting that function, such as containment sprays; and

4. The change does not reduce the effectiveness of the emergency preparedness program, including the ability to detect and measure releases of radioactivity, notify offsite agencies and the public, and shelter or evacuate the public as necessary.

3.2.2 Over-Reliance on Programmatic Activities as Compensatory Measures Associated with the Change in the Licensing Basis is Avoided

This DID consideration evaluates if design features are substituted for programmatic activities to an extent that significantly reduces the reliability and availability of design features to perform their safety functions. The licensee identified that the change would not adversely affect any of the programmatic activities already in place at Fermi, such as the inservice inspection (ISI) program, plant personnel training, RCS leakage detection program, containment cleanliness inspection activities, and the inservice testing program which requires testing of active components such as pumps and valves. The proposed change does not rely heavily on programmatic activities as compensatory measures, nor does the change propose any new programmatic activities that could be heavily relied upon (Reference 1,2,3,4). The NRC staff reviewed the licensee's description of programmatic activities and concludes that this DID consideration is met because the proposed change does not affect how safety functions are performed, nor does it reduce the reliability or availability of the SSCs that perform those functions. Existing programmatic activities are maintained, and therefore, there is not an excessive reliance on programmatic activities as compensatory measures related to the risk-informed approach.

3.2.3 System Redundancy, Independence, and Diversity are Preserved, Commensurate with the Expected Frequency, Consequences of Challenges to the System, and Uncertainties (for Example, No Risk Outliers)

The licensee highlighted the redundancy, independence, and diversity of the core cooling and containment heat removal equipment and asserted that the proposed license change does not require any design change to these systems. Therefore, system redundancy, independence, and diversity are preserved. In addition, the licensee stated that the proposed licensing basis change does not call for any changes to the system operating procedures. These systems were analyzed by the licensee relative to their contribution to nuclear safety through the Fermi plant-specific PRA (which meets industry PRA standards for risk-informed applications), accounting for a full range of LOCA events and uncertainties, and no risk outliers were identified (Reference 1).

The NRC staff reviewed the licensee's evaluation of this DID consideration and concludes that it is met because the risk-informed analysis is consistent with the assumptions in the safety analysis for Fermi. In addition, this DID consideration is met because the risk-informed analysis does not significantly increase the expected frequency of challenges to the systems, or consequences of failure of the system functions as a result of a decrease in redundancy, independence, or diversity; therefore, they are adequately preserved. The NRC staff confirmed that the licensee performed a comprehensive risk assessment and demonstrated that reductions in redundancy, independence, or diversity of systems resulting from postulated LOCAs do not cause a significant increase in risk, as evidenced by a margin to RG 1.174 risk acceptance guidelines. The NRC staff noted that the licensee included sensitivity cases to assess uncertainty. Although some sensitivity cases yielded higher risk increases, those alternatives were considered as part of the uncertainty of the risk estimates and controlled by different sets of assumptions. See Section 3.4.2.9, "Systematic Risk Assessment" of this SE.

3.2.4 Defenses Against Potential Common-Cause Failures are Preserved, and the Potential for the Introduction of New Common-Cause Failure Mechanisms is Assessed

The licensee examined common-cause failure (CCF) mechanisms in the context of the effects of debris on the RHR and CSS strainers; specifically, the primary failure mechanism of concern is strainer clogging limiting adequate flow to any of the RHR and CSS pumps. The licensee determined that defenses against potential strainer clogging are not changed by the risk-informed methodology; there are no design changes to the equipment or changes to emergency operation procedures (Reference 1,3,4).

The NRC staff reviewed the evaluation of this DID consideration and concludes that it is met because the risk-informed evaluation: (1) does not introduce a new potential CCF or event for which a defense is not in place, (2) does not increase the probability or frequency of a cause or event that could cause simultaneous multiple component failures, (3) does not introduce a new coupling factor for which a defense is not in place, and (4) does not weaken or defeat an existing defense against a cause, event, or coupling factor. Even though the strainer blockage failure mechanism is not deterministically eliminated, the risk analysis shows that the risk is very small and that additional mitigative and DID measures exist.

3.2.5 Independence of Barriers is Not Degraded

The three barriers to a radioactive release are the fuel cladding, RCS piping and components, and reactor containment (drywell). In a LOCA, the RCS barrier is postulated to be breached. The licensee stated that the proposed change does not affect the design and analysis requirements for the fuel. Following a LOCA, the coolant is mobilized by pumps outside the drywell and recirculated back to the reactor vessel and containment. The licensee stated that the proposed licensing basis change does not involve any change to the design and operating requirements for the equipment and that the presence of the additional debris does not create any new failure mechanisms for the equipment. The licensee also stated that the performance of fission product barriers is not affected by the debris. Therefore, the licensee concluded that there is no significant increase in the probability of a challenge of any barrier (Reference 3).

The NRC staff reviewed the licensee's evaluation of this DID consideration and concludes that it is met because implementation of the methodology does not result in a significant increase in the frequency of existing challenges to the integrity of the barriers or in the failure probability of any individual barrier. Moreover, implementation of the methodology does not introduce new or additional failure dependencies among barriers that significantly increase the likelihood of failure.

3.2.6 Defenses Against Human Errors are Preserved

This consideration evaluates whether implementation of the proposed methodology significantly increases the potential for or creates new human errors that might adversely impact one or more layers of defense. The licensee stated that the proposed license change does not involve any design change to the current equipment or change to operating procedures. The licensee stated that operators are trained to recognize indications of ECCS strainer blockage and take appropriate mitigating actions. These operator actions are controlled by emergency operating procedures (EOPs). The risk-informed approach does not change any of the EOPs or impose any additional operator actions or complexity. The licensee concluded that the defenses that are already in place with respect to human errors are not impacted by the proposed licensing basis change.

The NRC staff reviewed the evaluation of this DID consideration and concludes that it is met because the implementation of the proposed methodology does not reduce the ability of plant staff to perform actions. Specifically, the methodology does not create new human actions that are important to preserving any of the layers of defense, or significantly increase the probability of existing human errors by affecting performance shaping factors, including mental and physical demands and level of training.

3.2.7 The Intent of the Plant's Design Criteria is Maintained

The licensee stated that the proposed license change does not involve any change to the design or design requirements of the current plant equipment. The proposed license change revises the licensing basis amounts for some debris types associated with ECCS strainer design generated after postulated LOCAs. The licensee concluded that the intent of the plant's design criteria is maintained.

The licensee stated that the design and licensing basis descriptions of accidents requiring ECCS operation [including analysis methods, assumptions, and results provided in the updated FSAR Chapters 6 and 15] remain unchanged. The proposed change to the licensing basis continues to meet the intent of the design criteria. The licensee based its conclusion partially on the results of the risk-informed approach which demonstrated that the calculated risk of debris interacting with long-term core cooling functions is very small for Fermi and are in accordance with the Region III acceptance guidelines defined by RG 1.174.

The performance evaluations for accidents requiring ECCS operation described in updated FSAR Chapters 6 and 15 are based on the Fermi 10 CFR Part 50, Appendix K LBLOCA analysis, where the licensee demonstrated that for breaks up to and including the DEGB of a reactor coolant pipe, the ECCS will limit the clad temperature to below the limit specified in 10 CFR 50.46, thus assuring that the core will remain in place and substantially intact with its essential heat transfer geometry preserved. The licensee demonstrated that the risk of the loss of long-term cooling is very small and demonstrated that additional DID and mitigative measures are available. Since the proposed license change does not involve a change to the ECCS acceptance criteria specified in 10 CFR 50.46, the licensee concluded that the intent of the plant's design criteria is maintained (Reference 1).

The NRC staff reviewed the licensee's evaluation of this DID consideration and concludes that the proposed change maintains the intent of the plant's design criteria because an alternate risk-informed evaluation method provides an acceptable approach which demonstrates that the risk of losing initial core cooling and LTCC due to debris generated by a LOCA is very low. Thus, the proposed change does not result in a reduction in the effectiveness of one or more layers of defense.

3.2.8 NRC Staff Conclusion Regarding Key Principle 2: Defense-in-Depth

The NRC staff finds that the philosophy of DID is maintained under the analysis described in Section 6.1 of the licensee's LAR (Reference 1) as well as the supplemental information provided in the May 30, 2024, RAI response (Reference 3) and October 31, 2024, supplement (Reference 4) because the licensee has appropriately addressed each of the seven factors in Section 2.1.1 of RG 1.174, Revision 3 (Reference 23).

3.3 Key Principle 3: The Proposed Change Maintains Sufficient Safety Margins

RG 1.174 states that safety margins are maintained when codes and standards or their alternatives approved for use by the NRC are met and when the safety analysis acceptance criteria in the licensing basis (e.g., FSAR, supporting analyses) are met, or proposed revisions provide sufficient margin to account for analysis and data uncertainty.

The licensee stated that sufficient safety margins are maintained and that the safety margins will remain as long as the amounts of Min-K and miscellaneous debris do not increase. The LAR stated that safety margins are defined as a conservatism included in the analysis beyond the regulatory requirements to ensure that the risk of failure scenarios is low. The licensee identified the following safety margins in the risk-informed analysis:

- For isolable breaks, the analysis assigns the full NUREG-1829 LOCA break exceedance frequency to the much smaller population of isolable break locations.
- For isolable break locations, the analysis assumes that any break 0.5 inches or larger

results in a scenario failure (i.e., core damage) if not isolated, despite that some breaks would not generate enough debris to cause ECCS failure.

- The ECCS is assumed to fail (and cause core damage) if only one strainer accumulates sufficient debris to exceed failure threshold criteria.
- Breaks were assumed to be fully offset DEGBs, even if this would not occur due to pipe supports and whip-restraints.
- The probability for single division operation was greatly overestimated. For example, simultaneous multiple pump failure resulting in single division operation is very unlikely.
- The analysis assumes loss of 100 ft^2 of strainer area at the time the pumps start due to strainer blockage by tags and labels. These tags would take time to transport and would not likely fully block the assumed portion of the active strainer area.
- The present strainer design would allow exceeding the assumed LDFG debris bed thickness limit (i.e., 1/8-inch debris bed thickness in the Baseline analyses) without failing the strainer. However, the risk analysis assumes that scenarios with fiber loads exceeding the debris bed thickness limit are associated with strainer failure and core damage. Using more realistic assumptions of strainer capacity would lower the numeric risk estimates.
- The ECCS strainers were initially designed with structural and NPSH margin. The most recent debris generation and transport analyses found that debris loading for all debris types, except the two evaluated using a risk analysis, are reduced from the qualified debris assumptions. Therefore, the strainers have additional margin compared to the original design parameters.
- The analysis assumes that 100 percent of fiber that reaches the suppression pool transports to the strainers. It is likely that some of this fiber would be trapped in transport and not reach the strainers.

The licensee discussed the debris bed thickness limit to define strainer failure with respect to margin. The licensee concluded that the assumption of immediate loss of flow of all ECCS pumps when the strainer bed thickness on a single strainer reaches the limit provides significant margin. The licensee stated that it is likely that exceeding the debris bed thickness limit would not cause a complete stoppage of flow. Instead, flow would likely continue, especially on the strainers with lesser debris bed loads, until additional debris is collected on all the active strainers. The licensee stated that there is significant testing evidence that the practical limit to define failure (i.e., 1/8-inch LDFG debris bed thickness in the risk analysis) is conservative.

3.3.1 Barriers for Release of Radioactivity

The licensee stated that the change does not significantly affect the safety margins in the barriers for the relief of radioactivity. Many of the following are associated with a very small increase in risk that may occur due to the change. The NRC staff noted that the LAR does not request a change that would result in any of the following:

- Affect or remove any of these barriers. There are no physical or design changes to the fuel, RCS, or containment.
- Result in a significant increase in the existing challenges to the integrity of the barriers. The change does not create additional scenarios or significantly increase the risk associated with analyzed scenarios.
- Significantly change the failure probability of any individual barrier.
- Introduce new or additional failure dependencies among barriers that significantly increase the likelihood of failure when compared to the existing conditions.

- Change the overall redundancy and diversity features among the barriers that are sufficient to ensure compatibility with the risk acceptance guidelines.

The licensee also discussed margins in alternate water supplies that can be aligned to the RCS in the event that the normal ECCS systems are not functioning. The HPCI, RCIC, CRD and standby feedwater systems are all available.

The licensee evaluated aspects contributing to safety margin such as the emergency core cooling and long-term cooling, the RCS pressure boundary, the ISI program, RCS weld mitigation, RCS leakage detection, and containment integrity.

As described in the LAR (Reference 1):

- Fermi has a system to provide abundant emergency core cooling, including during scenarios of loss-of-offsite or onsite power.
- Although the RCS pressure boundary is postulated to be failed (i.e., a LOCA occurs) for the risk-informed evaluation, the proposed change does not make any change to the previous analyses and testing programs that demonstrate the integrity of the RCS. In response to RAIs (Reference 2), the licensee provided additional information regarding the programs that ensure RCS integrity. Some specific examples are cited below.
- The Fermi ISI Program Plan provides verification that structural integrity of ASME Class 1, 2, and 3 piping components are within the limits specified in the ISI Program, and verification that the structural integrity of the main feedwater piping is within the limits specified in the augmented ISI Program.
- The leak detection program at Fermi is capable of early identification of RCS leakage to provide time for appropriate operator action prior to a large break.
- The containment remains a low leakage barrier against the release of fission products for the duration of the postulated LOCAs. The RHR system can be used to reduce the containment pressure and temperature after a design basis accident including a loss-of-offsite power.

The NRC staff noted that the proposed change to the licensing basis does not involve any changes to the Emergency Plan. Specifically, the use of the risk-informed approach does not impose any additional operator actions or complexity.

The licensee stated that it was not making any physical changes to the plant and that the LAR did not require any changes to the analyses in Chapters 6 and 15 of the updated FSAR. Therefore, the design basis for the ECCS, fuel, and containment systems is unchanged, except for a risk-informed justification for the limited debris source terms in excess of the existing strainer qualified debris loads.

In 2023 the NRC staff performed an audit (Reference 24,25) of the licensee's documents supporting the LAR (Reference 1). By letter dated April 24, 2024 (Reference 2), the licensee provided supplements to the LAR to address the NRC staff's questions as part of the audit activities. The letter included responses to audit questions Vessels and Internals Branch (NVIB)-RAI-1, 2, 3, 4, 5, 6, 7, and 8 regarding DID measures for the RCS pressure boundary. Although these measures were evaluated as part of the RCS pressure boundary contribution to DID, they also contribute safety margin to failure of the RCS pressure boundary and are therefore discussed here, in Section 3.3 of this SE, "Key Principle 3: The Proposed Change Maintains Sufficient Safety Margins."

Based on the licensee's programs, the NRC staff concluded that adequate actions are in place to assure that the frequencies of pipe breaks causing a LOCA are adequately estimated based on information in NUREG-1829 (Reference 22). Details of the NRC staff's review regarding the structural integrity of welds included in the risk-informed analyses are provided in this section.

Because the proposed licensing basis change does not impact any design or programmatic requirements for the RCS pressure boundary, the likelihood of a LOCA is not affected. The NRC staff recognizes that the LAR does not change the original licensing basis for the design, analysis, and programmatic requirements (e.g., inspections) for the RCS pressure boundary. The NRC staff has determined that the probability of a LOCA (i.e., probability of RCS piping failure) is not significantly affected. Nonetheless, the NRC staff reviewed the LAR to determine whether DID measures are maintained for the RCS pressure boundary to address the potential material degradation as part of the review of the LAR.

In response to NVIB-RAI-1 (Reference 2), the licensee stated that not all of the 884 welds have been ultrasonically examined on at least once. In accordance with the ASME Code, Section XI, Code Case N-716-1, "Alternative Classification and Examination Requirements, Section XI, Division 1," and BWRVIP-75-A, "BWR Vessel and Internals Project Technical Basis for Revisions to GL 88-01 Inspection Schedules," ultrasonic examinations are performed on a sampling basis. The NRC staff noted that although the licensee has not inspected all the in-scope welds at least once, the licensee has inspected certain welds in accordance with Code Case N-716-A and BWRVIP-75-A. The NRC staff further noted that the licensee has inspected welds in accordance with the ASME Code, Section XI as required by 10 CFR 50.55a. The NRC staff recognizes that the ASME Code, Section XI permits sample inspections. Therefore, the NRC staff finds that, as required by the Code, some of the in-scope welds have been inspected in accordance with the NRC approved Code Case N-716-A and BWRVIP-75-A, and therefore the welds considered in the analysis are acceptable.

The NRC staff noted that Attachment 3 to the June 13, 2023, letter, Section 6.5 of the Serco Calculation, page 83, states that all Class 1 welds at Fermi are either Category A, (i.e., welds with no known cracks that are made from materials that are considered resistant to intergranular stress corrosion cracking (IGSCC)), or Category B (i.e., welds made from material that is considered susceptible to IGSCC but have been mitigated by stress improvement prior to two cycles of operation). The NRC staff questioned whether Category A or B welds have recorded indications or degradation based on the examinations performed during ISI. In its response to NVIB-RAI-2, dated April 24, 2024 (Reference 2), the licensee stated that Class 1 piping welds at Fermi have no indications unacceptable to the ASME Code, Section XI and that no degradation in the form of IGSCC Category B welds has been identified after mitigation.

The NRC staff noted that austenitic stainless steel welds in BWRs have experienced IGSCC and questioned whether the in-scope welds include this type of welds, whether these welds have been mitigated, and whether corrective actions have been taken for any in-scope unmitigated austenitic stainless steel welds. In its response to NVIB-RAI-5, dated April 24, 2024 (Reference 2), the licensee stated that 38 Category A and 106 Category B austenitic stainless steel welds are included in the risk analysis. These welds have been mitigated to reduce their susceptibility to IGSCC. The licensee stated that Class 1 austenitic stainless steel welds outside the scope of BWRVIP-75A have not been mitigated and no corrective actions have been required. The NRC staff noted that all of these type welds are periodically inspected by the ASME Code, Section XI, Code Case N-716-1, or BWRVIP-75-1. The structural integrity of these welds will be monitored accordingly and therefore are acceptable.

In NVIB-RAI-3, -4 and -5, the NRC staff asked whether the failure probability value in the risk analysis will be increased for the in-scope welds considering their inspection status, and potential susceptibility to degradation. The licensee responded (Reference 2) that no adjustments (up or down) were made to NUREG-1829 weld break frequencies to account for inspection results or industry standard mitigation practices. The licensee stated that Fermi has no adverse findings from weld inspections. Additionally, in its response, the licensee stated that NUREG-1829 includes consideration of all degradation mechanisms and assumes adherence to industry best practice weld management initiatives, which Fermi implements. According to the licensee, uncertainties in weld break frequency are addressed by quantification of risk assuming arithmetic mean aggregation of the NUREG-1829 expert panel elicitation. The licensee explained that it is not typical for risk-informed applications to adjust individual weld break frequencies. The licensee stated that NUREG-1829 weld break frequencies applied in the LAR are consistent with values used in the Fermi PRA.

<u>ISI program</u>

Section 6.5 of the Serco Calculation, page 83, states that "…Pressure retaining welds are inspected in accordance with ASME Code Case N-716-1 'Alternative Classification and Examination Requirements.' This Code Case prioritizes inspection of risk significant welds and welds potentially susceptible to a degradation mechanism, such as IGSCC or thermal fatigue… Ten percent of Class I welds are examined over a ten-year interval..." The NRC staff requested additional details regarding inspection of the in-scope welds. In its response to NVIB-RAI-3, dated April 24, 2024 (Reference 2), the licensee stated that consistent with ASME Code, Section XI requirements, 100 percent of in-scope welds have not been examined. However, the licensee stated that for those welds that have been inspected, it has not detected indications adverse to ASME weld management standards. The licensee stated that the current 4th ISI interval is the first full interval implementing Code Case N-716-1. Pending any programmatic changes, the same ten percent of Class 1 welds will be examined per Code Case N-716-1 during future 10-year ISI intervals. The licensee stated that unless programmatic weld inspection requirements change, or adverse indications are found in the inspected weld population, the same 90 percent of Class 1 welds will not be inspected to the end of the license renewal period. Changes to programmatic requirements made in response to changes in ASME standards or industry best practice initiatives, or adverse indications found during periodic inspections may result in additional inspections of previously uninspected Class 1 welds.

The NRC staff noted that nickel-based Alloy 82/182 weld metal has experienced stress corrosion cracking in pressurized-water reactor and BWRs. As such, the NRC staff asked whether any in-scope welds that are fabricated with nickel-based Alloy 82/182 have been mitigated to reduce their susceptibility to stress corrosion cracking or if any unmitigated welds of this type have been inspected to monitor their structural integrity. In its response to NVIB-RAI-4, dated April 24, 2024 (Reference 2), the licensee stated that welds within the scope of GL 88-01 (Reference 38) have been mitigated to reduce their susceptibility to stress corrosion cracking. The licensee stated that Class 1 welds that are not within the scope of GL 88-01 or N-716-1 are subject to VT-2 visual inspection during the RPV pressure test. The NRC staff determined that the welds that are susceptible to IGSCC have been mitigated and are therefore acceptable. The NRC staff noted that Class 1 welds are required to be inspected for leakage via VT-2 visual inspection during the pressure test prior to the plant restart in accordance with the ASME Code, Section XI, IWB-5000. As such, the NRC staff finds that the in-scope, unmitigated welds that have not been inspected will be inspected for leakage during the periodical pressure testing and therefore are acceptable.

In its response to NVIB-RAI-6, dated April 24, 2024 (Reference 2), the licensee stated that Fermi currently implements BWRVIP-75-A for ISI of in-scope welds. The licensee further stated that ten percent of Category A welds and 25 percent of Category B welds are ultrasonically examined every interval as part of the ISI Program in accordance with ASME Code, Section XI, Appendix VIII and the Electric Power Research Institute Performance Demonstration Initiative. The NRC staff notes that the provisions of the ASME Code, Section XI, Appendix VIII and Electric Power Research Institute's (EPRI's) Performance Demonstration Initiative provide rigorous qualification for the ultrasonic examination of welds and therefore is acceptable.

The NRC staff determined that the licensee has implemented an ISI program in accordance with the ASME Code, Section XI, which is incorporated by reference in 10 CFR 50.55a. The licensee also implemented the inspections of Code Case N-716 and BWRVIP-75-A. The NRC staff determined that the Fermi ISI program is acceptable to monitor structural integrity of the RCS pressure boundary and is an adequate DID measure.

RCS Leakage Detection Program

The NRC staff finds that RCS piping, if it degrades, would most likely leak before catastrophic failure to generate debris in the containment. The NRC staff determined that to prevent catastrophic pipe failure, the strategy is to install leakage detection systems in the containment that have the capability to detect minor leakage before a pipe flaw becomes significantly large. Fermi has a monitoring system to detect leakage inside the containment as discussed in updated FSAR Section 5.2.7, "Reactor Coolant Pressure Boundary Leak Detection System." The leakage detection system will alert control room operators who are required to take timely corrective actions to shut down the plant before pipe failure.

Updated FSAR Section 5.2.7 states that the reactor coolant pressure boundary (RCPB) leak detection system consists of temperature, pressure, flow, and fission product sensors with associated instrumentation and alarms. This system detects and annunciates abnormal leakage in the following systems: main steam lines, RWCU, RHR, RCIC, reactor feedwater, HPCI, and reactor recirculation piping. UFSAR Table 5.2-11 shows various methods to detect, isolate, and alarm leakage from affected piping systems.

Updated FSAR Section 5.2.7.1.2, "Detection of Abnormal Leakage Within the Primary Containment," states that leakage in the primary containment is detected by monitoring for: (a) abnormally high pressure and temperature within the primary containment, (b) frequency of sump pump operation for floor and equipment drains, (c) decrease in the RPV water level, (d) hydrogen and oxygen concentration, (e) high flow rate in process lines, (f) high gaseous radiation levels in the primary containment atmosphere, and (g) floor drain sump level rate-of-change.

Temperatures within the primary containment are monitored at various elevations. Excessive temperature in the primary containment, increased drain sump flow, and increased fission product radiation levels are annunciated by alarms in the main control room. Low RPV water level and high drywell pressure are annunciated by alarm in the main control room and cause automatic isolation of the containment. In addition, low RPV water level isolates the main steam lines.

The floor drain sump includes a level monitor to enhance leak detection capability. A continuous analog level measurement of the drywell floor drain level is provided to meet the sensitivity requirement of RG 1.45 (Reference 39). This sump level monitor provides a rate-of-change measurement, which is qualified seismically and has the sensitivity to detect a 1-gallon per minute (gpm) leak integrated over a 1-hour interval.

The drywell equipment drain sump level monitors identify leakage collected in the equipment drain sump. The sump receives condensate drainage from pump seal leakoff. Collection in excess of background leakage would indicate reactor coolant leakage. The equipment drain sump temperature is also monitored. High temperature would indicate leakage of high temperature water.

Updated FSAR Section 5.2.7.1.3 states that four basic leak detection methods are used to determine sump collection rates. As the water in each of the floor or equipment drain sumps is pumped out, the flow is metered by a flow integrator. Level switches are used to set fill time and pump-out time periods using adjustable reset timing devices. If the nominal pumping out or filling time for a sump is exceeded, an alarm is generated in the control room. In addition, if both pumps are started in order to handle the flow into the sump, an alarm is generated. The sumps are located at the lowest elevation of the drywell area, and there are no areas that can temporarily hold up water that is collected by the sumps.

The licensee stated that the sump level switches are functionally checked during plant operation by manually controlling the pumps, monitoring of the flow integrators, and comparing pumping times.

An increase in primary containment atmosphere temperature would increase the temperature rise in the cooling water passing through the coils of the drywell air coolers. Thus, an increase in temperature difference of the cooling water between inlet and outlet to the air coolers may indicate the presence of reactor coolant or steam leakage. Because the drywell temperature is maintained relatively low, steam leaks will be condensed by contact with the relatively cold surfaces in the drywell. If steam or atmosphere with high humidity enters the cooler units, condensation will occur. The drains from the coolers are collected in the drywell sumps so that the condensation will be detected via the sump leak detection. It is expected that the normal operating humidity will be at or near saturation, which will promote rapid condensation and subsequent detection. Also, a drywell ambient temperature rise above normal may indicate the presence of reactor coolant or steam leakage.

The airborne gaseous sampling system monitors the airspace and has the capability to detect leaks quickly. The licensee stated that radiation monitoring of the primary containment is provided, as required by General Design Criterion 30 of 10 CFR Part 50, Appendix A, and RG 1.45 (Reference 39). The primary containment radiation monitoring system is part of the redundant leakage detection system. The primary containment radiation monitoring system information is used in conjunction with the drywell floor drain sump level indicating system. The licensee stated that it is provided to improve the total drywell leakage detection diversity and sensitivity.

Technical Specification Requirements

Technical Specification Section 3.4.4, “RCS Operational LEAKAGE,” Limiting Condition for Operation (LCO) 3.4.4 requires that RCS Operational LEAKAGE be limited to: (a) No pressure boundary LEAKAGE, (b) ≤ 5 gpm unidentified LEAKAGE, (c) ≤ 25 gpm total LEAKAGE averaged over the previous 24-hour period, and (d) ≤ 2 gpm increase in unidentified LEAKAGE within the previous 24-hour period in MODE 1.

Technical Specifications Section 3.4.6, “RCS Leakage Detection Instrumentation,” LCO 3.4.6 requires the following RCS leakage detection instrumentation be operable: (a) the drywell floor drain sump flow monitoring system; (b) the primary containment atmosphere gaseous radioactivity monitoring system; and (c) the drywell floor drain sump level monitoring system.

The NRC staff determined that Fermi’s RCS leakage detection systems satisfy GDC 30 of 10 CFR Part 50, Appendix A, and RG 1.45 (Reference 39). In addition, the Fermi Technical Specifications impose limits on the leak rate and specific requirement for the operability of the RCS leakage instrumentation. Therefore, the NRC staff finds that Fermi’s RCS leakage detection systems and technical specification requirements provide adequate DID measures to minimize the potential for pipe failure.

3.3.2 Break Selection

For the risk-informed analysis, the NRC staff confirmed that the licensee considered all weld locations in ASME Class-I piping to define possible break locations that could cause a LOCA. The licensee used the CASA Grande software to examine zones of influence of DEGBs, assuming a complete break and full offset of the pipe at each weld location, to compute potential debris amounts. Pipes down to 0.5 inches were included.

3.3.3 Debris Generation

The licensee referred to approved guidance used in support of the debris generation analysis. Guidance from the URG and the associated NRC SE (Reference 9) were used to develop the methods to calculate the amounts of generated debris by postulated pipe breaks. The licensee used a 3D CAD model to automate the calculation of debris amounts. The 3D CAD model tracks locations and volumes of potential debris source types such as coatings and insulation in the reactor containment. Destruction pressures of water jets after a LOCA pipe break and zones of influence (ZOI) for each debris type were also based on the URG. The postulated pipe break locations in the CAD model were based on isometric drawings and ISI records. The results of the debris generation analysis were documented in the licensee’s calculation DC-5979, Rev. A (Reference 40) and Rev. 2 (Reference 41). The debris generation calculation was revised by the licensee to DC-5979, Rev. 2 (Reference 41) (the sequential letter system was replaced by numbers for revision tracking of the DC-5979 document). The updated calculation reflects some incorporated changes that are consistent with updated debris amounts developed during NRC staff’s review of the LAR. Rev. 2 of DC-5979 (Reference 41), Attachment J describes how the loads in Table 2-2 of DC-5979 were developed using the GE methodology for strainer debris limits. Other changes, such as updated limits on miscellaneous debris, are being tracked by the licensee’s corrective action program and will be incorporated in a revision following issuance of the license amendment associated with this LAR.

Except for Min-K insulation and miscellaneous debris (e.g., tags and labels), the debris generation calculation determined that the strainer design basis qualified loads bounded the debris amounts in containment, providing margin in the strainer sizing for most breaks. Only the Min-K and miscellaneous debris were identified with potentially larger sources than the qualified strainer loads.

The licensee provided CAD drawings depicting the locations of the Min-K debris that is the subject of the risk-informed analysis. The licensee also cited RG 1.82 (Reference 28) as guidance for selection of break locations. The risk-informed method chosen by the licensee postulated breaks to occur at all Class 1 welds. The NRC staff concludes that by choosing to model breaks at all ASME Code 1 welds, the licensee met the guidance. The guidance is designed to include inherent safety margins.

The licensee stated that the debris generation analysis assumed a spherical DEGB ZOI for all break scenarios, even for those where pressure would be present on only one side of the break. The licensee also stated that all breaks were assumed to result in DEGB spherical ZOIs assuming the full pipe size even if the breaks would not fully separate or offset due to pipe supports or whip-restraints.

3.3.4 Debris Transport

The licensee stated, and the NRC staff confirmed, that debris transport analysis was performed in accordance with NRC-approved methods in the URG and associated SE (Reference 9) and cited the following levels of conservatism of the risk-informed analysis [(Reference 1), Attachment 3, Section 6.3]:

- All debris that transports to the suppression pool is assumed to arrive there immediately at the start of the event.
- All debris that reaches the suppression pool is assumed to collect on the strainers.
- Pump runout flows are used for rate of debris collection.
- All scenarios are assumed to contribute to core damage as soon as the amount of debris transported to one strainer reaches the design basis thresholds or the 1/8-inch bed thickness threshold.
- The bed thickness threshold to assume strainer failure was chosen conservatively.

3.3.5 Strainer Performance

The licensee stated that the risk-informed analysis examples of conservatism in strainer performance, namely [(Reference 1) Attachment 3, Section 6.3]:

- For the risk-informed analysis, the licensee selected a failure metric for fibrous debris bed thickness of 1/8 inch in the Baseline analyses. When the first strainer accumulates 1/8 inch of fibrous debris, the analyses assumed that all strainers become fully blocked, compromising the ECCS and causing core damage. The licensee stated that the failure metric was conservatively selected based on BWR strainer tests that indicate that 1/8-inch beds are not able to sustain significant pressure drop to fail the strainers. The licensee stated that the qualified load for the strainer results in a debris bed that exceeds 1/8 inch by a significant margin. It is expected that the flow through the strainer would slowly degrade, and the strainer would only fail after a thicker bed had accumulated.
- The strainer is designed to accommodate the design basis qualified loads with sufficient NPSH and structural margin. Most possible debris loads computed with the CASA Grande model are less than the strainer qualified loads resulting in margin, except for Min-K.
- In the risk-informed analysis system, failure and core damage are assumed when debris on one strainer exceeds the assumed failure limits (i.e., 1/8-inch debris bed thickness or the Min-K DB qualified load); however, other strainers with lower debris loads could still support water circulation.

3.3.6 RoverD and Risk

The licensee highlighted aspects of the risk-informed analysis [(Reference 1) Attachment 3, Section 3.6]:

- All isolable pipe breaks greater than 0.5 inches under a scenario for which the inboard valve does not shut are assumed to result in core damage independently of debris generation. Small breaks would not generate enough debris to challenge the strainer.
- The risk-informed analysis for isolable welds assumed a conservative valve failure probability.
- Testing has shown that the strainer design can successfully accommodate loads exceeding 1/8-inch fiber bed thickness. Thus, adopting 1/8-inch fiber bed thickness as criterion for strainer failure is conservative, resulting in a higher predicted ∆CDF.
- The total risk was overestimated due to assigning the full NUREG-1829 LOCA break frequency to the isolable breaks, while also assigning the same full NUREG-1929 frequency to the non-isolable breaks. A lower estimate of the ΔCDF could be attained by proportionally distributing the NUREG-1829 frequency between the isolable and non-isolable breaks.
- The analysis overestimated the probability of one division strainer system (equal to 0.1). The actual probability for conditions leading to one division to be not available is expected to be much lower.
- The ZOI for breaks near penetrations with Min-K insulation is expected to be reduced due to the space crowded with hardware not included in the 3D CAD model, and due to the presence of pipe guards protecting the Min-K. More realistic considerations for Min-K debris generation would lower estimates of Min-K damage near penetrations.

3.3.7 NRC Staff Conclusion Regarding Key Principle 3: Safety Margins

The NRC staff concludes that the applicant considered all relevant ASME Class-I piping welds in its risk-informed analysis, and that safety margin is not affected by this aspect of the risk-informed analysis. The NRC staff also notes that the ASME Class-I RCS piping considered in the debris generation analysis is fabricated with material that is resistant to cracking or mitigated such that catastrophic pipe breaks would not likely occur. If cracking does occur, the RCS leakage detection systems will be able to detect leakage, and the operator is expected to take corrective actions (see Section 3.3.1, “Barriers for Release of Radioactivity” of this SE). The NRC staff determined that the subject piping maintains DID and safety margin because it satisfies the regulations of 10 CFR 50.55a; GDC 1, “Quality Standards and Records”; GDC 14, “Reactor Coolant Pressure Boundary”; GDC 30, “Quality of Reactor Coolant Pressure Boundary”; GDC 31, “Fracture Prevention of Reactor Coolant Pressure Boundary”; and GDC 32, “Inspection of Reactor Coolant Pressure Boundary.” Therefore, the NRC staff concludes that the piping considered in the debris generation analysis maintains sufficient safety margin to minimize the potential for a large break that would significantly affect the ECCS strainer performance.

The NRC staff confirmed that the licensee considered approved guidance such as RG 1.82 (Reference 28) as well as the URG and associated SE (Reference 9) when evaluating debris generation and debris transport. The licensee also used conservative assumptions based on the initial strainer design and other BWR strainer studies to postulate failure metrics for the risk-informed analysis. Therefore, the NRC staff concludes that the proposed approach maintains safety margins and that the licensee’s evaluation included independent margins that help assure that the analysis results in a conservative prediction of risk associated with the impact of debris on the ECCS and CSS.

3.4 Key Principle 4: When Proposed Changes Result in an Increase in Risk, the Increases Should be Small and Consistent with the Intent of the Commission's Safety Goal Policy Statement

This section discusses the licensee's Base PRA model for Fermi, including the calculated total risk values [CDF and LERF] and the licensee's risk-informed assessment of debris. A review of this information was necessary to determine whether the risk attributable to debris is small or very small, and consistent with the Commission's Safety Goal Policy Statement.

3.4.1 Acceptability of the Base PRA Model

Regulatory Position 2.3 of RG 1.174, Revision 3 (Reference 23), states, in part, that the scope, level of detail, and technical adequacy [technical elements] of the PRA are to be commensurate with the application for which it is intended and the role the PRA results play in the integrated decision process.

The acceptability of the PRA is commensurate with the safety implications of the change being requested and the role that the PRA plays in justifying that change. That is, the more the potential change in risk or the greater the uncertainty in that risk from the requested change, or both, the more rigor is placed into ensuring the acceptability of the PRA.

The objective of the NRC staff's review of the Fermi Base PRA model was to determine whether the PRA used in evaluating the risk attributable to debris was of sufficient scope, level of detail, technical elements, and plant representation for this application. The licensee asserted that the Fermi's PRA is compliant with RG 1.200, Revision 2 for internal events and therefore acceptable to support the assessment of the risk of internal events associated with the effects of debris on the ECCS. However, the Fermi PRA model was used in a limited extent to support the risk-informed analysis. The use of the PRA was limited to:

- Providing the internal events CDF and LERF, on the order of 10^{-6} and 5×10^{-7} 1/yr, respectively [Table B-1 of Attachment 3 of (Reference 1)].
- Establishing a valve failure probability to support the screening of breaks downstream of normally closed valves.
- Justifying a CDF-to-LERF multiplier less than 0.1 to estimate a change in LERF (ΔLERF) value for the analysis.

The NRC staff's review focused on the above uses of the licensee's PRA model to evaluate the risk of debris in containment.

3.4.1.1 Scope of the Base PRA (Modes/Hazards)

The licensee evaluated generalized hazards such as internal events, internal floods, internal fires, seismic events, high winds, and external floods [Appendix C of Attachment 3 of (Reference 1)]. The licensee considered full power and low power/shutdown conditions. The licensee concluded the dominant hazards of relevance to the risk-informed evaluation are internal-event LBLOCAs. The licensee concluded that only very large weld breaks in the main reactor coolant piping could generate sufficient debris to threaten strainer performance. Other hazards would not cause LOCAs nor generate sufficient debris for ECCS suction strainer blockage. For example, the licensee concluded that LOCA events at high ground motion are of very low annual frequency and their inclusion would not change ΔCDF estimates. The licensee evaluated full power operation and excluded low power/shutdown operation. The licensee asserted that cold shutdown conditions do not contribute to the risk because low pressure and temperatures precluding damaging LOCA jet streams and lower coolant makeup required to the RPV.

Accordingly, the initiating events addressed in the Fermi risk-informed approach were limited to internal-event LOCAs in the primary RCS under full power operation. The licensee address Class-I welds before and after the first isolation valve.

The NRC staff reviewed the licensee's assessment regarding the scope of the risk-informed analysis (in lieu of a PRA) used to support this application and concludes that: (1) the at-power risk bounds the shutdown risk of debris because debris ZOI is either approximately the same, or significantly higher, at full power RCS pressure and temperature, the flow rate required to cool the core is significantly reduced for low power or shutdown modes, and the pressure of LOCA water jets at full power would generate more debris; and (2) focusing the analysis in internal-event LOCAs is adequate because the risk contribution from other external hazards does not affect the evaluation of the risk attributable to debris.

3.4.1.2 Level of Detail of the Base PRA

Regulatory Position 2.3.2 in RG 1.174 states that the level of detail required of the PRA is that which is sufficient to model the impact of the proposed change. The characterization of the problem should include establishing a cause-effect relationship to identify portions of the PRA affected by the issue being evaluated.

The NRC staff reviewed the licensee's description of its Base PRA and concludes that the level of detail of the licensee's Base PRA is appropriate to evaluate the risk attributable to debris from strainer, along with the associated LOCA initiating events. Furthermore, the licensee-implemented peer reviews that follow ASME/ANS standards and Nuclear Energy Institute (NEI) guidance, and these reviews did not identify issues that would affect the risk-informed evaluation.

3.4.1.3 Base PRA Technical Elements

RG 1.200 (Reference 29) describes one approach for determining whether the PRA, in total or the parts that are used to support an application, is acceptable such that the PRA can be used in regulatory decision-making for light-water reactors. RG 1.200 endorses, with comments and qualifications, the use of the ASME/ANS RA-Sa-2009 PRA Standard; NEI 00-02, Revision 1, "Probabilistic Risk Assessment Peer-review Process Guidance" (Reference 42) and; and NEI 05-04, Revision 2, "Process for Performing Follow-On PRA Peer-reviews Using the ASME PRA Standard" (Reference 43).

The NRC staff relied on the peer-review findings and reviewed the key assumptions in the licensee's PRA in its determination of the acceptability of the technical elements of the Base PRA model. The ASME/ANS PRA Standard provides technical supporting requirements in terms of three capability categories (CCs). The intent of the delineation of the capability categories within the supporting requirements is generally that the degree of scope and level of detail, the degree of plant specificity, and the degree of realism increase from CC-I to CC-III. In general, the NRC staff anticipates that current good practice (i.e., CC-II of the ASME/ANS Standard) is adequate for most applications. The licensee concluded its Base PRA to be CC-II [Appendix B of Attachment 3 of (Reference 1)]. Consistent with the guidance in RG 1.200 and RG 1.174 for this application of the Fermi PRA to assess the risk associated with debris-related phenomena, the NRC staff considered CC-II to be adequate.

3.4.1.3.1 Fermi Internal Events PRA

The licensee performed peer-review of PRA models according to RG 1.200, Revision 2 endorsed guidance consistent with NRC RIS 2007-06. The review and closure of finding-level Facts and Observations (F&Os) was performed by an independent assessment team using the process documented in Appendix X to NEI 05-04, NEI 07-12 and NEI 12-13, "Close-out of Facts and Observations" (F&Os) as accepted by the NRC in a letter dated May 3, 2017 (Reference 44). The reviews also met the requirements of NEI 17-07, Revision 2, "Performance of PRA Peer Reviews Using the ASME/ANS PRA Standard" (Reference 45). The licensee provided the evolution of CDF and LERF values output by the PRA model since 1989 up to the most recent update in 2021, which is contained in Table B-1 of Appendix B of Attachment 3 of (Reference 1). The licensee also briefly described PRA model changes over the years and the F&Os resolution process. The licensee asserted that all F&Os have been closed, based on independent assessments using the NEI guidance. The licensee concluded that the Fermi PRA scope and technical adequacy meets the ASME/ANS PRA Standard requirements at CC-II. The resolved findings and the basis for resolution are documented in the Fermi PRA documentation and the F&O Closure Review reports.

Based on the licensee-implemented peer reviews following ASME/ANS standards and NEI guidance, as well as the CC-II classification of the internal events PRA, the NRC staff concludes that the Fermi internal events PRA is adequate to support the risk-informed assessment.

3.4.1.3.2 Fermi Seismic PRA

The licensee asserted that the primary system at Fermi is generally rugged and robust against design seismic loads. In response to the Near-Term Task Force 2.1, DTE re-evaluated the seismic hazard (Reference 46), and the NRC staff concluded that changes to the seismic hazard profile for Fermi were not significant with respect to the design basis, and that plant-specific seismic PRA (SPRA) was not required (Reference 47). The licensee stated that the combination of low seismic hazards at Fermi and the generally rugged Nuclear Steam Supply System (NSSS) piping make seismic-induced large LOCAs to contribute negligibly to the ΔCDF associated with debris related processes [Appendix C of Attachment 3 of (Reference 1)].

The NRC staff concludes that it due to the low seismic hazard and rugged construction of the RCS, the risk due to seismic induced LOCA is very low. Therefore, it is acceptable to exclude seismic-induced LOCAs from the risk-informed assessment.

3.4.1.4 Plant Representation

RG 1.174, Revision 3, states that at the time of the application, the PRA should realistically reflect the risk associated with the plant.

The NRC staff concludes that the licensee's PRA model adequately represents the as-built and as-operated plant to the extent needed to support the risk assessment because the licensee's PRA maintenance procedures include an ongoing review of design and procedure changes for their impact on the PRA model, and PRA data or inputs are reviewed and updated, as necessary, on a periodic basis.

3.4.1.5 NRC Staff Conclusion Regarding the Base PRA Model

The NRC staff concludes that the Fermi Base PRA model used in support of the licensee's risk assessment is acceptable (e.g., has the appropriate scope, level of detail, technical elements, and plant representation) to evaluate the risk attributable to debris because the licensee applied approaches consistent with the guidance in RG 1.174 (Reference 23), and RG 1.200 (Reference 29).

3.4.2 Risk-Informed Approach for Addressing the Effects of Debris on Long-Term Core Cooling

The licensee implemented simplified computations, using limited information from the internal events PRA, and combined those computations with traditional engineering analyses to estimate the risk attributable to debris. This integrated analysis is referred to as the "systematic risk assessment."

3.4.2.1 Scope of the Systematic Risk Assessment

This section describes the specific approach used by the licensee to determine all relevant initiating events for which debris could adversely affect the CDF or LERF. This includes how relevant scenarios (i.e., an initiating event followed by a plant response leading to a specified end state, such as event prevention, core damage, or large early release) that could be mitigated by the activation of the ECCS were identified and considered in the systematic risk assessment.

In the letter dated June 13, 2023 (Reference 1), the licensee provided information regarding the scope of its systematic risk assessment that employed a screening process to eliminate scenarios that were deemed not relevant, not affected by debris, not requiring RHR or CSS injection, or having an insignificant contribution based on the identified failure modes. Screening is a common practice in quantitative risk assessments, and one acceptable approach is discussed in NUREG-1855, Revision 1 (Reference 48). Specifically, NUREG-1855, Revision 1 describes assessment of model and completeness uncertainty, including the identification of sources of uncertainty that are not related to either the parts of the PRA used to generate the results or the significant contributors to the results, and the use of screening and conservative analyses to address non-significant contributors. RG 1.174 recognizes that a screening approach "allows the detailed analysis to focus on the more significant contributions." Information pertaining to the licensee's initial plantwide and location-specific screening approach is described in the following subsections.

3.4.2.1.1 Initial Plant-Wide Screening

The initiating events considered in the licensee's risk-informed analysis included those with the potential to: (1) generate debris inside containment, (2) require ECCS and CSS recirculation from the suppression pool for mitigation of the event, and (3) result in debris transport to the strainers (Reference 1).

The licensee considered only scenarios that required flow through the RHR or CSS strainers, since without flow, there is no potential for debris-related failures of the strainers or ECCS. The licensee considered the following generalized hazards [Appendix C of Attachment 3 of (Reference 1)]:

- Internal Events
- Internal Floods
- Internal Fires
- Seismic Events
- High Winds
- External Floods
- Other Hazards

The licensee excluded hazards such fires, high winds, external floods, and other hazards, because they do not cause LOCA events that generate sufficient debris for ECCS suction strainer blockage. The licensee excluded seismic hazards based on low seismic hazards at Fermi and robust and rugged NSSS. The licensee concluded the only hazards relevant to the risk assessment are the internal events.

The licensee also considered full power and low power/shutdown conditions. Under full power conditions, the types of accidents from an internal events PRA model that could lead to core damage include [Appendix C of Attachment 3 of (Reference 1)]:

- Transient challenges to RPV makeup
- Loss of DHR
- LOCAs (small, medium, large LOCAs, and RPV rupture)
- Reactivity accidents (ATWS)
- Interfacing-system LOCA (ISLOCA)
- Breaks outside containment (BOCs)

The licensee excluded low power/shutdown conditions, based on low pressures and temperatures of the system, requiring lower makeup to the RPV, and low energy of jets to generate debris that could be transported to strainers. The licensee stated that it is unlikely to need ECCS makeup in case of a LOCA under low power/shutdown conditions.

The licensee concluded that the only initiating events of relevance to the risk-informed assessment were RCS pipe breaks causing LOCAs. The licensee excluded most initiating events based on reduced flows required to compensate the water inventory compared to equivalent flows in strainer tests, and location of breaks away from significant insulation sources.

The piping attached to the RCS at Fermi includes welds in ASME Class-I piping downstream of normally closed valves. The risk of these breaks is dependent on failure of the upstream valve function, which the licensee estimated to be 3.26×10^{-4} per demand, consistent with information in the internal events PRA model. The licensee estimated the contribution to the ΔCDF, treating the set of isolable welds as an independent set and conservatively distributing the NUREG-1829 LOCA frequency among those welds alone (i.e., ignoring the pipes upstream of the isolation valve).

The NRC staff reviewed the licensee’s screening approach and concludes that the approach is technically sound and consistent with state-of-practice approaches. The licensee demonstrated that the scenarios screened from the risk-informed analysis either would not result in the generation of significant quantities of debris, or were so unlikely that they would not contribute significantly to the risk calculated in the analysis. The staff verified that the licensee's conclusions were reasonable and that the quality of the information and evaluation of the screened scenarios was acceptable. Therefore, the NRC staff concludes that the results of the plantwide screening adequately reflect initiating events relevant to the licensee's systematic risk assessment of debris related phenomena.

3.4.2.1.2 Location-Specific Screening

For LOCA events, the effects of debris are dependent on the location of the initiating event and debris sources. Accordingly, the licensee completed a location-specific analysis to identify accident sequences that could be adversely impacted by debris. Based on initial screening results, the licensee performed a quantitative analysis of LOCA DEGBs on pipes ranging from one half inch to the largest pipe on RCS Class-I ISI welds. The licensee identified 1103 ISI welds that could result in a LOCA. The total set was reduced to 924 locations that could result in LOCAs with the plant at power operation. The reduction from 1103 to 924 was based on the system design and operation, including welds that are normally isolated during power operation. Within the population of 924 welds that could cause LOCAs, the licensee identified 37 welds that would be automatically isolated following a LOCA (isolable welds). A total of 887 welds (non-isolable welds) were evaluated for debris generation and transport due to a DEGB LOCA. The 887 non-isolable and 37 isolable welds were treated differently in the risk assessment.

The 37 isolable welds are protected by automatic isolation valves (i.e., these welds become isolated from the RPV after closure of the isolation valve). The licensee conservatively computed the increase in risk (ΔCDF) associated with LOCA breaks in the isolable welds as the product of the probability of the valve to fail to close (probability 3.26×10^{-4} per demand) times the frequency of a break exceeding 0.5 inches (frequency from NUREG-1829). This computation is conservative because it assumes that the strainer and the ECCS would fail for any 0.5-inch LOCA break independently of the debris generated, after failure of the inboard valve to close. For the 887 non-isolable welds, the licensee computed the increase in risk using a more detailed approach, described in the following paragraphs.

The licensee proposed that any LOCA break that generates and transports fibrous debris to the strainer forming a bed at least 1/8-inch thick could be assumed to cause strainer failure and core damage. Breaks that produce less than 1/8-inch bed thickness of fibrous debris on the strainer were considered to not challenge the RHR and CSS strainers. In addition, all non-isolable breaks that generate debris exceeding the strainer qualified load of Min-K are assumed to cause strainer failure and core damage.

The debris bed thickness criterion was established conservatively based on BWR strainer studies (see Section 3.3.5, "Strainer Performance" of this SE). The debris bed thickness criterion is significantly less than the estimated debris bed thickness based on the qualified LDFG debris loads spread over the limiting strainer alignment (single division operating) following a LOCA.

In order to estimate volumes of debris generated from each potential break location, the licensee developed a CAD model of containment and incorporated the CAD model in the CASA Grande model. The CAD model included locations of each potential break location (welds in the RCS) and locations of debris sources that could be damaged by a LOCA jet. The licensee calculated the volume of the fibrous and Min-K insulation debris that would transport to the strainer, considering the debris types generated by each break. All breaks were assumed to be

DEGBs. For each DEGB location, the volume of the debris generated and transported was computed, including volumes of fibrous and Min-K debris. The licensee assumed that Min-K debris contributed to the debris bed thickness, for comparison to the 1/8-inch failure criterion.

In NVIB-RAI-1 (Reference 2), the NRC staff asked the licensee to explain how 1103 potential LOCA weld break locations were reduced to 924 locations. The NRC staff also asked the licensee to clarify whether 884, 924, 921, or 1103 welds are considered in the scope of the LAR (i.e., in-scope welds).

In its response to NVIB-RAI-1, dated April 24, 2024 (Reference 2), the licensee stated that the purpose of identifying “active” LOCA locations on welds is to locate the center of damage zones that can generate debris if the weld ruptures. Welds not carried forward for analytic quantification are deemed to have negligible contribution to the risk of ECCS failure caused by debris sources. The licensee explained that candidate break locations started with ISI welds identified on isometric drawings. Of the candidate locations, the licensee further evaluated welds based on location relative to valves and on system configuration, with the purpose of confirming whether failure could result in ECCS suction strainer clogging. The selection process is documented in Appendix D of Attachment 3 to the June 13, 2023, letter (Reference 1), which includes the full list of Fermi welds evaluated and the valve positions during normal operation. The licensee stated that some welds in the initial set are outside of containment or downstream of normally closed isolation valves, which were thus removed from further consideration. The licensee stated that it also removed HPCI and RCIC steam line hanger support welds from the risk quantification. Of the welds selected for risk quantification, 37 welds are protected by automatic isolation valves (isolable) and 887 are analyzed as non-isolable, including 3 main steam (MS) Drain Line welds that could be screened out from further consideration but were conservatively left in the analysis.

In response to NVIB-RAI-1, the licensee stated that it defines “in-scope” welds to include 37 that are protected by automatic isolation valves (isolable) and 887 analyzed as non-isolable (including the 3 MS Drain Line welds). The total number of “in-scope” welds (924) was considered as two sets, isolable and non-isolable, for the purpose of risk quantification.

The NRC staff questioned whether failure of flanges and bolts of a piping system, and nozzle penetrations to the reactor vessel such as CRD mechanisms and standby liquid control systems are considered as potential LOCA locations in the risk analysis. In its response to NVIB-RAI-7, dated April 24, 2024 (Reference 2), the licensee stated that mechanical couplings are not included as potential LOCA locations, because: (1) the spatial coverage of welds that are included in the analysis is considered sufficient to capture potential debris generation that might occur near failed couplings, (2) NUREG-1829 specifically excludes mechanical couplings, so assigning NUREG-1829 break frequency to couplings would artificially reduce or “dilute” the intended weld break frequency, (3) mechanical couplings having multiple physical connection points are not readily susceptible to large catastrophic pressure release as could occur for a DEGB of a weld, and (4) multiple bolt failures on a flange needed to create an equivalently sized large break significantly reduce the estimated event frequency compared to a weld failure of the same size. The licensee stated that nozzle penetrations such as CRD mechanisms and the standby liquid control system are also not included as potential LOCA locations for similar reasons as those described for mechanical couplings. The licensee further stated that nozzle connections having proper structural integrity are assumed to be more mechanically robust than other RCPB welds. This results in negligible comparative break frequency and a longer expected service life of these components. The NRC staff finds that the licensee provided reasonable explanations for excluding flanges, bolted connections, and nozzle penetrations from consideration as potential LOCA locations.

In response to NVIB-RAI-2 (Reference 2), the licensee clarified that Class 2 welds are not considered as in-scope welds in the Fermi LAR as locations for a LOCA, because they are located generally on low-energy systems having minimal debris generation potential and, therefore, negligible risk contribution via ECCS strainer obstruction.

Treatment of normally closed isolation valves were also examined by the licensee and were determined to be of low risk consequence.

The NRC staff reviewed the licensee's location-specific screening evaluation and concludes that the licensee identified all locations that could result in a failure of the RHR or CSS functions because the full spectrum of possible break locations was considered and systematically assessed for potential effects on the calculation of debris amounts generated and transported to the strainers.

<u>NRC Staff Conclusion Regarding the Scope of the Systematic Risk Assessment</u>

The NRC staff reviewed the scope of the systematic risk assessment and finds it adequate because the licensee employed a systematic screening process using initial plant-wide and location-specific screening approaches to identify relevant scenarios and also eliminate scenarios that do not affect the risk assessment, in a manner consistent with state-of-practice approaches described in NUREG-1855, Revision 1 (Reference 48). The licensee included all scenarios and initiating events relevant to the evaluation.

3.4.2.2 <u>Initiating Event Frequencies</u>

The licensee implemented a simplified computation of the ΔCDF, considering the geometric mean aggregation exceedance LOCA frequencies in NUREG-1829 Table 7.19 (Reference 22), and not relying on the internal-events PRA model. NUREG-1829 provides exceedance frequencies at discrete break sizes, which is the annual probability of having a specified break of a given size or larger. The licensee considered end-of-plant-license estimates corresponding to 25 years of operation, with 25-year operation data selected in the Baseline analyses.

For the calculation of ΔCDF, the LOCA frequencies were uniformly allocated to individual pipe welds using a top-down distribution methodology considering only DEGB. The top-down LOCA frequency allocation methodology treats all DEGB of pipes of the same diameter as having an equivalent LOCA frequency, regardless of the weld location, operation conditions, and specific degradation mechanism (i.e., every DEGB is assumed equally likely).

The licensee used a linear interpolation scheme (i.e., linear interpolation between break sizes and between frequencies) to determine exceedance frequencies for DEGB dimensions not explicitly listed in NUREG-1829. The guidance in NUREG-1829 states that interpolation may be used but does not specify use of any one interpolation scheme. The NRC staff concludes the licensee's use of linear interpolation of NUREG-1829 data is acceptable because it overestimates the ΔCDF compared to alternative and acceptable interpolation approaches such as log-linear interpolation [log-scale in LOCA frequencies and linear-scale in break sizes or pipe diameters (Reference 35)].

NUREG-1829 guidance contains "25-year" or "current" LOCA frequencies and "40-year" or "end of license period" LOCA frequencies. For most LOCA types, the 40-year values are slightly higher due to anticipated aging effects and the possibility of new degradation mechanisms. In some cases, however, the 40-year values are lower, reflecting an expectation that improved mitigation techniques will lower LOCA frequencies. Fermi was initially licensed in 1985, with full commercial operation initiated in 1988. Fermi has been operating for more than 30 years. For the Baseline analyses, the licensee selected LOCA frequencies in NUREG-1829 corresponding to 25 years of operation, which the NRC staff determined is reasonable because the 25-year and 40-year NUREG-1829 exceedance frequencies are very similar under the expert elicitation geometric mean aggregation method. The 25-year exceedance frequencies are higher for breaks less than 18 inches in the arithmetic mean aggregation method, and very similar for larger breaks.

The NUREG-1829 guidance provides LOCA frequencies that are based on a formal expert elicitation process. Several aggregation schemes are presented in NUREG-1829 that combine, or aggregate, the inputs of the individual experts into a single set of frequencies that can be used for decision-making. The two primary aggregation schemes are the geometric mean (GM), and simple average or arithmetic mean (AM). Because alternate aggregation methods can lead to significantly different results, NUREG-1829 states that different methods may be appropriate for different applications and recommends that multiple methods and sensitivity studies be considered when selecting an aggregation method. The licensee considered GM aggregation NUREG-1829 LOCA frequencies in the Baseline quantifications of the ΔCDF, which is consistent with recommendations and observations in NUREG-1829. The licensee argued that AM aggregation produces exceedance frequencies biased by the expert with the highest estimate, instead of producing a consensus estimate (Reference 4). Nonetheless, the licensee considered AM aggregation in sensitivity analyses to address uncertainty in LOCA frequencies. The AM aggregation frequencies were obtained from NUREG-1829, Table 7.13 (Reference 22).

The licensee summarized ΔCDF results in Table 5-4 of Attachment 3 in its LAR (Reference 1) and provided updated values in Attachment 4 of the supplements dated May 30, 2024 (Reference 3), and October 31, 2024 (Reference 4). The licensee's approach for evaluating the impact of the aggregation method is consistent with recommendations in NUREG-1829. The NRC staff reviewed the licensee's sensitivity analysis and concludes that the licensee identified and dispositioned key assumptions and sources of uncertainty in its systematic risk assessment consistent with the guidance in RG 1.174. The staff's review of this topic is discussed in Section 3.4.2.9, "Systematic Risk Assessment" of this SE.

<u>NRC Staff Conclusion Regarding Initiating Event Frequencies</u>

The NRC staff reviewed the licensee's information on initiating events and concludes that the initiating event frequencies selected by the licensee for this evaluation are acceptable because:

- LOCA break frequencies were obtained from NUREG-1829, which is considered to be the most current source of information available.
- The licensee interpreted the NUREG-1829 data in a manner consistent with the guidance in NUREG-1829.
- The licensee's use of GM aggregation exceedance frequencies from NUREG-1829 for Baseline computations is consistent with Baseline analyses in precedent submittals addressing the risk of debris interacting with the ECCS, including the STP pilot program (Reference 13).

- The licensee performed sensitivity analyses to examine the selection of NUREG-1829 exceedance frequencies from AM and the GM aggregation methods, which is consistent with precedent submittals including the STP pilot program (Reference 13).

- In previous submittals addressing the risk of debris interacting with the ECCS, the ΔCDF which was computed assuming pipes exhibit only DEGB was generally greater than or comparable to the ΔCDF computed with models assuming pipes with a series of partial breaks up to the DEGB limit [e.g., (Reference 13,34)].

3.4.2.3 Scenario Development

For the purposes of this SE, the term "scenario" means an initiating event followed by a plant response such as a combination of equipment successes, failures, and human actions leading to a specified end state, such as successful event mitigation, core damage, or large early release.

The licensee considered system response to a LOCA break in the presence of debris. In the CASA Grande model, fiber and Min-K debris amounts were concluded to be the limiting debris types that may challenge the strainer function. The computation of fiber accumulation on the strainers accounted for miscellaneous debris (e.g. tags and labels) that could occlude the active strainer area; and it was conservatively assumed that tags and labels accumulated on strainers first before the fiber. Other debris types (i.e., particulates and sludge) were addressed by including bounding amounts in the strainer qualification. As described in Section 2.1, "Description of Affected Structures, Systems and Components" of this SE, the Fermi system includes two independent ECCS and CSS trains which take suction via strainers from the suppression pool. The CASA Grande model was aimed at the computation of debris quantities for postulated DEGBs and transported debris that are released into the suppression pool.

The licensee defined a Baseline case based on a one division system, with two strainers drawing flow from two RHR pumps and one strainer drawing flow from two CS pumps. The licensee assigned a probability to the one division system equal to 10 percent, based on a bounding probability of failure per demand of a single pump. The licensee assigned a complementary probability of 90 percent to the two-division system with six active strainers. However, results of the two-division system were also based on a one division system, which the licensee justified as a system with all functional pumps and strainers but with throttled flow circulating only through strainers of one division.

In the sensitivity analysis, the licensee considered several pump configurations with different active pumps and strainers, including scenarios with throttled flow and restored flow at different times. To compute debris accumulation on strainers, the licensee assumed that after a LOCA break, debris is discharged to the suppression pool in a very short time. Debris then accumulates on the active strainers at a rate proportional to the flow rate though the strainers and the debris concentration in the pool (i.e., debris mass divided by pool volume), with debris assumed perfectly mixed in the suppression pool. The licensee conservatively assumed debris accumulates on strainers, ignored the potential for debris penetrating strainers and passing downstream, and ignored settling of debris in the suppression pool. The licensee solved numerically the differential mass-balance equations for debris accumulation on strainers and debris depletion from the suppression pool using MATLAB. The solution to these equations yields the accumulated strainer debris load versus time, and the final fraction of debris loads in the different strainers after the pool is depleted. For a system with constant flow rates, this final fraction is simply the fraction of the total flow rate passing through that strainer. The licensee used the debris load versus time to compute the time at which the debris load exceeded failure criteria (i.e., 1/8-inch bed thickness, or the Min-K design basis load). The computation of the failure time by 1/8-inch bed thickness exceedance accounted for miscellaneous debris (e.g., tags and labels) blocking a portion of the active strainer area before arrival of the fiber. Also, in the computation of the fiber bed thickness, the licensee assumed that Min-K contributed to fibrous debris. In the letter dated October 31, 2024 (Reference 4), the licensee provided updated risk estimates for: (i) breaks solely exceeding 1/8-in fibrous debris bed thickness, (ii) breaks solely exceeding the Min-K design basis, and (iii) breaks exceeding both failure criteria, with and without accounting for 25 percent reduction of penetration Min-K. The NRC staff reviewed these changes and concluded that the licensee properly accounted for different scenarios contributing to the system risk measured as DCDF. The risk estimates in the final supplement dated October 31, 2024 (Reference 4), superseded risk estimates in prior documents of the LAR (Reference 1,2,3).

The licensee excluded other initiating events causing different scenarios. See Section 3.4.2.1.1, "Initial Plant-Wide Screening" of this SE.

NRC Staff Conclusion Regarding Scenario Development

The NRC staff evaluated the licensee's scenario development process and results and concludes that the licensee adequately evaluated the relevant scenarios potentially causing strainer failure. Specifically, the NRC staff confirmed that the licensee considered models greatly simplifying the description of the system response. The NRC staff also confirmed that the licensee used a systematic process to identify germane operating components and states, and properly considered the period of performance in the risk-informed analysis.

3.4.2.4 Failure Mode Identification

The licensee evaluated potential debris amounts reaching the strainers and concluded they are less than qualified amounts for the strainer, with two exceptions. The only two debris types that can exceed the qualified debris amounts are Min-K and miscellaneous debris (e.g., tags and labels that can block and reduce the strainer area). The licensee assumed that any scenario that was bounded by the design would not fail due to debris effects. Cases that exceeded the qualified debris amounts were assigned to strainer failure states for the purpose of quantifying DCDF.

The increase in miscellaneous debris can block a portion of the strainer area, which could increase the concentration of debris on the active strainer area. To quantify DCDF, the licensee established a practical strainer failure criterion, corresponding to a bed thickness limit of LDFG. Cases of DEGB generating debris exceeding the limit were considered scenarios of strainer failure and core damage. The bed thickness limit was set at 1/8 inch. The licensee stated that BWR strainer studies had demonstrated that at bed thicknesses of 1/8 inch and less the debris bed would not develop significant head loss. The licensee also demonstrated that the design basis qualified debris load would result in a debris bed significantly greater than 1/8 inch, even when considering the qualified amounts of miscellaneous debris blocking a portion of the strainer area. Therefore, the qualified debris load bounds the bed thickness limit. The licensee also stated that the qualified debris amounts were developed considering potential combinations of debris types reaching the strainer so that the qualified load is bounding for debris beds up to the maximum bed thickness in development of the qualified loads. That is, the composition of the debris bed will not cause strainer failure as long as debris types are within their qualified limits.

To assess the potential for failures due to Min-K, the licensee simply compared the calculated debris generation amount for each DEGB to the qualified debris load for Min-K. As stated previously, the qualified debris amounts were established considering the potential types of debris reaching the strainers at their maximum amounts. It was assumed that strainer failure due to Min-K would not occur if the debris load was less than the qualified Min-K load.

A few breaks at specific locations that can be isolated by automatic isolation valves, can generate Min-K debris in excess of the qualified load. LOCAs from these breaks were assumed to be mitigated if the valve successfully isolated the break. Otherwise, isolable breaks greater than 0.5 inches were conservatively assumed to cause strainer failure and core damage.

The following are potential failure modes considered in the risk-informed analysis for the Fermi strainers:

a. Excessive headloss at the strainer leads to loss of NPSH for adequate operation of the pumps.

b. Excessive headloss at the strainer causes mechanical collapse of the strainer.

c. Excessive headloss at the strainer lowers the fluid pressure, causing release of dissolved gases (i.e., degassing) and void fractions in excess of pump limits. Vortexing and flashing may also cause pump failure due to excessive void fraction in the fluid.

d. Debris results in core blockage, and decay heat is not adequately removed from the fuel.

e. Debris buildup on cladding results in inadequate decay heat removal.

The strainer failure modes a, b, and c are assumed not to occur if the debris load meets the design limits and the bed thickness criterion.

The failure modes d and e were evaluated separately in a BWROG analysis and it was determined that the BWR design would provide adequate core cooling considering the designs of the core, the RHR, the CSS, and the effects of debris on cooling of the fuel (Reference 19). The NRC staff evaluated the BWROG analysis and found it to be acceptable (Reference 20).

NRC Staff Conclusion Regarding Failure Mode Identification

The NRC staff evaluated the licensee's analysis and the potential failure modes identified by the NRC staff. The NRC staff determined that the potential failure modes that could reasonably lead to debris-induced failure of the ECCS were bounded by the licensee's analysis. Therefore, the NRC staff concludes that the licensee adequately evaluated the potential for failure in its evaluation.

3.4.2.5 Changes to the Base PRA Model

The licensee used the Fermi PRA model of record as the source of the base CDF and LERF values. The Fermi PRA model was not modified to incorporate initiating events for the risk-informed analysis. The licensee performed the risk quantification outside the PRA model, conservatively assuming specific equipment configurations.

NRC Staff Conclusion Regarding Changes to the Base PRA Model

The NRC staff reviewed the information provided by the licensee and concluded that the Fermi PRA is of adequate quality. Therefore, use of the Fermi PRA model of record, without changes, is acceptable to provide supplementary information required by the risk-informed assessment implemented by the licensee.

3.4.2.6 Debris Source Term Submodel

This section describes the debris that may be generated during an initiating event or may be present in the containment prior to the event. This section is simplified from typical PWR risk-informed analyses to focus only on the changes that could result in debris amounts greater than those qualified in the strainer design analysis. It includes a description of the debris characteristics that may transport to the strainers and affect the ability of the RHR and CSS to perform their functions. Since the licensee is maintaining its qualified debris load limits, the NRC staff found that it is not necessary to evaluate the bases for the amounts of debris types that are unchanged. These include coatings, sludge, fibrous debris, and latent debris. Only miscellaneous debris and Min-K have been identified with amounts greater than those currently qualified for the strainers.

The licensee used its strainer design qualification to determine bounding amounts of debris generated that could be accommodated by the strainer. The most recent debris generation and transport analysis found that the amounts of all types of debris predicted to reach the strainers are equal to or reduced from the qualified design limits, except for Min-K and miscellaneous debris (Reference 40,41). As described previously, the licensee assumed that LOCA break scenarios that can result in a fiber bed thickness greater than 1/8 inch are assumed to cause strainer failure and core damage. Also, for Min-K, all cases that generate more than the design limit for Min-K and are not automatically isolated (to eliminate the LOCA flow) are assumed to fail. The strainer failure scenarios are assumed to contribute to ΔCDF. The qualified strainer limit for Min-K is 9.5 lb while the maximum amount generated by non-isolable breaks was stated to be 5.9 lb in the initial LAR. The licensee used 5.9 lb as the Min-K limit for the Baseline evaluations and performed a sensitivity case with the limit set at 9.5 lb. The qualified allowance for tags and labels is 6 ft^2 of circumscribed area, or 63.5 ft^2 of strainer flow area. The amount of miscellaneous debris in containment is 87 ft^2, equivalent to 65.25 ft^2 when accounting for 25 percent overlap. However, the licensee assumed 100 ft^2 of blocked strainer flow area in its analysis. This equates to about 133 ft^2 of non-overlapping miscellaneous debris installed in the containment. RMI was not evaluated in the risk-informed analysis because it is treated separately from other debris in the strainer design. The amount of RMI that may transport to the strainer is bounded by the initial strainer qualification.

In the letter dated October 31, 2024 (Reference 4), the licensee stated that there are 30 breaks that exceed the Min-K debris limit of 5.9 lb on an RHR strainer, 66 breaks that exceed the 1/8-inch fiber threshold, and 104 breaks that exceed both limits. This results in 200 breaks total that exceed the limits, with 134 of them exceeding the Min-K limit, without crediting 25 percent of penetration Min-K reduction. For the case crediting 25 percent penetration Min-K reduction, 30 breaks exceeded the Min-K debris limit of 5.9 lb, 74 exceeded the 1/8-inch fiber threshold limit, and 94 breaks exceeded both limits.

The licensee conducted a debris generation evaluation that considered the sources of debris that may affect system performance. The debris generation evaluation included cases for all Class I welds that could result in a LOCA and were not screened from consideration. The evaluation considered hundreds of welds and assumed DEGBs at each weld. All non-isolable breaks computed to generate, transport, and load more Min-K on a single strainer than qualified limit, and all breaks that result in a fibrous debris bed on the strainer greater than the 1/8-inch limit are assumed to cause strainer failure and core damage. Isolable breaks greater than 0.5-inches are assumed to cause strainer failure if they are not automatically isolated by an upstream valve.

3.4.2.6.1 Break Selection

This section describes the licensee's process to identify the break sizes and locations that present the greatest challenge to post-accident ECCS and CSS strainer performance. The licensee provided a summary of the break selection process [Attachment 3 of (Reference 1) and Attachment 4 of (Reference 3)], as well as the method to address debris generation and zone of influence [Attachment 3 of (Reference 1)]. The licensee also considered other potential initiating events (e.g., debris generation locations), which were excluded from the systematic risk assessment or were not explicitly considered in the break selection process. The licensee evaluated LOCA breaks at all weld locations in ASME Class-I piping.

The licensee implemented a simplified risk-informed analysis relying on the CASA Grande software, considering a DEGBs at all welds in Class-I piping. The CASA Grande model uses a Fermi CAD model as input to identify weld locations and insulation distributions throughout containment. Debris amounts are computed in the CASA Grande software based on a ZOI concept. All other debris sources such as latent debris, qualified and unqualified coatings, sludge, and miscellaneous debris were assumed to be at the maximum qualified value for all breaks.

The licensee assembled a three-dimensional CAD model of the Fermi drywell, tracking the as-built insulation configuration. The CAD model was used as input to the CASA Grande software to calculate insulation debris quantities for each postulated break. CASA Grande implemented a ZOI concept to compute the amounts of debris generated. The ZOI represents the zone, or volume in space, where a two-phase jet from a high-energy line break can generate debris that may be transported to the suppression pool and strainers. The size of the ZOI is defined in terms of pipe diameters and is experimentally determined based on the system pressure and the destruction pressure of the insulation material impacted by the jet. Higher system pressures result in increased ZOIs. Robust insulation materials have smaller ZOIs than fragile materials. The licensee considered each circumferential butt weld as a postulated break location and assumed a DEGB at each location.[1] The amounts of fibrous and Min-K debris for each postulated break were computed and compiled in a database generated by CASA Grande.

The licensee stated that the Fermi debris generation analysis was performed in accordance with the NRC-approved methodology of the URG (Reference 9).

NRC Staff Conclusion Regarding Break Selection

The NRC staff concludes that the break selection evaluation is acceptable because the licensee evaluated all welds on ASME Code Class-I pipes that can result in a LOCA. Although the URG guidance approved by the NRC states that the licensee should evaluate all pipe locations for potential rupture (Reference 9), the staff concludes that the licensee's evaluation of piping only

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[1] A DEGB is a break of size equal to the pipe diameter, with a full pipe offset. The ZOI was assumed to be spherical and centered at the axis of the pipe at the break location.

at welds is acceptable because the weld locations adequately represent the potential debris generation of all breaks and are more likely break locations, consistent with recommendations in NUREG-1829 (Reference 22). The NRC staff reviewed the licensee's programs that help to assure the RCS piping does not degrade such that a piping rupture would occur, and the staff found these programs to be adequate.

The NRC staff concludes that the break selection process and criteria are acceptable because the licensee identifies a number of postulated LOCAs of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated LOCAs are calculated as part of an acceptable evaluation model as required, in part, by 10 CFR 50.46.

The NRC staff confirmed that the licensee provided a basis for the use of the break selection process in the overall evaluation of change in risk due to LOCAs. The staff further confirmed that the licensee evaluated all Class-I welds as potential break locations, and determined the locations that could exceed the acceptance criteria (i.e., fiber bed thickness or Min-K limit). The staff finds that the licensee accurately computed the ΔCDF accounting for the break frequency and assuming core damage for breaks exceeding the acceptance limits. Therefore, the NRC staff concludes that the break selection methodology is acceptable to support estimates of risk.

3.4.2.6.2 Debris Generation and ZOI Submodels

The licensee defined the ZOIs for Min-K and fibrous insulation using NRC-approved guidance in the URG and SE (Reference 9). The ZOIs are listed in (Reference 1), Attachment 3, Table 2-3. The licensee adopted debris size distributions for the insulation based on URG guidance (Reference 40) The licensee calculated the amounts of fibrous and Min-K debris that could be generated from each postulated break. To compute the probability of strainer failure, the licensee compared the computed fibrous debris amounts for each postulated break that accumulate on the strainer to a debris bed limit that is conservative based on the strainer qualified debris loading and other BWR strainer studies. The Min-K amounts for each non-isolable break were compared to the strainer qualified Min-K debris limit.

The licensee stated that it used ZOIs for fibrous and Min-K insulation types as defined in the URG. The URG is also listed in the licensee's debris generation calculation (Reference 40,41) as the basis for the debris ZOIs. The ZOI is assumed to be of spherical shape for DEGBs on circumferential welds. The size of the ZOI is defined by the radius of the sphere and expressed as multiples of the break size "D" and symbolized with "L." More robust materials have higher damage pressures and smaller values of radius/D. For example, fibrous material is more robust than Min-K, so Min-K has a larger ZOI.

The licensee stated that ZOIs were clipped at robust barriers so that material that would be within a break ZOI but was protected by a structure was not included in the debris generated for that break.

NUKON Insulation

For its risk-informed analysis, the licensee used a 10.4D ZOI for NUKON (i.e., fibrous insulation) which is consistent with URG guidance. The URG does not address the different sizes of debris that may be generated but provides transport fractions for each type of debris depending on whether it was installed above or below the lowest level of grating in the drywell. Debris transport is discussed in a later section of this SE (Section 3.4.2.7).

Min-K Insulation

The licensee used a ZOI of 11.95D for Min-K. This ZOI is consistent with the URG guidance. Min-K is assumed to be rendered into 100 percent fine debris. During the regulatory audit, the NRC staff questioned whether debris within penetrations was included in break ZOIs for the non-isolable breaks. The licensee determined that this potential debris source was not included for non-isolable breaks and concluded that the Min-K debris source term for these breaks should be recalculated to include the penetration Min-K debris. The licensee provided supplemental information in letters dated May 30, 2024 (Reference 3) and October 31, 2024 (Reference 4), which reflected updated debris generation values for Min-K and an updated risk analysis. The licensee stated it is reasonable to assume reduced amounts of Min-K compared to those predicted by the ZOI concept. For Min-K in penetrations the following physical barriers would reduce the amount of debris generated by providing shielding of the Min-K from the LOCA jet: (1) hydraulic pipes guards within the penetrations and, (2) regions crowded with hardware near penetrations not included in the CAD model. In addition, the axial directions of jets interacting with insulation will not strike the insulation in the same orientation as the perpendicular jets used in tests performed to define the ZOI., The tests were designed to predict a conservative amount of debris generation, therefore they predict a conservative amount of debris. A 25 percent reduction in Min-K debris generation from Min-K in penetrations was assumed for all breaks in the Baseline analyses (Reference 3,4). The licensee also stated that the guard pipes were credited as robust barriers in the debris generation calculation, but the hydraulic piping, valves, and fittings associated with pipes that pass through the penetrations were not. During the regulatory audit, the NRC staff requested that the licensee provide clarifying information on how the amounts of Min-K generated from penetrations were calculated and how it was determined that a 25 percent reduction was justified. During the audit, the licensee clarified that the 25 percent reduction is a qualitative value to credit some jet energy dissipation by hardware not explicitly treated as robust barriers. The licensee also clarified that the 25 percent reduction applies only to the generation of Min-K that is installed at penetrations, and that Min-K from whip restraints was not reduced.

During the audit, the licensee also clarified that the initial submittal contained the Baseline evaluation and the supplements, dated May 30, 2024 (Reference 3), and October 31, 2024 (Reference 4), described a Modified Baseline evaluation. The Modified Baseline evaluation is used by the licensee to establish the risk values associated with the LAR, which includes 25 percent Min-K reduction and crediting operators to mitigate LOCA effects when two ECCS divisions are functional.

RMI

The licensee recalculated the amount of RMI debris that would be generated. Two breaks were evaluated. One break was assumed to occur inside the reactor annulus and one outside. The reactor RMI is aluminum and the piping RMI is stainless steel. Based on the CAD model, the maximum amount of RMI debris that may be generated for both breaks is similar to the initial qualification calculation, but the amounts that transport to the suppression pool and strainers are reduced after accounting for more realistic transport metrics. The transported amount for the break outside the annulus was significantly reduced from the earlier debris generation calculations. Since the amount of RMI debris generated is not relevant to the risk-informed analysis, the NRC staff finds that it does not need to be discussed in detail here. The licensee maintains the strainer qualified load limit for RMI.

Risk-Informed Analysis

The licensee followed the debris generation calculation methodology specified in the URG. The licensee considered robust barriers using guidance that was developed during the PWR response to GL 2004-02 (Reference 11) and documented in the PWR guidance (GR/SE) (Reference 15,16) without deviation except as discussed previously for Min-K. The licensee evaluated all Class I weld locations for DEGBs instead of assessing only the limiting breaks, as recommend in the URG. All non-isolable welds within the Class-I ISI pressure boundary (i.e., welds inside the first isolation valve) were evaluated or screened from the analysis. To calculate debris generation from these break scenarios, the licensee considered a CAD model describing the insulation configuration and location of robust barriers within the containment, in conjunction with the CASA Grande software to automate computation of fibrous insulation and Min-K amounts within the ZOI of each postulated DEGB discharged to the suppression pool. For these DEGBs, a spherical ZOI was assumed centered at the axis of the pipe in the plane of the weld. The smallest break size computed by the licensee to potentially cause strainer failure was 3.63 inches in the Baseline analyses (Reference 3,4).

CASA Grande code algorithms have been evaluated previously by the NRC staff as part of the pilot license amendment application related to GL 2004-02 (STP) (Reference 13), supported by audits and independent calculations sponsored by the NRC to explore the adequacy of the CASA Grande software to identify insulation and coating sources and debris amounts. The licensee performed a comparison between debris generation values obtained via the original methods and the updated CAD model and CASA Grande DC-5979, Rev. A (Reference 40) and Rev. 2 (Reference 41). The values from the two methods were shown to be similar. The NRC staff concluded that use of CASA Grande in conjunction with a detailed CAD model is a reliable approach to quantify potential debris amounts within the ZOI of a postulated break (Reference 13).

The licensee identified a total of 884 welds in the Baseline scenario (Reference 1), Attachment 3, Section 2.3, “Pipe Break Location Selection”], and 1103 welds in general in the Class-I piping. Some of these welds were discounted from the analysis because they would not result in a LOCA during normal power operation. These values are unchanged in the final Baseline Case.

The isolable welds adjacent to penetrations were not evaluated for debris generation but were assumed to result in core damage if a break occurred at the weld greater than 0.5 inches in diameter and the isolation valve failed to close.

The licensee assumed that fixed amounts of coatings, sludge, rust, miscellaneous debris, and latent debris could transport to the suppression pool immediately after the LOCA event and were available to be transported to the strainer for any break. The NRC staff considered these debris amounts acceptable because the strainer qualified debris amounts were developed to ensure that any combination of varying amounts of all debris types would not prevent the strainer from performing its function. The licensee assumed that the following debris amounts are the maximum that could enter the suppression pool and transport to the strainers. The maximum amount of each debris type was calculated as:

- 42.24 lb of fibrous debris (Nukon),
- 190 lb of sludge,
- 71 lb of qualified coatings,
- 161 lb of non-qualified coatings,
- 50 lb of rust,
- 150 lb of dirt/dust, and

- 5.9 lb of Min-K.

The licensee also assumed 100 ft^2 of strainer area is blocked by overlapping miscellaneous debris for all scenarios, which is equivalent to 133 ft^2 of non-overlapping miscellaneous debris. Except for miscellaneous debris, these values in the bullets are all less than or equal to the strainer qualified limits. Min-K was re-evaluated and the maximum amount of this debris type generated from non-isolable breaks was determined to be 22.34 cubic feet (ft^3), equivalent to 254.73 lb. Based on a sensitivity case (Case 5a), a number of breaks exceeded the qualified Min-K limit of 9.5 lb (Reference 49). The amounts of fibrous and Min-K debris vary depending on the break location. Other debris types are assumed to be at the design value for all scenarios.

A comparison between the debris amounts is shown in the licensee's LAR, (Reference 1), Attachment 2, Table 2-5. The NRC staff questioned the amount of Min-K that could be generated during the regulatory audit (Reference 24,25) and provided an RAI (Reference 50) requesting the licensee to provide an updated value. The licensee responded in supplements (Reference 3,4), and stated that the updated value for Min-K generation is 0.334 ft^3 RHR strainer load based on a suppression pool load of 5.9 lb of Min-K. Breaks that result in values greater than this value are assumed to fail and result in increased CDF. For sensitivity analyses, the licensee also considered a RHR strainer load equal to 0.83 ft^3 based on a suppression pool load of 9.5 lb of Min-K [Table 3-1 in (Reference 49)]. The licensee also lists the amount of blockage (i.e., miscellaneous debris) in Table 2-5 of Attachment 3 (Reference 1) as 6 ft^2 of circumscribed area for the current qualified load value. The blockage is potentially greater than 6 ft^2 and amounts greater than this were evaluated using the risk-informed debris bed thickness limit in the Baseline cases and the sensitivity cases. The blockage from miscellaneous debris in the risk-informed analysis is assumed to be 100 ft^2 of the strainer flow area which is equivalent to about 12.6 ft^2 of circumscribed strainer area.

The licensee programmed algorithms in the CASA Grande software to automate computation of debris amounts generated by each postulated break location at each size and orientation.

The NRC staff concludes that the licensee properly quantified amounts of debris that could be generated within the Fermi containment by the postulated LOCA breaks. Specifically, the analysis included ZOI-dependent (e.g., debris from fibrous and Min-K insulation types) and ZOI-independent (e.g., dust and latent debris, coatings, sludge, and rust). For the ZOI-dependent debris, the licensee computed debris amounts using CASA Grande, which relied on a CAD model to identify the location and distribution of insulation debris sources within the containment. For each break, CASA Grande used CAD model information to determine debris amounts for the Min-K and fibrous insulation types. The CAD model clipped the ZOI for each break to account for robust barriers. The licensee also credited a 25 percent reduction in the generation of Min-K for isolable welds at penetrations based on qualitative arguments related to regions crowded with hardware, guard pipes, and ZOI experiments conservatively representing only perpendicular jet impacts on the insulation. This 25 percent reduction was applied to the Modified Baseline Case used to develop the final risk values for the LAR. Risk-informed analyses are allowed to use realistic estimates instead of estimates based on known conservative guidance. The NRC staff found the licensee's analysis to result in a reasonably realistic estimate for Min-K debris because the processes identified by the licensee would result in a reduction in the amount of Min-K generated. Considering the conservatisms included in the licensee's submittal, crediting a 25 percent reduction results is reasonable to establish more realistic debris amount estimates. The NRC staff previously concluded that algorithms in the CASA Grande code for the computation of debris were properly implemented (Reference 13). In addition, the NRC staff performed independent calculations to confirm the licensee's debris generation methodology is acceptable. The NRC staff also finds that the licensee adequately identified debris amounts to compare to strainer qualified load limits. Therefore, the NRC staff concludes that the licensee's methodology to calculate debris loads for each postulated break is acceptable.

NRC Staff Conclusion Regarding Debris Generation and ZOI Submodels

The NRC staff notes that the licensee considered guidelines in the URG Method 3 and associated staff SE, combined with the licensee's CAD model to: (i) define ZOIs; (ii) account for robust barriers; (iii) compute debris amounts of fibrous and Min-K insulation; and (iv) identify particulate debris amounts such as coatings, rust, latent debris, and sludge. The particulate debris and Min-K are assumed to be in the form of fine debris (fine particulates or fine fibers) in the URG analysis. The fibrous debris is not assigned a size distribution, however the URG provides metrics for the amounts of debris that are transported to the suppression pool. All debris types that reach the suppression pool are assumed to be in the form of fine debris and capable to transport to the strainers carried by the circulated water.

The NRC staff verified that the licensee's debris generation calculations were performed accurately and used acceptable assumptions. The NRC staff used a combination of confirmatory calculations, engineering judgement, and review of the licensee's software outputs to perform the verifications. The Fermi method to compute debris amounts relies on the CASA Grande software, which was examined in detail as part of the pilot GL 2004-02 risk-informed evaluation (Reference 13). This approach allows the staff to conclude, with a high level of confidence, that the calculations for debris generation were conducted and applied properly. The NRC staff reviewed the licensee's evaluation against the NRC staff-accepted guidance and concludes that the licensee adequately determined, for each postulated break location, the zone within which debris would be generated by a two-phase jet. The NRC staff also concludes that the amount and characteristics of debris predicted to be generated are acceptable because the licensee calculated amounts for all debris types discharged into the suppression pool that may be affected by the increase in Min-K and miscellaneous debris source terms, which were used as input to a separate set of computations in MATLAB to establish the strainer debris load versus time. In addition, the computed strainer debris loads were used to compare to either the strainer design basis qualified load debris limits or the debris bed thickness limit to identify breaks causing strainer failure. The NRC staff confirmed that the licensee also verified that other debris types remain bounded by the qualified strainer debris limits. Any break that results in any type of strainer debris load exceeding the qualified debris amounts or the risk-informed debris bed thickness limit is assumed to lead to strainer failure and contribute to the plant risk. The staff finds that the licensee's methods are consistent with staff guidance. Therefore, the NRC staff concludes that the licensee's evaluation of the ZOI and debris generation is acceptable. The amounts of debris from each postulated break scenario were determined appropriately.

The NRC staff concludes that debris generation and ZOI analysis and methodology are acceptable because it identifies postulated LOCAs of sufficiently different features to provide assurance that the most severe postulated LOCAs are calculated. Also, the NRC staff concludes that the debris generation and ZOI submodel described in the LAR is acceptable for use in an assessment or evaluation model of the effects of debris on the ECCS, as required, in part, by 10 CFR 50.46.

3.4.2.6.3 Debris Characteristics

The licensee used the URG and staff SE to evaluate the debris characteristics.

NUKON (Fibrous) Insulation

The URG does not specify a size distribution for fibrous debris. Instead, the URG assigns a transport fraction for this debris type depending on the source location. The URG guidance combines debris characteristics and transport to the suppression pool. All fibrous debris that reaches the suppression pool is assumed to be in the form of fine debris and capable to transport to the strainers carried in the flowing water without settling or trapped by other structures.

In its fibrous debris bed thickness calculations, the licensee assumed that the fibrous debris collected on the strainer using the material's manufactured density of 2.4 lb/ft^3.

Min-K

All Min-K debris generated is assumed to be 100 percent fines and all is assumed to transport to the suppression pool without settling.

To ensure conservatism in its treatment of Min-K and the 1/8-inch bed failure criterion, the licensee stated that in addition to considering the Min-K qualified limit as a strainer failure criterion, Min-K was also assumed to contribute to the fiber bed thickness and assumed to be 100 percent fiber for this calculation. The licensee used a Min-K density equal to 11.4 lb/ft^3 for the computation of debris volumes.

RMI

For RMI, the maximum potential amount of debris that could be generated was found to be decreased from the previous debris generation calculations. The licensee did not discuss RMI debris further because the URG guidance considers RMI separately from other debris with respect to effects on strainer performance. Additionally, the RMI debris amounts are bounded by the strainer qualified loads for RMI.

NRC Staff Conclusion Regarding Debris Characteristics

The NRC staff concludes that the debris characteristics were adequately considered in the analysis. In the URG model, the debris characteristics are not very important because the simplified model combines debris characteristics and transport. For the debris bed thickness calculation, the licensee used the as-manufactured densities of the insulation types. The NRC staff finds that this is the standard method for calculating a theoretical debris bed thickness and is acceptable because observations from testing and strainer studies are based on this assumption.

3.4.2.6.4 Latent Debris

The licensee followed the guidance in the URG to evaluate latent debris. For BWR strainers, latent debris is assumed to be 150 lb of dust and dirt, and the licensee adopted this value in its analysis. This value is also consistent with the assumptions in the strainer qualified load design basis. All the latent debris is assumed to transport to the suppression pool and be available for transport to the strainers without settling.

The licensee followed the URG guidance to determine the amount of sludge that could be transported to the strainer. The original strainer design allowed for a maximum of 300 lb of sludge to be transported to the strainers as specified by the URG. When the design basis qualified load was revised to account for additional RMI transport and blockage by miscellaneous debris (tags and labels), the maximum qualified sludge amount was reduced to 230 lb. Since that time, the licensee has reduced the total amount of debris considered in the sludge source term in the suppression pool to 190 lb. The sludge source term is controlled by cleaning the suppression pool every refueling cycle. DC-5979, Rev. A (Reference 40) and Rev. 2 (Reference 41) explain that the actual amount of sludge generated is 40 lb per year resulting in a maximum 80 lb debris term as the suppression pool is desludged on a periodic basis. There is an additional 110 lb in the sludge term that accounts for mill scale from uncoated piping and structural steel. The total sludge estimate is 190 lb which provides margin to the strainer qualified limit which is 230 lb.

The NRC staff finds that the licensee followed the URG guidance to determine the amount of rust that can be transported to the strainers. The URG requires that the strainers accommodate 50 lb of rust. The original strainer design included a rust source term of 50 lb. The risk-informed analysis also assumed 50 lb of rust was available to reach the strainers. This continues to be the design basis qualified rust limit for the strainers.

The original strainer design did not assume any strainer area would be blocked by miscellaneous debris (e.g., tags and labels). The strainer was later qualified for miscellaneous debris (e.g., tags and labels) blockage of 6 ft^2 of circumscribed strainer area (equivalent to 63.5 ft^2 of total flow area) for the strainers in service. The licensee identified additional miscellaneous debris and calculated that the total transport to the strainer, considering 25 percent overlap, would exceed the qualified design assumption. In its LAR, the licensee identified 87 ft^2 of non-overlapping tags and labels (equivalent to 65.25 ft^2 of flow area, assuming 25 percent overlap) that could transport to the strainers. The NRC approved guidance in the GR/SE allows a 25 percent overlap to be credited for these debris types. Other tags and labels remaining in the Fermi drywell are designed so that they will not become debris that could transport to the strainers. (Metal tags and fasteners are used.) To account for the additional miscellaneous debris, the licensee developed the 1/8-inch debris bed thickness limit to evaluate the effects of the excessive miscellaneous debris using its risk-informed evaluation. This aspect of the risk assessment is described in Sections 1.3, 3.3.5, 3.3.6, and 3.4.2.4 of this SE and referred to in other sections. The licensee assumed 100 ft^2 of overlapping debris would be instantly distributed among active strainers depending on strainer flow rates. On a single strainer, the overlapping miscellaneous debris (a fraction of the 100 ft^2 total) reduces the flowing area of the strainer. The licensee assumed fibrous debris to accumulate on the flowing area not blocked with miscellaneous debris, and computed the corresponding fibrous debris bed thickness, for comparison to the 1/8-inch limit of the Baseline computations.

During the regulatory audit (Reference 24,25) the NRC staff questioned how the value for the area of miscellaneous debris was developed. The licensee responded in its RAI response letter of April 24, 2024) (Reference 2). The licensee assumed that 133 ft^2 of potential miscellaneous debris could transport to the strainers. Considering the overlap allowed, the total strainer flow area blocked would be 100 ft^2 (blockage proportionally distributed among multiple strainers, depending on the strainer flow rates). This is greater than the 63.5 ft^2 assumed in the strainer qualified debris limits. It is also greater than the amount of tags and labels found in containment

(65.25 ft^2 of flow area). In its review of the licensee response to STSB-RAI-9, the NRC staff noted that the strainer circumscribed and flow areas were combined in some examples in which comparison does not appear logical. This issue was discussed during the audit without clear resolution. However, the NRC staff was able to conclude that the assumptions for miscellaneous debris are acceptable regardless of the calculations provided in response to the RAI. Based on a review of the updated information, the NRC staff concluded that the licensee calculated the miscellaneous debris amount acceptably and used a conservative value in the risk-informed analysis.

The NRC staff concludes that the licensee provided sufficient information to demonstrate that the latent debris was addressed adequately in its analysis because the licensee followed the guidance in the URG which is consistent with its initial strainer design. The NRC staff also concludes that the excess miscellaneous debris was conservatively evaluated in the risk-informed analysis. In addition, the latent debris amounts were not changed by the risk-informed analysis. The staff finds that the strainers are qualified to accommodate the maximum amounts of all debris types, including the latent debris amounts, within the qualified load and continue to perform the required functions. Only the amounts of miscellaneous debris and Min-K were evaluated by the LAR. Therefore, the NRC staff concludes that the licensee latent debris source term considered in the LAR was established per staff accepted guidance and is adequate for use in the LAR evaluations.

3.4.2.6.5 Coatings

The licensee's coatings evaluation was performed in accordance with the guidance in the URG. The licensee stated that the amount of qualified coatings assumed in the source term is 85 lb. The 85 lb value is based on the URG guidance for a qualified system that consists of an inorganic zinc base layer with epoxy topcoat. Fermi's qualified coatings were identified as epoxy only. For qualified epoxy only coating systems, the URG guidance recommends a source term of 71 lb. This provides a 14 lb margin between the qualified strainer load and the URG required source term for qualified coatings.

For unqualified coatings the licensee initially assumed 15 lb. This was later increased to 150 lb and then to 161 lb to account for coatings on a new recirculation pump motor. The design limit for unqualified coatings is established at 161 lb, equal to the calculated amount for these coating systems. The URG recommended that unqualified coatings should be based on a site-specific analysis. The licensee's debris calculation, DC-5979, Rev. A (Reference 40) and Rev. 2 (Reference 41), state that the unqualified coating source term is maintained in a Fermi specific Technical Evaluation, TE-T23-20-008, also known as the site's unqualified coatings log.

The qualified and unqualified coatings in the source term are assumed to be fine debris which transport to the suppression pool and to the active strainers regardless of the break location.

NRC Staff's Conclusion Regarding Coatings

The licensee did not change its coatings source term as part of the LAR. The NRC staff checked the source term evaluation to verify that it was performed in accordance with NRC approved guidance. The licensee used the URG and associated NRC staff SE as guidance. The NRC staff confirmed that the debris generation amounts reflected in the licensee's calculations were determined appropriately based on the guidance and all debris was assumed to transport to the active strainers.

Furthermore, the licensee maintains an unqualified coatings log to assure that the unqualified coatings do not exceed the qualified debris amount.

The coatings source term was not evaluated by the licensee as part of the LAR because the strainers are qualified to accommodate the maximum amounts of all debris types within the qualified load and continue to perform the required functions. Only the amounts of miscellaneous debris and Min-K were evaluated by the LAR. The NRC staff concludes that the licensee coatings source term considered in the LAR was established per staff accepted guidance and is adequate for use in the LAR evaluations.

3.4.2.7 Debris Transport Submodel

3.4.2.7.1 <u>Strainer Transport</u>

Debris transport for the BWR analyses as specified in the URG are significantly simplified compared to PWR transport analyses. The PWR transport methodologies include refinements that had not been developed at the time that the URG guidance was written. The licensee used transport guidance from the URG and RG 1.82.

The transport for all fine debris, including coatings, latent debris, rust, sludge and Min-K was assumed to be 100 percent. Labels are also assumed to transport at 100 percent.

The transport for fibrous debris (i.e., Nukon) was based on the location of the insulation in the drywell. All fibrous insulation within a ZOI above the lowest grating in the drywell was assumed to transport at a rate of 28 percent. All fibrous insulation within a ZOI below the lowest grating in the drywell was assumed to transport at a rate of 78 percent.

LAR Attachment 3 (Reference 1), Table 2-3 provides the debris transport percentages for Min-K and fibrous debris. The NRC staff noted, and the licensee confirmed, that the Above/Below grating values in the table were inadvertently reversed. The licensee stated that the values were correctly applied in the transport analysis. The updated maximum transport amounts for non-isolable breaks for fibrous and Min-K insulation types are shown in LAR Attachment 3, Table 5-1 (Reference 1). Based on a reanalysis of the Min-K debris generation from penetrations for non-isolable breaks and additional fibrous debris discovered, these values were updated to a maximum LDFG fibrous debris of 17.9 ft^3 and a maximum 22.3 ft^3 Min-K debris generated by a single break and discharged to the suppression pool (Reference 3). The maximum LDFG + Min-K debris generated by a single break is 34.11 ft^3 (Reference 49).

The transport values indicate the amount of debris that transports to the suppression pool. Once in the suppression pool, all the debris types, except RMI, are assumed to transport to the operating strainers in proportion to the mass of water flow through the strainers. This considers the duration pumps operate and the pump flow rates.

The transport analyses for RMI debris are more complex. However, since RMI is not a subject of the licensee's risk-informed analysis, it is not discussed further in this SE.

The licensee did not consider any amount of fiber penetration through the strainer when evaluating strainer failure scenarios. Ignoring fiber penetration is a conservative approach with respect to strainer effects.

The licensee stated that all transportable debris is assumed to be present and fully mixed in the suppression pool at the beginning of all scenarios. Miscellaneous debris is assumed to be instantly collected on the strainer at the beginning of all scenarios. The licensee did not credit settling of debris in the suppression pool.

NRC Staff Conclusions Regarding the Debris Transport Submodel

The NRC staff finds that the licensee's approach to evaluating debris transport was consistent with the URG and NRC staff SE (Reference 9) as well as RG 1.82 guidance (Reference 28).

The NRC staff reviewed the licensee's transport evaluation against the NRC staff-accepted guidance in the URG and verified the consistency of the computed debris amounts. The NRC staff also verified that the licensee's assumptions were consistent with guidance and performed independent calculations to examine the licensee's results. The NRC staff concludes that the licensee appropriately estimated the fractions of debris that would transport from fibrous and Min-K sources within the drywell to the ECCS and CSS strainers. The licensee made conservative assumptions regarding the timing of debris transport to the strainers. Therefore, the NRC staff concludes that the licensee's evaluation of debris transport is acceptable.

3.4.2.8 Impact of Debris on the Strainers Submodel

This section evaluates the potential effects that the debris, as described in Section 3.4.2.6, "Debris Source Term Submodel" of this SE, may have on the operation of the ECCS and CSS strainers. For this section, all descriptions attributed to the licensee's submittal are taken from the licensee's letters dated June 13, 2023 (Reference 1), April 24, 2024 (Reference 2), May 30, 2024 (Reference 3), and October 31, 2024 (Reference 4).

3.4.2.8.1 Strainer Evaluation

The headloss evaluation for this LAR is based on the initial strainer design and updated qualified debris limits for the strainers. The RoverD (risk-informed) analysis does not include headloss calculations, but instead uses pass/fail criteria for the strainer based on the loads that have been qualified for the strainer.

The strainer evaluation is only concerned with two types of debris that are above those currently qualified for the strainer, Min-K and miscellaneous debris.

The NRC staff had previously approved the methodology that the licensee used to design and qualify the strainer for debris loading. Since most of the debris type amounts are unchanged and the strainer is designed to accommodate all debris and debris combinations up to the qualified loads for all debris types, the licensee only evaluated the changes in Min-K and miscellaneous debris.

For Min-K, the licensee considered two independent contributions to the increase in ΔCDF, from isolable and non-isolable welds. The isolable welds are 37 welds located between an inboard isolation valve that automatically closes when a LOCA occurs. The licensee assumed that breaks at these welds greater than 0.5 inches cause strainer failure and core damage if the inboard isolation valve does not shut, independently of debris generated by the LOCA break. The contribution in the ΔCDF by the isolable welds was simply calculated by multiplying the exceedance break frequency of 0.5-in breaks by the probability that the inboard valve will not shut on demand. Since any break greater than 0.5 inches in the 37 isolable welds was assumed to lead directly to core damage if not successfully isolated by a valve, the licensee did not need to evaluate effects of increased amounts of miscellaneous debris for isolable breaks.

The licensee estimated a second independent contribution to the ΔCDF from the set of 884 isolable welds. The licensee evaluated debris from potential break locations using two strainer failure criteria. The licensee assumed that if the amount of Min-K debris generated by a break and loaded on any strainer exceeds the qualified Min-K amount for the strainers, independently of the active strainer area and miscellaneous debris (e.g., tags and labels), the strainer is assumed to fail, cause core damage, and contribute to an increase in risk.

To evaluate the effects of the excess miscellaneous debris, the licensee defined a strainer failure criterion based on a limit to fiber bed thickness. The licensee assumed that if fibrous debris that accumulated on any strainer (considering fibrous debris with volume contributions from LDFG and Min-K) exceeded the bed thickness criterion, the strainer failed followed by core damage. Because the miscellaneous debris can block a portion of the strainer area, increasing the miscellaneous debris can cause other debris to accumulate on a smaller strainer area. Thus, the licensee established a method to compute the amount of fibrous debris per unit of active strainer area. The licensee set a bed thickness limit equal to 1/8 inch of fibrous debris for the Baseline cases. The licensee stated that BWR strainer studies demonstrated that at bed thicknesses of 1/8 inch and less, the debris bed would not develop significant head loss. The licensee also demonstrated that the design basis qualified LDFG debris load would result in a debris bed significantly greater than 1/8 inch, including consideration of qualified amounts of miscellaneous debris (causing blockage of a portion of the strainer area). Therefore, the qualified debris load bounds the 1/8-inch bed thickness limit. In other words, the qualified load for the strainer results in a fibrous debris bed significantly greater than 1/8 inch.

The licensee stated that the qualified debris amounts were developed considering all potential combinations of debris types reaching the strainer so that the qualified load is a bounding limit. Therefore, the composition of the debris bed will not cause strainer failure as long as all debris types are within their qualified limits.

The licensee conservatively assumed that Min-K debris was fibrous and contributed to the bed thickness calculation in addition to the LDFG debris contribution. The bed thickness computation assumed debris is deposited on the strainer uniformly and at the manufactured density. The licensee also conservatively assumed that the miscellaneous debris reached the strainer before blocking a fraction of the strainer area, so that fibrous debris accumulated exclusively in the non-blocked area. These assumptions maximize the debris bed thickness.

The licensee also considered that increasing the area of the strainer blocked by miscellaneous debris would result in an increase in flow velocity through the remaining strainer area and the associated debris bed. The licensee provided an analysis of the velocity effects (Reference 2). The evaluation concluded that the velocity through the debris bed could be 20 percent greater than that for a clean strainer. The difference between the velocity based on the current miscellaneous debris amount and the amount proposed in the licensee's request is lower than 20 percent. With respect to headloss across the debris bed and strainer, the licensee determined that the increase in velocity was more than accounted for by the reduction of the bed thickness imposed by the 1/8-inch risk-informed limit. The NRC staff concluded that the licensee's evaluation was acceptable because the NRC staff performed confirmatory calculations for the strainer area that could be blocked by the miscellaneous debris and considered the effects of velocity increases through the debris bed. The NRC staff also performed an independent evaluation of the velocity and bed thickness effects associated with the additional miscellaneous debris and the licensee's bed thickness limit. The NRC staff discovered some calculation errors in the licensee's analysis provided in the response to STSB-RAI-9 (Reference 2). These errors were related to comparisons regarding miscellaneous debris amounts and the velocity of fluid through a debris bed. The miscellaneous debris amounts were not always compared consistently because circumscribed areas were combined with strainer face areas, making comparisons confusing. Also, the licensee claimed that the velocity of flow through a circumscribed bed would be much greater than the flow through a thin bed. The NRC staff noted that the flow through the outside of a circumscribed bed would be higher but would decrease as the flow approached the face of the strainer. The flow is a gradient and not a constant velocity. These issues were discussed during the audit (Reference 25). Regardless of the issues, the NRC staff concluded that the headloss due to the increase in velocity through the debris bed and strainer would be less than those that would occur if the strainer was operated at the design basis flow velocity and qualified debris load. This is based on the qualified debris load bed thickness being significantly greater than 1/8 inch and a relatively small increase in velocity through the debris bed and strainer.

The licensee provided conservatisms associated with the headloss analysis. The margins are summarized as follows:

- The estimates for fibrous debris loads (excluding Min-K) are lower than the qualified fiber amount.
- The design basis fibrous debris load would generate a bed thicker than the assumed 1/8-inch limit.
- Debris beds of 1/8 inch have been shown to be unable to sustain significant headloss. Therefore, the risk associated with the assumed bed thickness limit is overpredicted.
- The miscellaneous debris is assumed to arrive before other debris types.
- The analysis assumes immediate core damage at the time that any strainer accumulates 1/8 inch of fiber. It is likely that the strainer (and other strainers with lower loads) would continue to function, allowing for other mitigative actions to prevent core damage.
- For isolable breaks, the assumption that any failure of the valve to isolate causes core damage is conservative. Some scenarios with valve failure to isolate could be mitigated.
- No credit is taken for transport time from the drywell to the suppression pool.

The NRC staff recognizes that these assumptions provide margins that help to ensure that the risk-informed results bound the plant risk.

<u>NRC Staff Conclusion Regarding Strainer Performance</u>

The NRC staff reviewed the licensee's evaluation and concludes that the licensee has appropriately approximated (with conservatism) the risk attributable to the Min-K and miscellaneous debris amounts that are greater than the qualified debris loads. The licensee has demonstrated that the strainer will perform acceptably under postulated LOCA conditions, limited by the amount of debris represented by the qualified debris loads and the 1/8-inch bed thickness criterion. Therefore, the NRC staff concludes that the licensee's evaluation of the strainer is acceptable.

3.4.2.8.2 Strainer Structural Analysis

The structural loads for the strainers were developed using NRC staff approved methods. Any debris amount larger than the qualified debris loads for the strainer were assumed to result in a strainer failure and increase in plant risk.

NRC Staff Conclusion Regarding Strainer Structural Analysis

The NRC staff concludes that the RHR and CSS strainers are structurally acceptable for the assumed design-basis loads for which it is deterministically qualified because any debris load greater than the deterministically accepted load limit, or that exceeds the conservative bed thickness criterion such that structural limits could be exceeded, also results in a failure scenario. Therefore, the structural analysis remains valid and acceptable.

3.4.2.8.3 NPSH

The NPSH margins were calculated assuming the maximum debris amount for each debris type. The debris amounts were determined using NRC approved methods. Any scenario that exceeded the qualified amount for any debris type or exceeded the conservative bed thickness criterion was assigned to failure and results in increased plant risk.

NRC Staff Conclusion Regarding Net Positive Suction Head

The NRC staff concluded that the NPSH margins for the successful scenarios would be unchanged by the evaluation and that the risk-informed criteria were established conservatively. Therefore, the NPSH calculations remain valid for Fermi and all scenarios not bounded by the analysis are assigned to failure. Therefore, the NRC staff concludes that the licensee's NPSH analysis is acceptable without revision.

3.4.2.8.3 Submodel Integration

This section provides an overview of how the submodels are combined to obtain the final results of the risk analysis.

The licensee considered a total of 887 non-isolable welds, distributed over the piping system. The licensee noted that 3 of those 887 welds were in lines with valves closed during full power operation and should be removed from the set of non-isolable welds; however, the licensee considered a set of 887 welds in the analysis (Reference 1). Having 3 extra welds that would cause medium-size LOCAs without enough debris generated to cause strainer failure would slightly underestimate the risk (Reference 1). The results the licensee reported, including updated results in (Reference 3,4), considered 887 non-isolable welds.

The licensee used CASA Grande to compute Min-K debris and fibrous debris volumes for postulated breaks on the 887 isolable welds. CASA Grande was integrated with a CAD 3-dimensional model of the piping system, robust barriers, and insulation types. For each postulated DEGB, CASA Grande draws a spherical zone of influence as a function of the break size, adjusted for the presence of robust barriers (which cannot be penetrated by two-phase jets). Based on the ZOI, CASA Grande computes the amount of debris generated and transported to the suppression pool, with transport computed using simple NRC staff approved transport fractions. The amount of debris generated also includes fixed amounts of latent debris (particles and fiber) independently of the break size.

The licensee used separate computations in matrix laboratory (MATLAB) to solve differential mass-balance equations to track the volume of accumulated debris on strainers as a function of time, assuming debris is introduced to the suppression pool in a short time, debris is perfectly mixed in the pool, and debris is perfectly captured by the strainers in proportion to their flow rates. The solution of the mass-balance differential equations was used to compute the fraction of miscellaneous debris (100 ft^2 in the Baseline cases) that was assumed to deposit first among the multiple strainers before arrival of the fibrous debris. As a practical approach, the licensee assumed that partial strainer blockage by miscellaneous debris occurs instantaneously as soon as the start of water circulation without affecting strainer flow rates. The licensee used the same solution of the differential mass-balance equations to compute the volume accumulation of debris, Min-K and fiber, on the active strainers of the case considered. The accumulated Min-K volume was compared to the design basis Min-K limit to establish strainer failure and the time of failure, in cases where failure occurs. For fibrous debris, the licensee computed the volume accumulation of fibrous debris (including contribution from NUKON, lead blanket, latent fibrous debris, and Min-K assumed to form 100 percent fibrous debris) versus time. The licensee divided the fibrous debris volume by the active strainer area (i.e., the area not blocked with miscellaneous debris) to compute the debris bed thickness on each strainer loaded with debris. The licensee compared the debris bed thickness to the 1/8-inch criterion to identify breaks that could cause strainer failure, and also to compute the time at which strainer failure occurred. The licensee conservatively assumed failure of the ECCS as soon as any strainer failed by any of the failure criteria (i.e., exceedance of Min-K design limit or 1/8-inch debris bed thickness), and core damage. The licensee applied this procedure for postulated DEGBs on each of the 887 non-isolable welds to identify all breaks caused core damage. The licensee separated breaks in three sets:

(i) breaks that solely exceed the 1/8-inch debris bed thickness,
(ii) breaks that solely exceed the Min-K design basis load, and
(iii) breaks that exceed both criteria.

The licensee computed independent ΔCDF contributions for these three sets of breaks. The sum of these three contributions is the increase in risk, ΔCDF, from the non-isolable welds. The licensee computed the ΔCDF for the Baseline cases and multiple sensitivity cases and strainer flow configurations. In all these cases, the source debris from the CASA Grande computations remained the same; however, the debris accumulation on the different strainers changed depending on the flow rates and variability of those flow rates with time. The licensee reported values of the ΔCDF for the non-isolable welds, itemized in contributions for the sets (i), (ii), and (iii), for the Baseline cases and multiple sensitivity cases (Reference 3,49,4). The licensee did not report individual welds for the sets (i), (ii), and (iii); however, the licensee provided an Excel file with CASA Grande outputs which allowed computation of the welds in the different failure groups. The licensee provided a total count of welds in sets (i), (ii) and (iii) for the Suppression Pool Cooling strainer flow configuration case, with and without including a 25 percent reduction in penetration Min-K (Reference 4).

As previously explained, the licensee computed the ΔCDF contribution of the isolable welds simply as the product of the exceedance frequency of 0.5-inch breaks from NUREG-1829 data, and the isolation valve failure probability. This ΔCDF contribution is constant, independently of the strainer flow rate cases and the number of isolable welds. The ΔCDF contribution of isolable welds only depends on the assumed exceedance frequency, for example based on GM or AM aggregation. In the October 31, 2024, supplement (Reference 4), the licensee updated the ΔCDF contribution of the isolable welds for the sensitivity cases, properly considering GM or AM aggregation cases of the NUREG-1829 exceedance frequencies.

The ΔCDF for a given configuration of strainers and flow rates is the sum of the isolable and non-isolable weld contributions. To compute the system level ΔCDF, the licensee considered two complementary scenarios (Reference 3,4):

- Scenario 1 – a scenario with failure of a single pump, and
- Scenario 2 – a scenario with successful operation of all pumps.

The scenario 1 was represented by a one division ECCS system (referred to as Case 2A) with two RHR strainers and one CS strainer. The licensee conservatively assumed that failure of one pump would cause the loss of one full division of the ECCS. This scenario was assigned a probability 0.1, based on an overestimate of the probability of failure of a single pump per demand. To compute the ΔCDF of the scenario, the ΔCDF of Case 2 was multiplied by 0.1.

The scenario 2 corresponds to a two-division ECCS system with four RHR strainers and two CS strainers, with a complementary 0.9 probability. However, the license selected a case named Case 3A referred to as Suppression Pool Cooling case, which is a one-division system, to represent scenario 2. The licensee argued that although all strainers are functional, one division would be throttled to reach a Suppression Pool Cooling mode (Reference 3,4). The Case 3A is very similar to the Case 2A concerning pump flow rates, and the corresponding ΔCDF are nearly identical. To compute the ΔCDF of scenario 2, the licensee argued that operator actions are broadly available to mitigate effects of a LOCA accident and prevent core damage. The licensee assigned a probability of 0.2 to operators failing to mitigate a LOCA break, and multiplied the ΔCDF of Case 3A by 0.2 to define the ΔCDF of scenario 2.

The licensee also argued that the ΔCDF could be further decreased by reducing Min-K debris sources from penetrations. The licensee stated that the recommended ZOI for Min-K greatly overestimates debris production because penetrations are crowded regions with hardware not accounted for as robust barriers in the 3D CAD model and the CASA Grande model. Also, the ZOI is based on experiments with perpendicular incidence of jets on insulation, instead of the axial incidence on insulation due to the presence of guard pipes protecting Min-K at penetrations. The licensee did not credit hydraulic pipes as robust barriers, although it is likely for those hydraulic pipes to shadow the Min-K insulation. Accordingly, the licensee credited a 25 percent reduction to Min-K from penetrations. Min-K from whip-restraints was left unchanged. This adjustment was equally applied to the Case 2A one-division system and to the two-division system (represented by the Case 3A) (Reference 3,4). In summary, the licensee's computation of the total ΔCDF included non-isolable weld contributions of a one-division (0.1 probability) and a two-division (0.9 probability) ECCS system that included 25 percent reduction of penetration Min-K for both cases. The ΔCDF computation assumed 0.2 operator failure probability to address indications of strainer misfunction under the two-division ECCS system. Finally, the ΔCDF also included a contribution from isolable breaks (Reference 4).

The NRC staff verified that the licensee's debris generation and transport calculations were performed accurately and used acceptable assumptions (Reference 1,2,3,4). The NRC staff used a combination of confirmatory calculations, engineering review, and review of the licensee's software outputs to perform verifications. The verifications included:

- Computing delta frequency contributions for each break based on NUREG-1829 break exceedance mean frequencies, considering GM and AM aggregation data.
- Independently solving the differential mass-balance equations to compute strainer debris accumulation with time, and to establish the distribution of debris among the active strainers for different flow configuration cases.

- Computing the breaks with loads exceeding the 1/8-inch debris bed thickness considering partial strainer blockage by miscellaneous debris.
- Computing the breaks with loads exceeding the Min-K design basis volume.
- Computing the ΔCDF contribution for three sets: (i) breaks exceeding solely the 1/8-inch debris bed thickness, (ii) breaks exceeding solely the Min-K design basis volume, and (iii) breaks exceeding both failure criteria.
- Computing the effect in ΔCDF by crediting a reduction of 25 percent in the Min-K from penetrations only (values of Min-K from whip-restraints were not reduced).
- Computing the ΔCDF contribution by the isolable welds.

The NRC staff's verification computations employed as input an Excel database with debris volumes computed with CASA Grande for postulated DEGBs at 887 non-isolable welds provided by the licensee. The results of the verification computations were in close agreement with results the licensee reported in the letter dated May 30, 2024 (Reference 3), and matched the revised computations in the supplement dated October 31, 2024 (Reference 4), for multiple sensitivity cases. The approach allows the staff to conclude, with a high level of confidence, that the licensee's calculations for debris generation for each potential weld break location were conducted as described and applied properly and are therefore acceptable. The staff also concludes that the resulting debris amounts were adequately compared against the Min-K qualified load and conservative bed thickness criteria to determine LOCA break scenarios that could lead to core damage. Deterministic analyses were also performed using staff accepted guidance.

NRC Staff Conclusion Regarding Submodel Integration

The NRC staff concluded that the licensee's submodel integration was acceptable based on its review of the methodology, the CASA Grande results (debris amounts for postulated breaks), and computation of ΔCDF using weld counts and NUREG-1829 as inputs and MATLAB numerical solutions of debris mass-balance equations. The NRC staff concludes that the approach for integrating submodels described in the licensee's submittal is acceptable for use in an assessment or evaluation model of the effects of debris on long-term cooling of ECCS, as required, in part, by 10 CFR 50.46.

3.4.2.9 Systematic Risk Assessment

RG 1.174 (Reference 23) states that the licensee may use its risk assessment to address the risk-informed decision-making principle that proposed increases in risk are small and are consistent with the intent of the NRC's Safety Goal Policy Statement. In Attachment 3 of the submittal dated June 13, 2023 [(Reference 1)], the licensee describes the risk-informed basis, including the systematic risk assessment. The licensee deterministically excluded potential failure modes addressed in Section 3.4.2.8, "Impact of Debris Strainers Submodel" of this SE. The only failure modes not excluded are failure of the strainer due to fibrous debris buildup exceeding 1/8-inch bed thickness or the accumulation of Min-K in any strainer exceeding the qualified debris limit. For non-isolable welds, the licensee assumed that all debris loads exceeding one or both of these limits would cause strainer failure and core damage. The ΔCDF contributions from the non-isolable welds was computed considering the frequency of breaks generating debris exceeding the debris limit metrics, as described in Section 3.4.2.8 of this SE.

For isolable welds, the licensee assumed that any 0.5-in break in a weld between the drywell penetration and its associated inboard isolation valve would produce Min-K in excess of the qualified limit. However, the break could be mitigated by the inboard valve automatically closing and terminating the LOCA. The increase in risk for the isolable welds was calculated by multiplying the 0.5-in exceedance break frequency and the probability of the failure of the inboard valve to close.

The system level ΔCDF is the sum of the independent ΔCDF contributions from non-isolable and isolable welds. Breaks generating transported fibrous and Min-K debris less than the qualified limits, and breaks between the inboard valves and drywell penetrations that are successfully isolated were concluded not to contribute to increases in plant risk. The licensee referred to the evaluation methodology as RoverD [Attachment 1-1, Section 2.3 of (Reference 1)].

The licensee screened break locations and other scenarios, which are evaluated in Section 3.4.2.1, "Scope of Systematic Risk Assessment" of this SE. The licensee concluded that the only breaks contributing to the ΔCDF are breaks in Class-I welds. Debris generation models are evaluated in Section 3.4.2.6, "Debris Source Term Submodel" of this SE. The licensee considered LOCA break frequencies from NUREG-1829 to estimate ΔCDF and ΔLERF; the frequency selection and allocation approach is evaluated in Section 3.4.2.2, "Initiating Event Frequencies" of this SE. LOCA break frequencies from an approach considering GM aggregation of expert elicited frequencies, and 25-year plant life frequencies, were used by the licensee in the Baseline computations.

The licensee reported a Baseline ΔCDF value in its supplement dated October 31, 2024, equal to 6.94×10^{-7} 1/yr, in RG 1.174 risk Region III (Reference 4). Computation of this value includes the following features:

(i) It is based on GM aggregation NUREG-1829 frequencies.
(ii) It credits 25 percent reduction in Min-K from penetrations.
(iii) It assumes 0.2 probability for operators failing to detect and mitigate strainer obstructions after a LOCA break, for the case with all pumps of the ECCS and CS system operational.

To estimate the ΔLERF, the licensee conservatively assumed that a large early release would occur in 1 of 10 instances of core damage (Reference 1). The NRC staff considered this assumption to be reasonable and conservative because the probability of a large-early release event conditional on a core damage event is commonly estimated to be much lower, based on detailed PRA analyses. Accordingly, considering the updated ΔCDF estimates (Reference 4), the licensee estimated the mean ΔLERF equal to 6.94×10^{-8} 1/yr, also in the RG 1.174 risk Region III.

The licensee evaluated the impact of key assumptions and sources of uncertainty in the systematic risk assessment. The licensee examined different assumptions than the Baseline assumptions by varying the obstructed strainer area by miscellaneous debris, the debris bed thickness failure threshold, Min-K design basis volume, and the NUREG-1829 break frequency aggregation method (i.e., AM instead of GM) [Table 4 of Attachment 4 of (Reference 3), and Table 6 of Attachment 4 of (Reference 4)]. The sensitivity results were reported without credit for operator actions and without crediting Min-K reduction from penetrations, so to more readily compare changes to Baseline values. The results were summarized in Table 7 of Attachment 4 of (Reference 3), and Table 9 of Attachment 4 of (Reference 4) and described in more detail in (Reference 49).

The sensitivity analysis revealed that the ΔCDF estimate increased by almost one order of magnitude with respect to the Baseline ΔCDF using the AM aggregation NUREG-1829 LOCA break frequencies. The licensee has identified several factors that could be used to reduce ΔCDF estimates including: (i) crediting more than 25 percent reduction in Min-K damage for risk-dominant breaks, (ii) assigning more credit to operator actions to mitigate strainer clogging, (iii) accounting for distribution of debris to more strainers before switching to Suppression Pool Cooling mode (Reference 4). The licensee noted conservatisms in the computation of the ΔCDF such as considering Min-K as 100 percent fibrous debris, as well as defense-in-depth considerations described in Attachment 3 of (Reference 1). The NRC staff notes that computation of the ΔCDF includes considerations such as assuming immediate core damage with limited opportunity for recovery if any single strainer performance criterion was violated; conservative criteria for strainer failure; and not crediting LBLOCA reduced or terminated spray flow rates as directed by EOP, as well as using alternative clean water sources. The NRC staff also notes that the licensee identified performance monitoring strategies to ensure that inputs and assumptions of the LAR remain valid. The NRC staff concluded that the sensitivity to NUREG-1829 LOCA break frequencies based on the AM aggregation does not change the license's conclusion of very low risk (in RG 1.174 Region III) because conservatisms exist in the licensee's assessment that can offset the impact of the use of AM aggregation. The NRC staff continues to view the aggregation method of the NUREG-1829 LOCA break frequencies as a key assumption and source of uncertainty for the systematic risk assessment. The staff is not endorsing any specific aggregation method of NUREG-1829 LOCA expert-elicited frequencies for general use. It is noted that the licensee risk-informed analysis relying on GM NUREG-1829 LOCA break frequencies is consistent with precedent submittals examining the risk of debris interacting with the ECCS such as the STP pilot program (Reference 13), as noted by the licensee in Attachment 4 of the LAR supplement (Reference 4).

The NRC staff concluded that the licensee addressed dominant uncertainties in sensitivity analyses. The licensee's approach to compute the ΔCDF only includes a few factors. Other factors, such as uncertainty in fiber generated and transported, were addressed for example by using guidance with safety margin in the ZOI and consideration of bounding transport fractions. Other failure modes and secondary break sources were properly screened and excluded.

<u>NRC Staff Conclusion Regarding the Systematic Risk Assessment</u>

The NRC staff evaluated the systematic risk assessment methodology and concluded it acceptable because inputs and assumptions (e.g., initiating event frequencies LOCA breaks) were derived using NRC accepted methods and state of practice data and approaches, scenarios that affect the risk assessment were adequately identified and included in the risk evaluation, elements of the risk evaluation were developed in a systematic and acceptable manner, and key assumptions were appropriately considered and described. The NRC staff verified selected computations in support of the ΔCDF. Therefore, the licensee used a verifiable and robust methodology to calculate the risk attributable to debris.

The licensee properly considered sources of uncertainty in the computation of the ΔCDF and ΔLERF. The NRC staff found acceptable the conclusion that ΔCDF and ΔLERF belong in RG 1.174 risk Region III, based on the licensee's Baseline computations, as well as the licensee's factors contributing to safety margins, evaluated in Section 3.3, "Key Principle 3: The Proposed Change Maintains Sufficient Safety Margins" of this SE, and factors contributing to DID.

3.5 Key Principle 5: The Impact of the Proposed Change Should Be Monitored Using Performance Strategies

RG 1.174, Section C.3, "Element 3: Define Implementation and Monitoring Program," states, in part, that:

The primary goal of Element 3 is to ensure that no unexpected adverse safety degradation occurs because of the change(s) to the licensing basis. The NRC staff's principal concern is the possibility that the aggregate impact of changes that affect a large class of SSCs could lead to an unacceptable increase in the number of failures from unanticipated degradation, including possible increases in common-cause mechanisms. Therefore, an implementation and monitoring plan should be developed to ensure that the engineering evaluation conducted to examine the impact of the proposed changes continues to reflect the actual reliability and availability of the SSCs evaluated. This ensures that the conclusions drawn from the evaluation remain valid.

In its submittal dated June 13, 2023 (Reference 1), the licensee stated that it has implemented programs and procedures to control potential sources of debris in containment, including both the drywell and suppression pool. The licensee stated that its design change control procedure includes provisions for managing potential debris sources such as insulation, qualified and unqualified coatings, and potential effects of post-LOCA debris on RHR and CSS flow through the strainers. The licensee has procedures to ensure the following areas are adequately addressed:

- RCPB integrity
- Suppression pool cleanliness
- Quantity or type of coatings inside containment
- Change or addition of thermal insulation
- Change or addition of labels

The licensee stated that the design process requires changes within containment that could affect the debris amounts inside containment are considered. The licensee also stated that the debris amounts are documented in DC-5979 Vol. I, Rev. A (Reference 40) and Rev. 2 (Reference 41), and that these documents were reviewed to ensure that the effects of any debris load changes would be understood. The design review checklist specifically states, "All design materials (coatings, labels, insulation, etc.) have been reviewed and do not introduce new or additional existing potential ECCS suction strainer debris. Installation instructions specify removal of paper and plastic labels/stickers prior to installation of new or replacement components inside primary containment. All new labeling installed inside primary containment complies with … that such labels be metallic."

The licensee also stated that for the purpose of monitoring future facility changes or other conditions that may impact the PRA results, appropriate changes to the as-built, as-operated plant are reflected in updates to the Fermi PRA model. The licensee has instituted a procedure that directs the responsibilities and guidelines for updating the full power internal events PRA model. The procedure also provides the process for making regularly scheduled and interim PRA model updates for issues that are identified as potentially affecting the PRA models. The licensee stated that these procedures are adequate to ensure that the PRA model remains an accurate description of the as-built, as-operated plant.

Additionally, licensed operators are trained, and procedures have been developed to take operator action in the event that injection via the RHR or CSS strainers become blocked. The licensee provided a discussion of DID actions in (Reference 1), Attachment 3, Section 6.2, and in its response to STSB-RAI-14 (Reference 3). The licensee stated that these DID actions are not credited in the risk analysis ΔCDF calculations for the Baseline, but the Modified and Final Baseline cases credit limited operator actions in Scenario 2 using a conservative assumption for probability of operator failure to mitigate strainer blockage effects The licensee cited actions to reduce flow through the strainer, backflush the strainer, and use alternate injection flowpaths for RCS makeup. The licensee cited several clean injection sources that do not rely on the suppression pool or flow through the ECCS strainer.

The NRC staff reviewed the licensee's information and concluded that the licensee's monitoring program is acceptable because it is consistent with the guidance in RG 1.174, Section C.3.

3.6 TECHNICAL EVALUATION CONCLUSION

The licensee’s proposed updated FSAR changes discussed in its submittal [(Reference 1), Attachment 1-2] and RAI response (Reference 2) were reviewed by the NRC staff and determined to accurately describe the licensing basis for Fermi with respect to the effects of debris on the ECCS strainers. The proposed changes describe how the effects of debris are evaluated and how these effects are analyzed to affect the ECCS and CSS strainers. During the audit (Reference 24,25), the NRC staff determined that additional information regarding the FSAR changes was required and asked RAIs [(Reference 50) (STSB-RAI-2, 3, 4, and 5)] requesting clarifications or additions to the FSAR proposed revisions. In these RAIs, the NRC staff requested that the licensee provide: 1) details on the analysis including how the risk-informed and deterministic analyses combine to establish the licensing basis; specification of the design limits; and clarification on whether the risk analysis would be used to evaluate future conditions or only apply to the current condition, 2) the key methods of the analysis that cannot be changed without NRC approval, 3) how the design limits are used to establish system operability, and 4) clarification on requirements to meet Key Principle 5 of RG 1.174.

The licensee provided a revised markup of the affected FSAR sections. The NRC staff reviewed the updated markup (Reference 2). The NRC staff asked clarifying questions regarding the miscellaneous debris description in the markup during the audit (Reference 25). The licensee provided an additional update to the FSAR markup in the LAR supplement dated October 31, 2024 (Reference 4). The markup provided in Reference 4 includes all of the proposed changes to the FSAR. The description of the key methods used in the risk-informed evaluation, as reflected in the final markup, was found to be acceptable. Any change in these methods is to be evaluated to determine departures from an approved methodology as described in the FSAR. In the markup, the licensee stated that the debris limits in DC-5979, Revision 2 (Reference 41) provide for system operability. The FSAR markup also refers to the risk-informed analysis contained in the LAR [(Reference 1), Attachment 3] and provides a brief summary of the analysis including the use of the risk analysis and the deterministic debris limits. The licenses RAI responses of May 30, 2024, (Reference 3) provide some changes to the risk-informed analysis. The markup in the first RAI response (Reference 2) clarifies that the risk analysis applies only to the current plant conditions. The final markup (Reference 4), which includes all of the markup pages, clarifies that the limits in the FSAR do not allow for the purposeful addition of any debris source to containment. Future additions, if proposed, are required to be evaluated by the licensee.

The NRC staff concluded that the proposed FSAR changes are acceptable.

As discussed in this SE, the NRC staff reviewed the licensee's LAR, including the supplemental information provided. The NRC staff finds that the information provided by the licensee demonstrates that there is reasonable assurance that debris will not adversely affect the ability of RHR or the CSS to perform their functions at Fermi. The NRC staff's conclusions are described in detail in the previous sections of this SE. The NRC staff finds that the licensee adequately addressed most LOCA break scenarios using approved deterministic methods or conservative criteria for strainer failure. The licensee demonstrated that the risk associated with scenarios that do not meet deterministic criteria is very small. A limited set of LOCA break scenarios that generate Min-K debris loads greater than the design basis qualified loads for the strainers and that do not meet the acceptance criteria using the accepted deterministic methods resulted in the increase in risk. To complete its evaluation of these lowrisk scenarios, the licensee demonstrated- that the five key principles of RG 1.174, Rev. 3 (Reference 23), were met. Therefore, the NRC staff concluded that the licensee's riskinformed -methodology for assessing the effects of debris on the ECCS and CSS at Fermi (including submodels and integration of the submodels) demonstrates that the requirements of 10 CFR 50.46 will not be adversely affected by debris.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Michigan State official was notified of the proposed issuance of the amendment on January 17, 2025. The State official did not have any comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment allows the use of risk-informed method to evaluate the impact of potential LOCA generated debris sources on the ECCS suction strainer performance and changes the UFSAR to document that. The NRC staff has determined that the amendment involves no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, as published in the *Federal Register* on September 5, 2023 (88 FR 60717), and there has been no public comment on such finding. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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7.0 REFERENCES

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SUBJECT: FERMI-2 - ISSUANCE OF AMENDMENT NO. 230 REGARDING REVISION OF FINAL SAFETY ANALYSIS REPORT TO ALLOW USE OF RISK-INFORMED APPROACH FOR EVALUATING EMERGENCY CORE COOLING SYSTEM STRAINERS (EPID L-2023-LLA-0092) DATED FEBRUARY 18, 2025

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