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

September 29, 2016

Mr. Paul Fessler
Senior Vice President and
Chief Nuclear Officer
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Fermi 2-210 NOC
6400 North Dixie Highway
Newport, MI 48166

SUBJECT: FERMI, UNIT 2 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0770 AND MF0771)

Dear Mr. Fessler:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond- Design-Basis External Events" and Order EA-12-051, "Issuance of Order to Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML12054A736 and ML12054A679, respectively). The orders require holders of operating reactor licenses and construction permits issued under Title 10 of the *Code of Federal Regulations* Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit for review Overall Integrated Plans (OIPs) that describe how compliance with the requirements of Attachment 2 of each order will be achieved.

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A262), DTE Electric Company (DTE, licensee) submitted its OIP for Fermi, Unit 2 (Fermi) in response to Order EA-12-049. At six-month intervals following the submittal of the OIP, DTE submitted reports on its progress in complying with Order EA-12-049. These reports were required by the order, and are listed in the attached safety evaluation (SE). By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all operating power licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits," (ADAMS Accession No. ML082900195). By letters dated November 25, 2013 (ADAMS Accession No. ML13220A133), and October 1, 2015 (ADAMS Accession No. ML15245A287), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated January 20, 2016 (ADAMS Accession No. ML16022A118), DTE submitted a compliance letter and Final Integrated Plan in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A285), DTE submitted its OIP for Fermi in response to Order EA-12-051. At six-month intervals following the submittal of the OIP, DTE submitted reports on its progress in complying with Order EA-12-051.

These reports were required by the order, and are listed in the attached SE. By letters dated November 21, 2013 (ADAMS Accession No. ML13309B129), and October 1, 2015 (ADAMS Accession No. ML15245A287), the NRC staff issued an ISE and audit report, respectively, on DTE's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all operating power licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated January 20, 2016 (ADAMS Accession No. ML16022A117), DTE submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed SE provides the results of the NRC staff's review of DTE's strategies for Fermi. The intent of the SE is to inform DTE on whether or not its integrated plans, if implemented as described, provide a reasonable path for compliance with Orders EA-12-049 and EA-12-051. The NRC staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515/191, "Inspection of the Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans," Revision 1 (ADAMS Accession No. ML15257A188). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact Stephen Monarque, Orders Management Branch, Fermi Project Manager, at 301-415-1544 or at Stephen.Monarque@nrc.gov.

Sincerely,

Mandy K Halter

Mandy K. Halter, Chief
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No.: 50-341

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDERS EA-12-049 AND EA-12-051

DTE ELECTRIC COMPANY

FERMI, UNIT 2

DOCKET NO. 50-341

1.0 INTRODUCTION

The earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011, highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation and emergency preparedness defense-in-depth layers already in place in nuclear power plants in the United States. At Fukushima, limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure. During the events in Fukushima, the challenges faced by the operators were beyond any faced previously at a commercial nuclear reactor and beyond the anticipated design-basis of the plants. The U.S. Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed at U.S. commercial power reactors to mitigate such beyond-design-basis external events (BDBEEs).

On March 12, 2012, the NRC issued Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 4]. This order directed licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities in the event of a BDBEE. Order EA-12-049 applies to all power reactor licensees and all holders of construction permits for power reactors.

On March 12, 2012, the NRC also issued Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" [Reference 5]. This order directed licensees to install reliable SFP level instrumentation with a primary channel and a backup channel, and with independent power supplies that are independent of the plant alternating current (ac) and direct current (dc) power distribution systems. Order EA-12-051 applies to all power reactor licensees and all holders of construction permits for power reactors.

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic and methodical review of the NRC regulations and processes and determining if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 [Reference 1]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012, the NRC staff provided SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," [Reference 2] to the Commission. This paper included a proposal to order licensees to implement enhanced mitigation strategies, and install enhanced SFP instrumentation. As directed by the Commission in staff requirements memorandum (SRM)-SECY-12-0025 [Reference 3], the NRC staff issued Orders EA-12-049 and EA-12-051 on March 12, 2012.

2.1 Order EA-12-049

Order EA-12-049, Attachment 2, [Reference 4] requires that operating power reactor licensees and construction permit holders use a three-phase approach for mitigating BDBEEs. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and SFP cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Specific requirements of the order are listed below:

1) Licensees or construction permit (CP) holders shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event.

2) These strategies must be capable of mitigating a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink [UHS] and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this Order.

3) Licensees or CP holders must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this Order.

4) Licensees or CP holders must be capable of implementing the strategies in all modes.

5) Full compliance shall include procedures, guidance, training, and acquisition, staging, or installing of equipment needed for the strategies.

On August 21, 2012, following several submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0 [Reference 6] to the NRC to provide specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Order EA-12-049. The NRC staff reviewed NEI 12-06 and on August 29, 2012, issued Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 7], endorsing NEI 12-06, Revision 0 [Reference 6], with clarifications, as an acceptable means of meeting the requirements of Order EA-12-049. On September 7, 2012, the NRC staff published a notice of the availability of JLD-ISG-2012-01 in the *Federal Register* (77 FR 55230).

2.2 Order EA-12-051

Order EA-12-051, Attachment 2, [Reference 5] requires that operating power reactor licensees and construction permit holders install reliable SFP level instrumentation. Specific requirements of the order are listed below:

> All licensees identified in Attachment 1 to the order shall have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel: (1) level that is adequate to support operation of the normal fuel pool cooling system, (2) level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.
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> 1. The spent fuel pool level instrumentation shall include the following design features:
>
> 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
>
> 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.

1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the spent fuel pool structure.

1.4 Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool water at saturation conditions for an extended period. This reliability shall be established through use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).

1.5 Independence: The primary instrument channel shall be independent of the backup instrument channel.

1.6 Power supplies: Permanently installed instrumentation channels shall each be powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable generators or replaceable batteries. Onsite generators used as an alternate power source and replaceable batteries used for instrument channel power shall have sufficient capacity to maintain the level indication function until offsite resource availability is reasonably assured.

1.7 Accuracy: The instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration.

1.8 Testing: The instrument channel design shall provide for routine testing and calibration.

1.9 Display: Trained personnel shall be able to monitor the spent fuel pool water level from the control room, alternate shutdown panel, or other appropriate and accessible location. The display shall provide on-demand or continuous indication of spent fuel pool water level.

2. The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of the following programs:

2.1 Training: Personnel shall be trained in the use and the provision of alternate power to the primary and backup instrument channels.

2.2 Procedures: Procedures shall be established and maintained for the testing, calibration, and use of the primary and backup spent fuel pool instrument channels.

2.3 Testing and Calibration: Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup spent fuel pool level instrument channels to maintain the instrument channels at the design accuracy.

On August 24, 2012, following several NEI submittals and discussions in public meetings with NRC staff, the NEI submitted document NEI 12-02, "Industry Guidance for Compliance With NRC Order EA-12-051, To Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1 [Reference 8] to the NRC to provide specifications for an industry-developed methodology for compliance with Order EA-12-051. On August 29, 2012, the NRC staff issued its final version of JLD-ISG-2012-03, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation" [Reference 9], endorsing NEI 12-02, Revision 1 [Reference 8], as an acceptable means of meeting the requirements of Order EA-12-051 with certain clarifications and exceptions. On September 7, 2012, the NRC staff published a notice of the availability of JLD-ISG-2012-03 in the *Federal Register* (77 FR 55232).

3.0 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated February 28, 2013 [Reference 10], DTE Energy Company (DTE, the licensee) submitted its Overall Integrated Plan (OIP) for Fermi, Unit 2 (Fermi) in response to Order EA-12-049. By letters dated August 26, 2013 [Reference 11], February 27, 2014 [Reference 12], August 28, 2014 [Reference 13], February 23, 2015 [Reference 14], and August 27, 2015 [Reference 48], the licensee submitted six-month updates to the OIP. By letter dated August 28, 2013 [Reference 15], the NRC notified all operating power licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 36]. By letters dated November 25, 2013 [Reference 16] and October 1, 2015 [Reference 17], the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated January 20, 2016 [Reference 18], the licensee reported that full compliance with the requirements of Order EA-12-049 was achieved, and submitted a Final Integrated Plan (FIP).

3.1 Overall Mitigation Strategy

Attachment 2 to Order EA-12-049 describes the three-phase approach required for mitigating BDBEEs in order to maintain or restore core cooling, containment and SFP cooling capabilities. The phases consist of an initial phase (Phase 1) using installed equipment and resources, followed by a transition phase (Phase 2) in which portable onsite equipment is placed in service, and a final phase (Phase 3) in which offsite resources may be placed in service. The timing of when to transition to the next phase is determined by plant-specific analyses.

While the initiating event is undefined, it is assumed to result in an extended loss of ac power (ELAP) with loss of normal access to the ultimate heat sink (LUHS). Thus, the ELAP with LUHS is used as a surrogate for a BDBEE. The initial conditions and assumptions for the analyses are stated in NEI 12-06, Section 3.2.1, and include the following:

1. The reactor is assumed to have safely shut down with all rods inserted (subcritical).
2. The dc power supplied by the plant batteries is initially available, as is the ac power from inverters supplied by those batteries; however, over time the batteries may be depleted.

3. There is no core damage initially.
4. There is no assumption of any concurrent event.
5. Because the loss of ac power presupposes random failures of safety-related equipment (emergency power sources), there is no requirement to consider further random failures.

Fermi is a General Electric boiling-water reactor (BWR) Model 4 with a nitrogen-inerted Mark I containment. The FIP describes the licensee's three-phase approach to mitigate a postulated ELAP event. The specific mitigating strategy implemented by the licensee would depend upon whether the extreme natural hazard initiating the event occurs without warning or if the plant would receive advanced warning (e.g., a pending severe flood).

In the case of an ELAP event without advanced warning, the reactor is assumed to trip from full power. The main condenser is isolated from the reactor due to the automatic closure of the main steam isolation valves (MSIVs), and feedwater flow to the reactor is also lost. Decay heat is removed by safety relief valves (SRVs) opening in response to high pressure and venting steam from the reactor pressure vessel (RPV) to the suppression pool. Makeup to the RPV is provided by the turbine-driven reactor core isolation cooling (RCIC) pump, which will automatically initiate and will be used as necessary to restore and maintain RPV water level. Because the condensate storage tank (CST) is not robust, the licensee's mitigating strategy assumes that the RCIC pump suction realigns to the suppression pool. Reactor pressure will be controlled by the SRVs. Plant operators may also operate the high-pressure (HPCI) system to reduce the need for recycling SRVs. The suppression pool is heated from the exhaust steam discharged from the SRVs and the RCIC system, as well as the HPCI system, if used.

After either (1) determining that installed on-site and off-site ac power sources are unlikely to be restored within the station blackout (SBO) coping time of 4 hours or (2) 45 minutes has elapsed with no reasonable expectation of restoration of ac power, the operating crew at Fermi initiates the mitigating strategies.

The Phase 1 core cooling strategy relies on RCIC and SRVs. The coping time for Phase 1 is approximately 5 hours for the limiting case. The Phase 2 primary strategy uses FLEX pumps to establish "feed and bleed" to cool the suppression pool, thereby extending the use of RCIC. FLEX pumps are used to "feed" cool water from the circulating water (CW) reservoir to the suppression pool. The HPCI system is used to "bleed" heated water from the suppression pool back to the CW reservoir. The flow path is through the HPCI test line through cross-connect piping to the general service water (GSW) system, which discharges to the CW reservoir. If feed-and-bleed is effective (as analyzed), the licensee will continue to provide RPV makeup from the RCIC system until the gradual reduction in RPV pressure, resulting from diminishing decay heat, requires a transition to Phase 2. The RCIC injection source will be maintained for as long as possible, since it would be operated in a closed-loop configuration using relatively clean suppression pool water. To support continued operation of the RCIC and HPCI systems, the protective logic for these systems is bypassed to defeat all trips. In a scenario where feed-and-bleed cannot be established, the torus hardened vent system will be used for containment heat removal. Supplemental cooling water for the RCIC and HPCI systems is established to allow these systems to cool the reactor core. The compressed air and electrical power needed for operation of the torus hardened vent are restored as part of the FLEX response. If necessary due to the unavailability of HPCI/RCIC, such as following depressurization of the reactor, FLEX pumps could be used to inject water into the RPV via RHR system piping.

DTE will perform dc load stripping to remove any loads not needed for ELAP response. A portable 480-voltage alternating current (Vac) generator is deployed within 12 hours and used to restore the battery chargers and other loads. Once FLEX ac power is available, DTE would attempt to isolate reactor recirculation pump suction and discharge valves and reactor water cleanup system valves to reduce the recirculation pump seal leakage, which in turn reduces the rate of drywell pressure increase.

Portable, diesel-driven FLEX water pumps, hoses and associated equipment are deployed to establish a flow path from the CW reservoir to one of two exterior connections to the residual heat removal (RHR) system. Through valve manipulation, the RHR system can be configured to direct flow to the RPV, SFP, or suppression pool. The licensee stated that the initial flow from the FLEX pumps will be directed to the SFP, which simultaneously accomplishes two objectives in that, in the process of filling and venting FLEX hoses, makeup will be provided to the SFP.

The licensee's response to a flooding event has some important differences relative to the non-flooding event. Due to the expectation of advanced warning for the limiting flooding event, preparatory actions may be taken. The licensee has entered into a Letter of Agreement with the National Weather Service (NWS) to provide a minimum 48-hour notification of conditions conducive to a bounding flooding event. Upon receipt of the NWS notification, procedures direct the plant to be brought to cold shutdown in a timely and controlled manner, and augmented personnel and resources would be brought on-site and staged in protected locations prior to the event. The licensee also takes actions to extend the plant response in anticipation that deployment of FLEX equipment may be delayed. The licensee would perform a deeper load shed, such that batteries can last for 24 hours. Feed-and-bleed would be established for containment heat removal. Following the ELAP, the reactor (having been brought to cold shutdown after notification of a severe flood warning), would repressurize and provide steam for RCIC, which would be used to maintain RPV water level and provide bleed flow from the suppression pool. The HPCI is also available to provide additional bleed flow if needed to respond to a high decay heat load. The advanced warning period would also allow the licensee to raise the water level in the main condenser hot well, such that it can serve as an additional heat sink for residual heat from the reactor, thereby prolonging the availability of the suppression pool. When reactor pressures are low enough, a FLEX water source will be utilized for reactor heat removal.

For Phase 3, resources from the National Strategic Alliance for FLEX Emergency Response (SAFER) Response Center (NSRC) will be utilized to augment the strategies used in Phase 2.

The licensee performed a containment evaluation and determined that its strategies for containment heat removal will allow containment temperature and pressure to stay within acceptable levels until equipment from the NSRC can be set up for cooling of the suppression pool.

The SFP is located in the reactor building. The pool will initially heat up due to the unavailability of the normal cooling system. The licensee has calculated that, depending on the spent fuel loading in the pool, boiling could start as soon as 4.2 hours after the start of the ELAP. The SFP water level would drop to a level of ten feet above the top of fuel in a minimum of 28 hours. The licensee determined that habitability on the pool operating deck area could become compromised as early as 4.2 hours after the ELAP. In order to maintain SFP cooling capabilities, DTE stated that it will establish the water injection lineup before the environment on the SFP operating deck degrades from boiling in the SFP so that personnel can access the refuel floor to perform the coping strategies.

In order to provide make up to the SFP, DTE has a primary and alternate strategy to account for the condition of the SFP. The primary SFP strategy is to refill the SFP via RHR as described above. The alternate strategy would be to connect FLEX hoses to a diesel-powered FLEX pump, using installed cross connections from the FLEX supply to the fire header. The discharge ends of these hoses are either routed all the way to the SFPs, with the discharge ends positioned over the edge of the pool or connected to nozzles that spray the water over the spent fuel. These will be positioned prior to the refuel floor becoming uninhabitable.

The dc bus load stripping would be initiated within the first hour to ensure safety-related battery life is extended to at least 12 hours. When an extensive load shed is performed due to a flooding event, the battery service time is extended to 24 hours. Following dc load stripping and prior to battery depletion, one of the two FLEX portable 480 Vac diesel generators (DGs), stored in FLEX Support Facility (FSF) 1, would be deployed to the FSF 1 building apron for operation. A permanent FLEX electrical distribution system is provided to deliver electrical power from the DG at FSF 1 to the plant electrical system connection points in the divisional vital switchgear rooms. The connection between the DG and the FLEX distribution at FSF 1 is made using staged cables connected between the DG and a wall mounted connection box in FSF 1. The connection in the switchgear room is made using staged cables from a connection box in the switchgear room to a "breaker insert device" (BID). This distribution system is an alternative strategy to the requirements of NEI 12-06, which is further described and evaluated later in Section 3.14 of this safety evaluation (SE).

3.2 Reactor Core Cooling Strategies

In accordance with Order EA-12-049, licensees are required to maintain or restore cooling to the reactor core in the event of an ELAP concurrent with a LUHS. Although the ELAP results in an immediate trip of the reactor, sufficient core cooling must be provided to account for fission product decay and other sources of residual heat. Consistent with endorsed guidance from NEI 12-06 [Reference 6], Phase 1 of the licensee's core cooling strategy credits installed equipment (other than that presumed lost to the ELAP/LUHS) that is robust in accordance with the guidance in NEI 12-06 [Reference 6]. In Phase 2, robust installed equipment is supplemented by onsite FLEX equipment, which is used to cool the core either directly (e.g., pumps and hoses) or indirectly (e.g., FLEX electrical generators and cables repowering robust installed equipment). The equipment available onsite for Phases 1 and 2 is further supplemented in Phase 3 by equipment transported from the NSRCs.

As reviewed in this section, the licensee's core cooling analysis for the ELAP/LUHS event presumes that, per endorsed guidance from NEI 12-06 [Reference 6], the reactor would have been operating at full power prior to the event and that no additional random failures occur. Therefore, primary containment integrity is being credited by the licensee, and the nominal suppression pool liquid volume during power operation is assumed to be available as a heat sink for core cooling during the ELAP/LUHS event. Maintenance of sufficient RPV inventory, despite blowdown from SRVs and the ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The specific means used by the licensee to accomplish adequate core cooling during the ELAP/LUHS event are discussed in further detail below. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions under which the reactor is shut down or being refueled is reviewed separately in Section 3.11 of this evaluation.

3.2.1 Core Cooling Strategy and RPV Makeup for Non-Flood Event

3.2.1.1 Phase 1

The non-flood ELAP event for Fermi is assumed to occur without warning. As a result of the loss of electrical power that initiates the ELAP event, the reactor is assumed to trip, with all control rods inserting into the core. The loss of electrical power should further result in isolation of the reactor via the closure of valves on piping (including the main steam and feedwater lines) that connects the reactor vessel to equipment located outside of the containment building. Although the worth of the inserted control rods should be sufficient to maintain the reactor core subcritical throughout the ELAP event, fission product decay and other sources of residual heat continue to heat up and pressurize the primary system following the reactor trip.

With the reactor isolated from the main feedwater system and main condenser, DTE's Phase 1 strategy for core cooling relies upon the use of installed plant equipment, including the RCIC and HPCI systems and SRVs, to remove residual heat from the reactor. Both the RCIC and HPCI systems use turbine-driven pumps powered by steam generated from core decay heat. At Fermi, this equipment can operate automatically under analyzed ELAP event conditions, with the SRVs discharging steam from the reactor vessel in response to elevated reactor pressure, and the RCIC system providing makeup to the reactor vessel upon indication of low water level. However, in accordance with plant emergency procedures, operators would assume manual control of the equipment necessary to provide core cooling.

The preferred suction source for the RCIC system is the condensate storage tank; however, because it is not robust to all hazards, it is not credited for mitigating the limiting ELAP event. Therefore, the licensee's analysis assumes that the RCIC system would draw suction from its robust backup source, the suppression pool. The licensee stated, during the audit, that the design-basis for Fermi ensures automatic transfer of the RCIC pump suction to the suppression pool when necessary; even if level transmitters for the condensate storage tank were destroyed by a missile strike, control logic should ensure automatic realignment. The suppression pool also serves as the heat sink for the steam discharged from the SRVs, thereby absorbing the residual heat from the reactor. The licensee stated that the HPCI and RCIC systems may also be operated electively in recirculation mode to reduce the need for cycling SRVs. As described in DTE's FIP [Reference 18], some residual energy can be dissipated through the work of the steam rotating the turbines used to power the RCIC and HPCI pumps, the exhaust from which is also discharged to the suppression pool.

According to the mitigating strategy for Fermi, plant operators would use the SRVs to depressurize the reactor in stages only when required by existing emergency operating procedures in response to violations of the suppression pool heat capacity limit at a given pressure. As the suppression pool absorbs residual heat from the reactor, its ability to absorb additional heat diminishes, thereby requiring reactor depressurization prior to the loss of the suppression pool as an effective heat sink. Depending upon the method of containment heat removal, DTE's thermal-hydraulic analysis predicts that depressurization would begin from the normal SRV pressure relief setpoint at approximately 3.9 hours and would be completed at approximately 4.9 hours at 400 per square inch gage (psig) (using feed-and-bleed cooling) or

5.1 hours at 200 psig (using containment venting). The licensee considered the end of Phase 1 as occurring approximately 5 hours into the event, since suppression pool cooling would become necessary at this time to support continued RCIC operation for reactor core cooling.

3.2.1.2 Phase 2

In Phase 2, the licensee's credited strategy for core cooling will depend upon whether the containment cooling strategy follows the preferred plant-specific feed-and-bleed method or the alternate method using the hardened containment vent. If the feed-and-bleed strategy is in effect, then the licensee expects that suppression pool temperature will be maintained below approximately 200 °F. Thus, this strategy should permit continued operation of RCIC in recirculation mode drawing suction from the suppression pool. Although the circulating water reservoir is robust for all ELAP initiating events, the feed-and-bleed cooling method may not be creditable in all scenarios, for example due to the failure of other equipment, such as the crosstie valve between the HPCI and general service water systems. In the case that the circulating water reservoir cannot be used, the licensee stated that a hardened containment venting strategy similar to that implemented at similarly designed BWRs would be used.

If containment venting becomes necessary, suppression pool temperatures in excess of 215 °F would be expected by approximately 5.9 hours into the event, with an approximate peak value of 260 °F by 15 hours into the event. Because operation of RCIC at increased temperatures in this range could result in reduced performance or equipment failure, the licensee does not credit operation of the RCIC pump above 215 °F. However, DTE stated that operators would attempt to use this system for as long as it remains functional. Similarly, the licensee noted that suction temperatures in excess of 200 °F could lead to an increased likelihood of seal failures for the RCIC or HPCI pumps at Fermi. The licensee stated that the suppression pool temperature would not rise above this value prior to 5 hours for the analyzed ELAP event, which would allow FLEX pumps to be set up prior to the suction temperature rising into the range where seal failure could become more likely. The licensee's FIP [Reference 18] further states that when the containment venting strategy is implemented, supplemental cooling water would be provided for both RCIC and HPCI. However, the licensee's mitigating strategy aligns FLEX equipment to provide reactor core cooling, independent of RCIC and HPCI, by 5 hours into the event and credits the functionality of this equipment when the suppression pool temperature exceeds 215 °F.

The licensee's Phase 2 FLEX equipment used for cooling the reactor core consists of two redundant sets of pumps connected in series via collapsible hose to provide flow for multiple uses during the ELAP event. Each set includes a main suction pump (i.e., Neptune pump), along with its floating lift pump (i.e., Triton pump), which are used to draw suction on the circulating water reservoir, along with a booster pump (i.e., Dominator pump). Discharge flow from the Dominator pump can be directed to diverse connection points on either division of the RHR system, from where it can be used to supply makeup flow to the reactor vessel (as well as the suppression pool and SFP). The licensee stated that the discharge of the Neptune pump has a relief valve that is set for 180 psig, and that the discharge side of the Dominator pump has no relief valve. The licensee further stated during the audit that the maximum pressure differential for the Dominator pump would be approximately 185 pounds per square inch differential. The NRC staff understood that the hose used to supply flow via these FLEX pumps is rated for 175 psig and has a burst pressure of approximately 400 psig. Based on the information provided by the licensee, the NRC staff concluded that operators should use caution when operating the Dominator pump, since even a moderate pressure boost could result in exceeding rated hose pressure. However, according to the information provided by the licensee, even in the case of erroneous operation, the burst pressure of the FLEX hose should not be exceeded.

The licensee's FLEX strategy for core cooling involves the use of raw water sources. The licensee's strategy attempts to minimize the potential for inadequate core cooling as a result of water-quality issues via several means. First, if reactor-grade water is available in the condensate storage tank, it would initially be used to supply RCIC suction in lieu of the suppression pool. Second, strainers are present on the FLEX pumps, both to protect these pumps from debris, as well as to prevent blockage in downstream flowpaths, including the reactor core. Coarse strainers with 1.5-inch openings are present on the Triton lift pump. Because their suction point is located approximately 2.5 to 3 feet beneath the water surface, the potential for clogging these strainers is reduced. However, should clogging occur, the licensee concluded that the strainer could be cleaned and restored to operation within 25 minutes, which timeframe the licensee further concluded would be acceptable. In addition, fine-mesh duplex strainers with 20-mesh openings are located upstream of the Neptune pump. The use of duplex strainers supports continuous flow through one strainer while the other is being cleaned. During the audit, DTE stated that openings in the duplex strainers are sized to protect clearances in both system valves and fuel assembly lower tie plates. Third, in alignments where FLEX flow is supplied to the suppression pool prior to being injected into the core via the RCIC pump, debris suspended in the FLEX flowstream may have the opportunity to settle in the suppression pool volume prior to being injected into the reactor vessel. In this case, the RCIC suction strainers in the suppression pool add an additional level of filtration capability. However, the NRC staff notes that the fuel assemblies have fine mesh screens at the inlet and, thus, a relatively high sensitivity to debris clogging. The licensee confirmed that the reactor vessel water level would be procedurally maintained above the minimum level necessary to ensure downflow of liquid through the steam separators. Thus, even if blockage were to occur at the fuel assembly inlets, water would have the opportunity to drain into the fuel assembly through the larger openings at the outlet of the bundle.

In Phase 2, DTE intends to deploy a portable 480 Vac generator, the operation of which would facilitate several aspects of the core cooling strategy. In particular, the availability of this electrical power source would permit powering dc loads associated with the RCIC and HPCI systems, including barometric condensers that reduce the rate of local water accumulation. Furthermore, the logic for protective trips for these systems would be bypassed, which is intended to prevent unnecessary interruptions in flow when system operation is demanded to support mitigation of the ELAP event. In addition, electrical power would be restored to the suction and discharge valves on the recirculation pumps, which may permit the isolation of these valves, thereby reducing recirculation pump seal leakage.

A portable, diesel-powered air compressor would further be deployed to provide compressed air to support SRV operation in Phase 2 and for indefinite coping in Phase 3. This air compressor would also allow operation of the hardened containment vent, if necessary.

While the circulating water reservoir is robust to all analyzed hazards, the licensee further indicated, during the audit, that the general service water intake on Lake Erie could serve as an alternate water source for FLEX equipment. The licensee stated that, although shoreline access is less convenient than for the circulating water reservoir, such that additional effort and time may be required to establish FLEX flow, it is an additional contingency option available for supplying water to mitigate an ELAP event.

3.2.1.3 Phase 3

According to DTE's FIP, the core cooling function could be continued indefinitely using the basic strategies developed using Phase 2 equipment. However, as required to satisfy Order EA-12-049, the arrival of additional equipment from offsite response centers in Phase 3 will provide additional capability and redundancy to supplement the Phase 2 strategies and equipment. The licensee's FIP states that the initial delivery of Phase 3 equipment to the site will occur within 24 hours of notification of an ELAP event.

3.2.2 Core Cooling Strategy and RPV Makeup for Flood Event

The licensee's strategy for mitigating the analyzed limiting flooding event for the Fermi site differs significantly from the description above for the non-flooding event in that the licensee expects to receive warning at least 48 hours in advance of the forecasted arrival of floodwaters per an agreement with the National Weather Service.

Upon receipt of notification that the limiting flood event is pending, the licensee would begin an orderly shutdown of the reactor, powering down and then scramming the unit in accordance with existing procedures at approximately 44 hours before the event. The reactor would subsequently be cooled down and depressurized, with the licensee predicting that cold shutdown could be achieved approximately 38 hours prior to the forecasted arrival of floodwaters.

In the flood-induced ELAP scenario, the licensee stated that plant operators would be procedurally directed to increase the water level in the condenser hotwell and to use this mass of water as a heat sink to reduce the rate of heatup for the suppression pool. To effect this strategy, main steam line drains would be opened at the onset of the ELAP event, which would allow a fraction of the steam generated in the reactor vessel to bypass the main steam isolation valves and reach the condenser hotwell, where it would be quenched. The licensee stated that the increased hotwell water level intended for mitigating the flooding event is typically used in routine evolutions during refueling outages. The licensee further stated that unanalyzed loads (e.g., steam impingement, condensation oscillation) would not be involved with the use of this configuration to mitigate an ELAP event, since this main steam line drain configuration is a typical configuration used during a normal plant startup. The licensee further stated that a rupture disk that provides overpressure protection for the condenser would be located well above the maximum water level encountered while applying this strategy under analyzed ELAP conditions.

The licensee stated, during the audit, that a vapor flowrate of 25,000 pounds mass (lbm) per hour could be transferred to the condenser by the main steam line drain flowpath, but did not have a documented calculation to support this value. In response to NRC staff questions during the audit, the licensee provided additional information concerning the characteristics of the piping and components in this flowpath. Based upon the audited information, the NRC staff performed confirmatory calculations, which indicated that a flowrate of 25,000 lbm per hour should be achievable. In light of the energy removal rate afforded by this nominal mass flow rate, simultaneous absorption of some fraction of the core decay heat by the suppression pool would also be required, as discussed above, using SRVs and potentially the RCIC and HPCI systems. The licensee further calculated that the condenser hotwell could accept approximately 570,000 lbm of steam prior to reaching a bulk boiling condition. Absorption of this steam in the main condenser would significantly extend the time for which the suppression pool can serve as a water supply and heat sink for the reactor. The NRC staff confirmatory calculations indicated that the condenser should be capable of condensing 570,000 lbm of steam from the reactor prior to the initiation of bulk boiling. During the audit, DTE clarified that as steam is being dumped in the condenser, vapor evaporated from the condenser would be continuously vented to the turbine building local atmosphere; whereas, venting of the condenser was not specifically reflected in the licensee's calculations. The NRC staff estimated that several thousand pounds of gas (i.e., air and water vapor) may be vented from the condenser to the turbine building as the result of quenching 570,000 lbm of steam in the condenser. The licensee stated that no FLEX actions are required to be taken in the turbine building in the vicinity of the discharge of the vent from the condenser and, furthermore, that the venting of this gas would not adversely affect the FLEX strategy.

During the audit, the NRC staff considered the capability of plant operators to haul heavy equipment over muddy ground that may exist in the wake of the limiting flooding event. The licensee stated that the Neptune and Dominator FLEX pumps would be deployed on concrete aprons surrounding the FLEX storage buildings where they are housed. However, soon after the recession of floodwaters, a trailer containing a flow manifold that is used to control the FLEX flow to different locations would need to be deployed across muddy ground. The licensee stated that, if necessary, a bulldozer could be used to deploy the flow manifold trailer.

3.2.3 Staff Evaluations

3.2.3.1 Availability of Structures, Systems, and Components (SSCs)

Guidance document NEI 12-06 [Reference 6] provides guidance that the baseline assumptions have been established on the presumption that other than the LUHS, installed equipment that is designed to be robust with respect to design basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Below are the baseline assumptions for the availability of SSCs for core cooling during an ELAP caused by a BDBEE.

3.2.3.1.1 Plant SSCs

Core Cooling and RPV Makeup

The licensee described in its FIP [Reference 18], that the RCIC System is used to assure core cooling in response to loss of feed water flow and isolation of the reactor from the main condenser heat sink. The licensee indicated that the RCIC system uses a steam turbine driven pump to deliver water to the RPV from either the CST or the suppression pool. The steam exhaust from the RCIC turbine discharges to the suppression pool. During an ELAP, RCIC will take suction first from the CST, if available, and then from the suppression pool. The CST is not credited as part of the overall FLEX strategy since it is vulnerable to external hazards. The CW reservoir is credited as the primary and fully protected water source throughout the ELAP/LUHS event. The FLEX Pumps can utilize the CW reservoir to provide make-up water to the RPV, suppression pool, and SFP. The licensee also described the HPCI system as being operated to discharge heated water from the suppression chamber. The flow path is the HPCI test line to a cross-connect to the GSW system which discharges to the CW reservoir. The portable FLEX injection pumps supply cool water to the suppression chamber from the CW reservoir. The Torus Hardened Vent system can also be used for containment heat removal in the event that the HPCI is unavailable. The licensee also described the SRVs as being able to automatically cycle for initially controlling reactor pressure until the control room operators manually control RPV pressure by operation of the RCIC/HPCI systems or manually initiating SRV openings to maintain RPV pressure in accordance with existing Emergency Operating Procedures (EOPs). All of the above components are located within the Reactor Building, which is described in Section 3.8 of the Fermi, Unit 2, Updated Final Safety Analysis Report (UFSAR) as a seismically robust and fully protected from all external hazards.

Based on the location and design of the credited plant SSCs, as described in licensee's UFSAR, and if implemented according to the overall FLEX strategy as described in the FIP [Reference 18], the credited plant SSCs should be available to support core cooling during an ELAP, consistent with NEI 12-06 [Reference 6], Section 3.2.1.3, Condition 6.

3.2.3.1.2 Plant Instrumentation

The licensee's FIP identifies the following instrumentation required to implement the core cooling strategy:

- RPV wide-range level indication
- RPV pressure
- RCIC suction pressure
- RCIC discharge pressure

The RPV level and pressure instrumentation identified by the licensee to support its core cooling strategy is consistent with the recommendation specified in the endorsed guidance of NEI 12-06 [Reference 6], whereas the availability of instrumentation for RCIC suction and discharge pressure exceeds these recommendations.

The licensee plans to monitor indication for the above instruments from the main control room. This instrumentation is powered by batteries and will be maintained throughout the event; it will be available prior to and after load stripping of the dc and ac buses during Phase 1, and supported via battery chargers powered by the FLEX DGs in Phases 2 and 3. Therefore, based upon the information provided by the licensee, the NRC staff understands that indication for the above instruments would be available and accessible continuously throughout the ELAP event.

The licensee's procedures identify specific locations for taking local readings and provide factors for converting the measured signal into the appropriate measurement units. Furthermore, where applicable, the licensee's procedures identify both electrical and mechanical means for performing local measurements. The licensee additionally stated that FLEX equipment is provided with local instrumentation needed to operate the equipment, and that the use of the instruments is described in Flex Support Guidelines (FSGs) associated with the use of the corresponding equipment.

3.2.3.2 Thermal-Hydraulic Analyses

The licensee concluded that its mitigating strategy for reactor core cooling would be adequate based in part on thermal-hydraulic analysis performed using Version 4 of the Modular Accident Analysis Program (MAAP). Because the thermal-hydraulic analysis for the reactor core and containment during an ELAP event are closely intertwined, as is typical of BWRs, Fermi has addressed both in a single, coupled calculation. This dependency notwithstanding, the NRC staff's discussion in this section of the SE focuses on the licensee's analysis of reactor core cooling. The NRC staff's review of the licensee's analysis of containment thermal-hydraulic behavior is provided subsequently in Section 3.4.4.2 of this evaluation.

The MAAP is an industry-developed, general-purpose thermal-hydraulic computer code that has been used to simulate the progression of a variety of light water reactor accident sequences, including severe accidents, such as the Fukushima Dai-ichi event. Initial code development began in the early 1980s, with the objective of supporting an improved understanding of and predictive capability for severe accidents involving core overheating and degradation in the wake of the accident at Three Mile Island Nuclear Station, Unit 2. Currently, maintenance and development of the code is carried out under the direction of the Electric Power Research Institute (EPRI).

To provide analytical justification for their mitigating strategies in response to Order EA-12-049, a number of licensees for BWRs and pressurized-water reactors (PWRs) completed analysis of the ELAP event using Version 4 of the MAAP code (MAAP4). Although MAAP4 and predecessor code versions have been used by industry for a range of applications, such as the analysis of severe accident scenarios and probabilistic risk analysis (PRA) evaluations, the NRC staff had not previously examined the code's technical adequacy for performing best-estimate simulations of the ELAP event. In particular, due to the breadth and complexity of the physical phenomena within the code's calculation domain, as well as its intended capability for rapidly simulating a variety of accident scenarios to support PRA evaluations, the NRC staff observed that the MAAP code makes use of a number of simplified correlations and approximations that should be evaluated for their applicability to the ELAP event. Therefore, in support of the staff's reviews of licensees' strategies for ELAP mitigation, the NRC staff audited the capability of the MAAP4 code for performing thermal-hydraulic analysis of the ELAP event for both BWRs and PWRs. The NRC staff's audit review involved a limited review of key code models, as well as confirmatory analysis with the TRACE code to obtain an independent assessment of the predictions of the MAAP4 code.

To support the NRC staff's review of the use of MAAP4 for ELAP analyses, in June 2013, EPRI issued a technical report entitled "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications." The document provided general information concerning the code and its development, as well as an overview of its physical models, modeling guidelines, validation, and quality assurance procedures.

Based on the NRC staff's review of EPRI's June 2013 technical report, as supplemented by further discussion with the code vendor, audit review of key sections of the MAAP code documentation, and confirmation of acceptable agreement with NRC staff simulations using the TRACE code, the NRC staff concluded that, under certain conditions, the MAAP4 code may be used for best-estimate prediction of the ELAP event sequence for BWRs. The NRC staff issued an endorsement letter dated October 3, 2013, which documented these conclusions and identified specific limitations that BWR licensees should address to justify the applicability of simulations using the MAAP4 code for demonstrating that the requirements of Order EA-12-049 have been satisfied.

The licensee addressed the limitations from the NRC staff's endorsement letter in an addendum to its MAAP calculation. The licensee's response utilized the generic roadmap document and response template that had been developed by EPRI. The NRC staff's audit review of this information, as well as its audit of the Fermi plant-specific MAAP analysis, confirmed that the licensee had acceptably addressed the limitations from the endorsement letter as follows:

- In addressing the NRC staff's request for providing benchmarks supporting the MAAP code's applicability to Fermi, the licensee cited the generic BWR roadmap document prepared by EPRI. The NRC staff's review of EPRI's BWR roadmap document determined that sufficient benchmark comparisons had been made to support application of the MAAP code to the beyond-design-basis ELAP event for BWRs.

- The NRC staff requested that the collapsed level in the reactor vessel remain above the top of the active fuel region and that the cooldown rate remain within the technical specification limits. The results from the licensee's applicable simulations with the MAAP code indicated that the limitation on water level should be satisfied for the analyzed ELAP event in that the collapsed level in the reactor vessel would remain at least 35 inches above the top of active fuel region. Regarding the limitation concerning the cooldown rate, as discussed in Section 3.2.1.1 of this evaluation, current emergency procedures for Fermi require staged reactor depressurizations of approximately 200 psi each when the heat capacity limit for the suppression pool is exceeded. The licensee's MAAP simulations indicate that staged depressurizations would be necessary during the analyzed ELAP event, and furthermore, during these staged depressurizations, technical specification limits on the cooldown rate would not necessarily be respected. The NRC staff's rationale for the endorsement letter position concerning cooldown rate was to avoid highly dynamic conditions in the reactor vessel where the MAAP code's capabilities for predicting reactor vessel water level could be challenged. Having reviewed the plant-specific MAAP analysis for Fermi, the NRC staff concluded that the intent of this limitation was satisfied inasmuch as (1) the collapsed level at the time of the staged depressurizations was significantly above the top of active fuel and (2) depressurization would be performed in approximately 200-psi stages rather than all at once.

- In addressing the NRC staff's request that the licensee's use of MAAP should be consistent with certain sections of a June 2013 Nuclear Energy Institute (NEI) position paper on the use of MAAP, the licensee confirmed that the position paper had been followed in the analysis performed for Fermi. The NRC staff's audit did not identify inconsistencies between the NEI position paper and the licensee's analysis.

- The NRC staff requested that the licensee identify key modeling parameters used in the analysis for the ELAP event and provide justification for their adequacy. The licensee responded according to a generic industry template. The NRC staff's audit did not identify any issues with the parameters assumed by the licensee and confirmed in particular that appropriate inputs and modeling options had been selected for the code parameters expected to have dominant influence for the ELAP event.

- In response to the NRC staff's request, the licensee's MAAP analysis was made available to the NRC staff during the audit. An overview of the NRC staff's audit review is noted below.

The licensee's MAAP analysis considered three main scenarios: (1) an instantaneous ELAP event using the feed-and-bleed strategy for containment cooling, (2) an instantaneous ELAP event using the hardened vent strategy for containment cooling, and (3) a flood-induced ELAP event for which warning time is assumed to be available. In each case, the licensee's MAAP analyses demonstrated adequate core cooling, inasmuch as the collapsed water level remained above the top of the active fuel and containment pressure and temperature limits were not exceeded.

Regarding the licensee's strategy for the instantaneous event, the NRC staff had several questions that were resolved during the audit. First, the NRC staff observed that the MAAP analysis used a single node for the suppression pool, which results in the calculation of averaged thermal-hydraulic values characteristic of perfect mixing. Therefore, the NRC staff reviewed drawings of the suppression pool showing the suction and discharge points for FLEX equipment relative to the installed connections for the HPCI and RCIC systems. The review showed that the injection points for FLEX to be separated from the RCIC suction point by approximately 90° and from the HPCI suction point by approximately 180 °F. Similarly, the NRC staff questioned how evenly steam discharged from the SRVs would heat the suppression pool inventory. The licensee stated that, if the use of multiple SRVs is necessary to depressurize the reactor, direction is provided that these SRVs be chosen such that the discharge is directed to different sections of the suppression pool. In addition, the licensee stated that if multiple SRV cycles are necessary, then guidance exists not to repeatedly discharge through the same SRV(s). Furthermore, the licensee stated that by the time the suppression pool may reach saturation conditions for the analyzed event, FLEX equipment should be deployed and capable of providing reactor core cooling. Based upon the information audited, the NRC staff concluded that the licensee had made a reasonable effort to fully utilize the potential for the suppression pool to serve as a heat sink and suction source for reactor core cooling for the analyzed ELAP event.

The NRC staff also reviewed the assumed circulating water reservoir temperature in the MAAP calculation. The NRC staff observed during the audit that the suction point for the FLEX pumps is located on the same side of the circulating water reservoir as the discharge point for heated water from the suppression pool that would be discharged using the HPCI system via a cross-tie to general service water system piping. As a result, the NRC staff questioned whether the licensee had considered the potential for higher suction temperatures due to the potential for flow to short-cycle between the discharge and suction points, with the bulk of the circulating water reservoir remaining stagnant. Although the licensee's analysis had not directly accounted for this potential effect, the NRC staff observed that (1) the MAAP analysis assumed a conservatively high initial temperature for the circulating water reservoir of 100 °F and (2) even if short-cycling prevents the feed-and-bleed method from cooling the containment as efficiently as predicted in the MAAP analysis, the hardened vent would still be available to prevent containment overpressurization.

During the audit, the NRC staff observed that the water level in the reactor vessel predicted by the MAAP code during certain scenarios could exceed the minimum elevation of the main steam line piping. Excessive vessel water level could threaten the functionality of the RCIC and HPCI systems, since water in the main steam lines could reach the inlet of the turbines powering the RCIC and HPCI pumps, which are designed to operate on steam only. The licensee stated that the prediction of excessive water level in the reactor vessel occurred as the result of modeling discrepancies in the MAAP input deck relative to the actual plant configuration. Subsequently these cases were reanalyzed and the licensee stated that the revised results demonstrated that correction of the identified modeling discrepancies resulted in the reactor vessel water level remaining both above the top of active fuel and below the main steam line elevation throughout the event. The NRC staff audited the licensee's revised calculation and observed results showing that the predicted collapsed water level no longer exceeds the main steam line nozzle minimum elevation. However, the MAAP-predicted collapsed water level was observed to peak within 9 inches of the main steam line nozzle, an elevation which should roughly correspond to the inlet / lower elevation of the steam dryer assembly. Such a level is significantly in excess of the maximum normal water level, as well as the (bypassed) Level 8 trip for the RCIC and HPCI systems. Because significant core voiding would be expected during this event, the two-phase mixture level would be expected to reach well into or even above the steam dryer, such that significant moisture content could be present in the steam directed to the RCIC and HPCI turbines. In response to this concern, the licensee clarified that the elevated reactor vessel water levels predicted by the MAAP code in the revised calculation are still influenced by simplified control logic and do not reflect expected behavior during an actual ELAP event. In particular, operators would be expected to maintain the reactor vessel water level within the applicable control band specified on Sheet 1 of EOP 29.100.01. The current revision of this procedure directs operators to maintain the reactor vessel water level within the range of 173-214 inches above the top of active fuel for the non-flooding event and within 120-220 inches for the flooding event. The upper bound for each of these control bands is below the (bypassed) Level 8 protective trip setpoint. Furthermore, the licensee stated that operators would anticipate and seek to minimize the impacts of transient water level imbalances. Based upon the information provided by the licensee, the NRC staff concluded that the procedurally specified water level control bands provide prudent protection against the potential for excessive moisture to adversely impact the RCIC and HPCI turbines during the beyond-design-basis ELAP event.

Therefore, based on the evaluation above, as well as the conclusions regarding the adequacy of the containment thermal-hydraulic modeling in Section 3.4.4.2 of this SE, the NRC staff concludes that the licensee's analytical approach should appropriately determine the sequence of events for reactor core cooling, including time-sensitive operator actions, and the required equipment to mitigate the analyzed ELAP event, including pump sizing and cooling water capacity.

3.2.3.3 Recirculation Pump Seals

An ELAP event would result in the interruption of cooling to the recirculation pump seals, potentially resulting in increased leakage due to the distortion or failure of the seals, elastomeric o-rings, or other components. Sufficient primary makeup must be provided to offset recirculation pump seal leakage and other expected sources of primary leakage, in addition to removing decay heat from the reactor core.

Fermi has Byron Jackson recirculation pumps with Flowserve N-7500 seals. The licensee's calculations for Fermi assume an initial seal leakage rate at full system pressure and temperature of 18 gallons per minute (gpm) per recirculation pump. This assumption was based on the leakage rate used in the existing station blackout analysis, as documented in Section 8.4.2.2 of the Fermi UFSAR, which originally derives from NUMARC 87-00. In addition, the licensee's calculation assumed additional primary system leakage at a rate of 5 gpm at full system pressure. Thus, between the two recirculation pumps and the additional primary system leakage, the total primary leakage rate assumed for Fermi at full system pressure and temperature during the initial phase of the ELAP event was 41 gpm. However, the leakage was modeled to decrease as the reactor is cooled and depressurized according to the critical flow correlation[1] in the MAAP code.

The Flowserve N-7500 seals installed on the Fermi recirculation pumps are similar in design to the N-Seals for which the NRC staff has reviewed and endorsed leakage rates for application to the ELAP event for specific PWRs. As noted in the NRC staff's endorsement letter on this topic, dated November 12, 2015, the upper bound leakage rates under ELAP conditions that have been estimated for Flowserve N-Seals installed at PWRs vary based on plant-specific conditions, but are in all cases less than 5 gpm. Among the noteworthy differences between the N-Seals installed at BWRs and PWRs are that current BWR installations (1) rely on a reduced number of stages due to the lower BWR operating pressure, (2) are scaled-down geometrically compared to most PWRs, according to differences in pump shaft size, and (3) do not provide for the possibility of isolating the controlled leakoff flow from the seal, as is possible for some PWRs. However, the NRC staff does not expect these differences to have a significant impact on the expected seal leakage rate for BWR applications because (1) the design of each seal stage is intended to be capable of sealing against full system pressure, and, furthermore, the vendor's method for determining the leakage rate for PWRs was not dependent upon the number of stages in the seal design, (2) the NRC staff's review of Flowserve's determination of the expected N-Seal leakage for PWRs explicitly considered pump shaft sizes for which the N-7500 model would be applicable, and (3) isolation of the controlled seal leakoff flow was not explicitly credited in determining the leakage rates determined in Flowserve's white paper, with the exception of determining the short-term thermal exposure profile for seal elastomers. These differences notwithstanding, according to the basic design of the hydrodynamic seals and pressure breakdown devices and their materials of construction, the NRC staff would expect a roughly similar level of performance for equivalent inlet conditions.

The NRC staff considered the expected leakage rate for the N-7500 seals installed at Fermi in light of experience obtained reviewing the application of N-Seals to PWRs. In particular, the NRC staff noted during its audit of the Fermi thermal-hydraulic analysis that the expected

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[1] A choked flow correlation is used to estimate the maximum fluid velocity across a restrictive cross-sectional flow area.

primary temperature and pressure conditions during an ELAP event generally compare favorably to those of the PWRs considered in the staff's endorsement letter. Furthermore, as is typical of the majority of U.S. BWRs, Fermi has installed steam-driven pumps (i.e., RCIC and HPCI) that are capable of injecting to the primary system under ELAP conditions. According to the Fermi UFSAR, the RCIC system is designed to provide an injection flow of 600 gpm, and the HPCI system is designed to provide an injection flow of 5000 gpm. Each of these flowrates individually exceeds the makeup flow requirement to offset boil-off from decay heat, in addition to the expected system leakage. Furthermore, the 3,000-gpm flow capacity provided by the licensee's FLEX equipment maintains this functional capability, even after accounting for the sharing of this flow with the containment and SFP. As such, the NRC staff concludes that (1) the licensee's assumed recirculation pump seal leakage rate of 18 gpm per pump at full system temperature and pressure appears reasonable for the ELAP event and (2) sufficient margin exists to accommodate primary system leakage rates greater than expected.

Considering an ELAP event without forewarning, upon restoration of electrical power using FLEX equipment, the licensee's analysis assumed the closure of the recirculation pump suction and discharge valves at 2 hours into the event with stopping recirculation pump seal leakage. In these scenarios, only a system leakage component (i.e., 5 gpm at full system pressure) was considered beyond 2 hours. In addition, considering an ELAP with prior warning, the licensee would attempt to close the recirculation pump isolation valves prior to the loss of electrical power, such that seal leakage was not modeled at all. (Furthermore, with the intent of maximizing suppression pool heatup, system leakage was also neglected in this scenario.) The description of these valves in Section 5.5.1.3 of the Fermi UFSAR notes that, since removal of the valve internals would require unloading of the nuclear fuel, the valves are provided with high-quality backseats and a trim to provide adequate leak tightness. The NRC staff observed that, although the pump discharge valve has a safety-related function to close to support low-pressure coolant injection into the reactor vessel, the pump suction valve does not. Furthermore, following the onsite audit, the licensee noted that terminating recirculation pump seal leakage would also require the closure additional valves in the reactor water cleanup system that cross-connect the reactor vessel bottom head to recirculation system piping downstream of the pump suction isolation valves. The NRC staff agreed with the licensee's intention to isolate the recirculation pumps in an attempt to reduce recirculation pump seal leakage. However, as a result of (1) incomplete justification for the qualification and actual performance of all valves that are necessary for recirculation pump isolation and (2) lack of information concerning the basis for the 5 gpm system leakage rate presented during the audit (compared to the technical specification limit of 25 gpm for total operational leakage), the NRC staff's evaluation did not credit the closure of these valves. Rather, the NRC staff noted that, although the heat distribution between the drywell and wetwell can be different for different recirculation pump seal leakage rate, sensitivity calculations performed by the licensee that the staff audited demonstrated that the effect is not dominant. Furthermore, as discussed above, the available injection flowrate to the reactor from installed systems (i.e., RCIC and HPCI) and FLEX equipment significantly exceeds the flow requirement, even with additional seal leakage beyond that considered by the licensee factored in.

Based upon the discussion above, the NRC staff concludes that the 41-gpm total system leakage rate at full system pressure assumed in the licensee's thermal-hydraulic analysis is well within the makeup capability of the licensee's FLEX strategy for the beyond-design-basis ELAP event.

3.2.3.4 Shutdown Margin Analyses

As described in its UFSAR, the Fermi reactor design is such that the control rods provide adequate shutdown margin under all anticipated plant conditions, with the assumption that the highest-worth control rod remains fully withdrawn. Additional margin is added to account for the expected impacts of burnup during the operating cycle. The Fermi Technical Specifications further clarify that shutdown margin is to be calculated for a cold, xenon-free condition to ensure that the most reactive core conditions are bounded.

Based on the NRC staff's audit review, the licensee's ELAP mitigating strategy maintains the reactor within the envelope of conditions analyzed by the licensee's existing shutdown margin calculation. Furthermore, the existing calculation retains conservatism because the guidance in NEI 12-06 permits analyses of the beyond-design-basis ELAP event to assume that all control rods fully insert into the reactor core, whereas, the licensee demonstrated adequate shutdown margin using the licensing-basis assumption of the strongest rod being fully withdrawn.

The licensee stated that for the Fermi operating cycle beginning in fall 2015, a minimum shutdown margin of 1.117 percent Δk/k would be available, assuming that the strongest control rod is fully withdrawn from the core. A shutdown margin of this magnitude is approximately 2-3 times larger than the minimum requirement in technical specifications. The licensee further stated that justification for adequate shutdown margin for the ELAP event will be verified for future operating cycles.

Therefore, based on the evaluation above, the NRC staff concludes that the sequence of events in the proposed mitigating strategy should result in acceptable shutdown margin for the analyzed ELAP event.

3.2.3.5 FLEX Pumps and Water Supplies

The licensee described in its FIP [Reference 18] the FLEX pumps to be used for core cooling, RPV makeup, and to provide water from the CW reservoir to either Division 1 or Division 2 of the RHR System. The CW water is supplied by a two-stage, diesel engine powered, arrangement consisting of a lift pump system (Neptune pump system) and booster pump (Dominator pump). The Neptune lift pump system includes a hydraulically driven source pump that floats in the CW reservoir and feeds to the diesel driven lift pump. Both pumps will collectively be referred as FLEX pumps for this discussion. The licensee described the two Neptune pump systems as being stored in FSF 2 and two Dominator pumps are stored in FSF 1, which satisfies the N+1 requirement in NEI 12-06 [Reference 6]. The licensee also described the portable, diesel power FLEX air compressor, which is deployed to provide compressed air to support hardened vent capability and extended SRV operation. A pneumatic hose is deployed from the compressor to pressurize the Instrument Air system. The FSF 1 has two FLEX air compressors to also satisfy the N+1 requirement in NEI 12-06 [Reference 6].

Section 11.2 of NEI 12-06 [Reference 6] states that design requirements and supporting analysis should be developed for portable equipment that directly performs a FLEX mitigation strategy for core, containment, and SFP that provides the inputs, assumptions, and documented analysis that the mitigation strategy and support equipment will perform as intended.

During the audit review, the licensee provided Calculation DC-0367 Volume VIII, "FLEX RHR Injection Configuration – Pressure Drop Calculation" [Reference 67], which evaluated the use of the FLEX pumps receiving makeup water from the CW reservoir to supply the water to the RHR for the respective makeup to the suppression pool, and RPV. Also, as described in SE Section 3.3.4.2, the RHR system will also supply makeup water to the SFP. The FLEX pumps can each supply a design flow of 3,000 gpm when taking suction on the CW reservoir. The Dominator pump is rated to provide 3,000 gpm at 150 psig. The Neptune pumping system is rated to provide 3000 gpm at 183 psig. The licensee stated that each pump's capabilities were confirmed by factory and site acceptance testing. The FLEX strategy is slated to restrict water flow from the CW reservoir to a maximum of 175 psig through one of two plant connections at the Reactor Building wall. This flow allows the operators to control pump flow as necessary, but will not need more than 3,000 gpm as specified in the calculation for all respective makeup areas.

The NRC staff reviewed the hydraulic analysis and also conducted a walkdown of the hose deployment routes for the above FLEX pumps during the audit to confirm the evaluations of the hose distance runs in the hydraulic analysis.

Based on the NRC staff's review of the FLEX pumping capabilities at Fermi, as described in the above hydraulic analyses and the FIP, and consistent with NEI 12-06 [Reference 6], Section 11.2, the licensee has demonstrated that its portable FLEX pumps should perform as intended to support FLEX strategies during ELAP caused by a BDBEE.

3.2.3.6 Electrical Analyses

The licensee's electrical strategies provide power to the equipment and instrumentation used to mitigate an ELAP and LUHS. The electrical strategies described in the FIP are practically identical for restoring core cooling, containment, and SFP cooling, except as noted in Sections 3.3.4.4 and 3.4.4.4 of this SE. The strategies are the same for all modes of operation.

The NRC staff reviewed the licensee's FIP, conceptual electrical single-line diagrams, the summary of calculations for sizing the FLEX diesel and turbine generators and station batteries, and the summary of calculations that addressed the effects of temperature on the electrical equipment credited in the FIP as a result of loss of heating, ventilation, and air conditioning (HVAC) during an ELAP caused by the event. The NRC staff also reviewed the separation and isolation of the FLEX generators from the Class 1E EDGs, and procedures that direct operators how to connect, and protect associated systems, and components.

The Fermi Phase 1 FLEX mitigation strategy involves relying on installed plant equipment and onsite resources, such as the use of installed Class 1E station batteries, vital inverters, and the 130 Volt direct current (Vdc)/260 Vdc Class 1E electrical distribution system. These equipment are considered robust and protected with respect to applicable site external hazards since they are located within safety-related, Class 1 structures. The dc power from the Class 1E station batteries will be needed in an ELAP to power loads such as shutdown system instrumentation, control systems, and other required loads. FLEX Support Guideline Strategy (29.FSG.01, "FLEX Plant," Revision 0) provides guidelines to the operators to extend the battery life during the event by stripping non-essential loads. The plant operators would commence stripping, or load shedding, of non-essential dc loads within 45 minutes after the occurrence of an

ELAP/LUHS event. The licensee expects to complete load shedding within 120 minutes from the onset of an ELAP/LUHS event.

Fermi has four Class 1E station batteries separated in two divisions which consist of Division I (2A-1 and 2A-2) and Division II (2B-1 and 2B-2). The 125 Vdc lead-calcium type station safety-related batteries were manufactured by C&D Technologies (model LCR-21) and are rated at 1500 ampere-hour at an 8 hour discharge rate to 1.75 V per cell for its 130/260 Vdc split dc system.

The NRC staff reviewed the summary of the licensee's dc coping analysis calculation DC-6584, "FLEX DC Calculations," Revision 0 [Reference 68], to verify the capability of the 130 Vdc system to supply the required loads during Phase 1 of the Fermi FLEX mitigation strategies plan for an ELAP as a result of a BDBEE. The licensee's analysis identified the required loads and their associated ratings (amperage and minimum voltage) and loads that would be shed to ensure battery operation for at least 12 hours (power is expected to be restored to the battery charger by this time). Table 3.1.1 of the above calculation showed that for the Instantaneous (non-flood) scenario, the coping time for battery 2A-1 is 13 hours and the coping time for battery 2A-2 is 13 hours, while the coping time of battery 2B-1 is 12.3 hours and the coping time for battery 2B-2 is 15 hours. For the flood scenario, Table 3.1.2 of the above calculation determined a coping time of 24 hours for vital batteries 2A-1, 2A-2, 2B-1, and 2B-2. The licensee's Operation's Procedure 29.FSG.01, "FLEX Plant," Revision 0 [Reference 69], provides guidelines to the plant operators to shed loads from the Class 1E station batteries to extend the battery coping time.

The NRC staff noted that the licensee has analyzed the extended duty cycle in accordance with NEI White Paper, "EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern," (ADAMS Accession No. ML13241A186), which was endorsed by the NRC (ADAMS Accession No. ML13241A188). In addition to the White Paper, the NRC sponsored testing at Brookhaven National Laboratory that resulted in the issuance of NUREG/CR-7188, "Testing to Evaluate Extended Battery Operation in Nuclear Power Plants," in May of 2015. The purpose of this testing was to examine whether existing vented lead acid batteries can function beyond their defined design-basis duty cycles (or beyond-design-basis duty cycles if existing SBO coping analyses were utilized) in order to support the necessary safety functions during an ELAP. The study evaluated battery performance availability and capability to supply the necessary dc loads to support core cooling and instrumentation requirements for extended periods of time. The testing provided an indication of the amount of time available (depending on the actual load profile) for batteries to continue to supply dc power to the core-cooling equipment beyond the original duty cycles for a representative plant. The testing also demonstrated that battery availability can be significantly extended using load shedding techniques to allow more time to recover ac power. The testing further demonstrated that battery performance is consistent with battery manufacturing performance data. According to the NUREG, the projected availability of a battery can be accurately calculated using the Institute of Electrical and Electronics Engineers (IEEE) Standard 485-2010, "IEEE Recommended Practice for Sizing Lead-Acid batteries for Stationary Applications," or using an empirical algorithm described in the report. Based on the evaluation above, the NRC staff concludes that the Fermi load shed strategy should ensure that the batteries have sufficient capacity to supply power to required loads for at up to 24 hours, depending on the scenario (flood/non-flood).

Based on its review of the above and the guidance in Procedure 29.FSG.01, the NRC staff finds that the Fermi dc system has adequate capacity and capability to power the loads required to mitigate the consequences during the first phase of an ELAP event as a result of a BDBEE provided that necessary load shedding is completed within the times assumed in the licensee's analysis.

During Phase 2, the licensee will deploy, stage, and connect a FLEX 480 Vac portable diesel generator (PDG), between 100 and 720 minutes after initiation of an ELAP, to repower 480 Vac buses to ensure power is available to the battery chargers prior to depletion of the Class 1E station batteries. The licensee has developed a primary and alternate strategy for supplying power to equipment required to maintain or restore reactor core cooling, containment, and SFP cooling. The licensee's Phase 2 strategy relies on two (2) trailer mounted 550 kW, 480 Vac, 0.8 power factor rated FLEX PDGs with 600 gallon diesel fuel tank stored in a robust FSF 1. One 550 kW FLEX PDG is sufficient to functionally support the Phase 2 FLEX loads. The FLEX PDG would be deployed to the FSF 1 Building apron for Phase 2 operation. In its FIP, the licensee stated that after the FLEX PDG deployment to the FSF 1 Building apron, ac load stripping and restoration of required 480 Vac loads takes place. Two 480 Vac FLEX PDGs provide N+1 capability to meet NEI 12-06 [Reference 6] criteria.

The NRC staff reviewed the summary of calculation DC-6583, "FLEX AC Calculations," Revision 0 [Reference 70], to confirm the adequacy of the capacity of the 480 Vac, 550 kilo Watt (kW) FLEX PDGs. This calculation provides the licensee's FLEX 480 Vac generator sizing analysis, and evaluated the FLEX equipment and circuits to be used with the existing electrical distribution system as part of the licensee's FLEX strategy. Section 3.5.1 and Attachment H of the above calculation list the required loads on the 480 Vac FLEX PDGs. These loads included Division I and Division II Battery Chargers, Motor Operated Valves, Control Room Emergency Lighting, Division I Switchgears, Motor Control Centers (MCCs), Battery Room Essential Fans, RB/AB Essential Lighting Transformer and other required loads. Attachment E of this calculation shows that the total expected running loads on the 480 Vac PDG will be 498.2 kW. The results of this calculation confirmed that one 480 Vac, 550 kW FLEX PDG is adequate to start and run the loads required for either the primary or the alternate Phase 2 FLEX strategies. Furthermore, the licensee's Phase 2 electrical strategy ensures that the safety-related battery chargers will be energized prior to the Class 1E station batteries deplete to the minimum acceptable voltage.

Based on its review of the summary of the licensee's calculation, FLEX Support Guideline 29.FSG.04, "FLEX AC," Revision 0 [Reference 71], conceptual single line electrical diagrams, and sketches, the NRC staff finds that the licensee's approach is acceptable given the protection and diversity of the power supply pathways, the separation and isolation of the FLEX PDGs from the Class 1E emergency diesel generators, and availability of procedures to direct operators how to align, connect, and protect associated systems and components. The NRC staff also finds that the FLEX PDGs have sufficient capacity and capability to supply the required loads during Phase 2.

For Phase 3, DTE plans to continue the Phase 2 coping strategy with additional assistance provided from an NSRC. Table 4 of the licensee's FIP [Reference 18] includes the list of electrical equipment that will be provided by an NSRC. The NSRC equipment includes two 1 Megawatt (MW), 4160 Vac, 3-phase Combustion Turbine Generators (CTGs), one 480 Vac, 1100 KW (derated to 1000 kW) CTG, electrical cables, and a 4160 Vac Electrical Distribution

System. The capacity of each NSRC-supplied CTG is of greater capacity than the capacity of the licensee's Phase 2 FLEX PDGs. In Technical Evaluation TE-K11-14-007, "FLEX Phase 3 Emergency Response (SAFER) Evaluation," Revision A [Reference 72], DTE analyzed loading requirements for the Phase 3 equipment and concluded that two (2) 1 MW, 4160 Vac CTGs, (total of approximately 2 MW capacity in parallel operation) would be adequate with spare capacity to provide power to the loads during Phase 3 operation. The NSRC supplied 4160 Vac CTGs will supply power to either of the two Class 1E 4160 Vac division buses. By restoring the Class 1E 4160 Vac bus, power can be restored to the Class 1E 480 Vac bus via 4160/480 Vac transformers to power selected 480 Vac loads. Based on its review of this evaluation, the NRC staff finds that the Phase 3 CTGs will have adequate capacity to supply the required loads to maintain or restore core cooling, SFP cooling, and containment indefinitely following an ELAP. The licensee expects that these CTGs would be available within 24 hours after the initiation of the ELAP event. DTE Procedure 29.FGS.15, "Toolbox Phase 3 Preparation," Revision 0 [Reference 73], provides the necessary guidance to enable connection of the Phase 3 FLEX 4160 Vac CTGs to the Fermi 4160 Vac buses. In its FIP, the licensee stated that no plant modifications are required to support mitigating strategies for Phase 3.

Based on its review, the NRC staff finds that the plant batteries used in the strategy have sufficient capacity to support the licensee's strategy, and that the FLEX DGs that the licensee plans to use have sufficient capacity and capability to supply the necessary loads during an ELAP event.

3.2.4 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately, should maintain or restore core cooling following a BDEE consistent with NEI 12-06, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.3 Spent Fuel Pool Cooling Strategies

In NEI 12-06 [Reference 6], Table 3-1 and Appendix C summarize an acceptable approach consisting of three separate capabilities for the SFP cooling strategies. This approach uses a portable injection source to provide the capability for 1) makeup via hoses on the refueling floor capable of exceeding the boil-off rate for the design-basis heat load; 2) makeup via connection to SFP cooling piping or other alternate location capable of exceeding the boil-off rate for the design-basis heat load; and 3) spray via portable monitor nozzles from the refueling floor using a portable pump capable of providing a minimum of 200 gpm per unit (250 gpm if overspray occurs). During the event, the licensee selects the method to use based on plant conditions. This approach also requires a strategy to mitigate the effects of steam from the SFP, such as venting.

3.3.1 Phase 1

For the Phase 1 SFP cooling, the licensee stated in its FIP [Reference 18] that no operator action is required other than monitoring the SFP level instrumentation (SFPLI). The licensee concluded that following a loss of SFP cooling at the maximum design heat load, the Fermi, Unit 2, SFP inventory level will reach 212°F in approximately 4.2 hours and boil off to a level 10 ft. above the top of fuel (SFPLI Level 2) in 28 hours after the declaration of an ELAP.

3.3.2 Phase 2

For the Phase 2 SFP cooling, the licensee stated in its FIP [Reference 18] that the strategy is to initiate makeup using the FLEX pumps connected to the RHR system. The licensee indicated that a portion of the nominal 3000 gpm flow provided by the FLEX pumps can be diverted to the SFP by repositioning the RHR SFP cooling assist mode valves at approximately 5 hours after declaring an ELAP.

The licensee also stated that a back-up method uses the capability to provide makeup to the SFP via hose connected to the spray nozzle. This method utilizes equipment that was initially intended to support the mitigating strategies required from previous NRC Order EA-02-026, Section B.5.b and Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.54(hh)(2). Section 3.2.1.3 of NEI 12-06 [Reference 6], initial condition 7, states that equipment for 10 CFR 50.54(hh)(2) may be used provided it is reasonably protected from the applicable external hazards discussed in Sections 5 through 9 and Section 11.3 of NEI 12-06 [Reference 6] and has predetermined hookup strategies with appropriate procedures. The licensee's FIP [Reference 18] states that monitor nozzle and hoses needed to provide spray and makeup to the SFP are stored in FSF 2.

3.3.3 Phase 3

The licensee stated in its FIP [Reference 18] that additional pumps from the NSRC will be available to the site to ensure a long-term source of water being used from the CW reservoir for SFP cooling.

3.3.4 Staff Evaluations

3.3.4.1 Availability of Structures, Systems, and Components

3.3.4.1.1 Plant SSCs

Condition 6 of NEI 12-06 [Reference 6], Section 3.2.1.3, states that permanent plant equipment contained in structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles, are available. In addition, Section 3.2.1.6 states that the initial SFP conditions are: (1) all boundaries of the SFP are intact, including the liner, gates, transfer canals, etc., (2) although sloshing may occur during a seismic event, the initial loss of SFP inventory does not preclude access to the refueling deck around the pool; and (3) SFP cooling system is intact, including attached piping.

The NRC staff reviewed DTE's Calculation HI992207, "Bulk SFP Thermal-Hydraulic Analysis for Reracking of Fermi, Unit 2," Revision 5 [Reference 74] on habitability on the SFP refuel floor. This calculation and the FIP [Reference 18] indicated that boiling begins at approximately 28 hours during a normal, non-outage situation. The NRC staff noted that DTE's sequence of events timeline in the FIP indicates that operators will align the FLEX pumps as a contingency for SFP makeup within 5 hours from the initiation of a BDBEE to ensure the SFP area remains habitable for personnel entry.

As described in DTE's FIP [Reference 18], the Phase 1 SFP cooling strategy does not require any anticipated actions. However, DTE does establish a ventilation path to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP. The licensee's operators are directed to implement actions, included in the FSGs, to establish building ventilation flow in approximately 6 hours after an ELAP is declared.

DTE's Phase 2 and Phase 3 SFP cooling strategy involves use of the FLEX pumps with suction from the CW reservoir to the RHR, which will supply water to the SFP. The NRC staff's evaluation of the robustness and availability of FLEX connections points for the FLEX pumps is discussed in Section 3.7.3.1 below.

3.3.4.1.2 Plant Instrumentation

In its FIP [Reference 18], DTE stated that the instrumentation for the SFP level will meet the requirements of Order EA-12-051. Furthermore, the licensee stated that these instruments will have initial local battery power with the capability to be powered from the FLEX DGs. The NRC staff's review of the SFPLI, including the primary and back-up channels, the display to monitor the SFP water level, and environmental qualifications to operate reliably for an extended period are discussed in Section 4 of this SE.

3.3.4.2 Thermal-Hydraulic Analyses

Section 11.2 of NEI 12-06 [Reference 6] states, in part, that design requirements and supporting analysis should be developed for portable equipment that directly performs a FLEX mitigation strategy for core, containment, and SFP that provides the inputs, assumptions, and documented analysis that the mitigation strategy and support equipment will perform as intended. In addition, NEI 12-06 [Reference 6], Section 3.2.1.6, Condition 4 states that SFP heat load assumes the maximum design-basis heat load for the site.

In accordance with NEI 12-06 [Reference 6], the licensee performed a thermal-hydraulic analysis of the SFP as a basis for the inputs and assumption used in its FLEX equipment design requirements analysis. During the audit, DTE referenced Calculation HI992207, "Bulk SFP Thermal-Hydraulic Analysis for Reracking of Fermi Unit 2," Revision 5 [Reference 74] to describe the conditions for the SFP. The licensee evaluated the SFP with the maximum design-basis heat loads to conclude that the minimum time to boiling is 4.2 hours with loss of normal SFP cooling with bulk boiling temperature of 212°F in the SFP. During the audit, the licensee also provided calculation DC-0367 Volume VIII, "FLEX RHR Injection Configuration – Pressure Drop Calculation," [Reference 67] which concluded that the FLEX pumps are capable of supplying the needed makeup flowrate of 101 gpm to the SFP. The licensee also concluded that the required SFP makeup is available with 5 hours of declaration of ELAP. The NRC staff evaluated the calculation during the audit to verify that the licensee's analysis demonstrated the FLEX pumps were capable of providing the necessary flow for SFP makeup and maintaining the volume of the SFP for shielding purposes.

Based on the information contained in the FIP [Reference 18] and the above hydraulic analysis, the NRC staff finds that the licensee has provided a thorough analysis that considered maximum design-basis SFP heat load during operating, pre-fuel transfer or post-fuel transfer operations, and the basis for assumptions and inputs used in determining the design requirements for FLEX equipment used in SFP cooling consistent with NEI 12-06 [Reference 6] Section 3.2.1.6, Condition 4 and Section 11.2.

3.3.4.3 FLEX Pumps and Water Supplies

As described in the FIP [Reference 18], the SFP cooling strategy relies on a FLEX pump to provide SFP makeup during Phase 2. Section 2.3.9 of the FIP describes the hydraulic performance criteria (e.g., flow rate, discharge pressure) for the FLEX pump. The NRC staff noted that the performance criteria of a FLEX pump supplied from NSRC for Phase 3 demonstrated that the NSRC pump was adequate and would provide SFP makeup if the Phase 2 FLEX pumps were to fail. As stated above, the SFP makeup rate of 101 gpm both meet or exceed the maximum SFP makeup requirements as described in Calculation DC-0367 [Reference 67].

3.3.4.4 Electrical Analyses

The licensee's initial coping strategy for SFP cooling (Phase 1) is to monitor SFP level using SFP instrumentation. For Phase 2, DTE's primary strategy includes using the 480 Vac PDGs to supply power to the Division 1 RHR pumps and valves to provide makeup water for SFP cooling. In its FIP [Reference 18], DTE noted that the portable, diesel driven FLEX water pumps would be deployed to establish a flow path from the CW reservoir to one of two exterior connections to the RHR system. The RHR system can be configured to direct the flow to the SFP. Fermi calculation DC-6583, "FLEX AC Calculations," Revision 0 [Reference 70], shows that a Phase 2 PDG would supply power to the RHR Low Pressure Cooling Injection Isolation MOV (and other required loads) to direct flow to the SFP. The NRC staff reviewed the summary of Fermi Calculation DC-6583 [Reference 70] which showed that one 480 Vac, 550 kW FLEX PDG will have sufficient capacity and capability to supply power to the required SFP loads following a BDBEE. During Phase 3, additional equipment such as the two 1 MW, 4160 Vac CTGs and one 480 Vac, 1100 kW CTG that will be supplied by an NSRC will be available to support Phase 2 SFP cooling operation indefinitely. These CTGs have sufficient capacity and capability to supply power to the required SFP loads following a BDBEE.

3.3.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed strategies and guidance that, if implemented appropriately, should maintain or restore SFP cooling following a BDBEE consistent with NEI 12-06 [Reference 6] guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.4 Containment Function Strategies

The industry guidance document, NEI 12-06 [Reference 6], Table 3-1, provides some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP event. One method is venting containment to keep pressure below limits. Fermi is a BWR with a Mark I containment. The Mark I containment is equipped with a hardened containment vent capable of performing the necessary pressure control and heat removal functions associated with an ELAP event; however, consistent with Table 3-1 of NEI 12-06, DTE has proposed an alternative containment heat removal approach to satisfy the requirements of Order EA-12-049 as its primary strategy. Specifically, DTE will establish a "feed and bleed" by directing FLEX water flow from the circulating water reservoir to the torus for cooling and pumping suppression pool water back to the circulating water reservoir using the HPCI system. The HPCI pump takes suction from the torus and discharges through a test line and GSW cross tie to the circulation water reservoir. A secondary approach of containment venting may be used as a backup strategy to maintain containment pressure and temperature within design limits.

The licensee performed a containment evaluation, CN-BWR-ENG-14-009, "DTE Fermi 2 MAAP Analysis for FLEX Coping Strategy," Revision 1 [Reference 75], which was based on the boundary conditions described in Section 2 of NEI 12-06 [Reference 6]. The calculation analyzed the primary containment heat removal approach of a "feed and bleed" strategy and the use of the backup containment strategy and concluded that the containment parameters of pressure and temperature in the Drywell remain well below the respective UFSAR Table 6.2-1, Containment Parameters, design limits of 62 psig and 340 degrees Fahrenheit (°F) for more than 72 hours following an ELAP-inducing event. Furthermore, DTE concluded, in its calculation, the pressure and temperature in the Torus (also referred to as the suppression pool) also remains below the design limit of 56 psig and 281°F for at least 72 hours. From its review of the evaluation, the NRC staff noted that the required actions to maintain containment integrity and required instrumentation functions have been developed, and are summarized below.

3.4.1 Phase 1

During Phase 1, Primary Containment integrity is maintained by normal design features of the containment, including the containment isolation valves. In accordance with NEI 12-06 [Reference 6], the containment is assumed to be isolated following the event.

The SRV actuation and RCIC system operation will remove energy from the RPV and deposit it into the suppression pool (SP).

The SP water level, Drywell and SP pressure and temperature indication will be available to the operators for the duration of the ELAP. Instrumentation indication is available in the Main Control Room (MCR).

3.4.2 Phase 2

Phase 2 coping strategy is to monitor primary containment conditions and establish SP cooling using a "feed and bleed" strategy.

"Feed and bleed" is established by directing FLEX water flow from the circulation water reservoir to the torus for cooling and pumping SP water back to the circulating water reservoir using the HPCI system. The HPCI pump takes suction from the torus and discharges through a test line and GSW cross tie to the circulation water reservoir. These actions are directed by 29.FSG.05, "Containment Cooling."

An available alternative method to remove containment heat is to use the torus hardened vent to reject containment heat to the outside environment per 29.FSG.13, "Containment Venting."

3.4.3 Phase 3

Phase 2 actions can be continued indefinitely. Additional pumps and electrical generators will be supplied by the NSRC and used to provide additional capability and redundancy for on-site equipment until such time that normal power to the site can be restored.

This capability will include a 4kV PDGs provided from the NSRC. Mobile 4kV diesel generators will be brought in from the NSRC in order to supply power to either of the two Class 1E 4kV divisions. Additionally, by restoring the Class 1E 4kV bus, power can be restored to the Class 1E 480 VAC via the 4160/480 VAC transformers to power selected 480 VAC loads.

Low pressure/high flow portable diesel driven pumps (up to 5,000 gpm) are also delivered from the NSRC to provide redundancy to existing site phase 2 portable equipment if needed.

Deployment of Phase 3 NSRC equipment will be directed by the emergency response organization (ERO) based on the circumstances of the specific ELAP/LUHS event.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

Guidance document NEI 12-06 [Reference 6] baseline assumptions have been established on the presumption that other than the loss of the ac power sources and LUHS, installed equipment that is designed to be robust with respect to design-basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Below are the baseline assumptions for the availability of SSCs for maintaining containment functions during an ELAP.

3.4.4.1.1 Plant SSCs

Containment

As stated in Section 6.2.1.2.1 of the Fermi UFSAR, the containment system employs the drywell/pressure suppression features of the BWR-Mark I containment concept. The primary containment (known as the Mark I containment) is a leaktight steel-plate containment vessel consisting of a light-bulb-shaped drywell and a torus-shaped suppression chamber. The drywell is a steel pressure vessel with a spherical lower portion, and a cylindrical upper portion. The drywell is enclosed in reinforced concrete for shielding purposes. Table 3.2-1 of the UFSAR, lists the containment as a Seismic Category I structure, and further defines the design criteria for Seismic Category I structures by stating that all civil structures classified as Seismic Category I are designed for the effects of Fermi natural phenomena such as tornado, wind loads, external missiles, and floods. Section 3.8.2.1.1 of the UFSAR further confirms that the containment has the capability to maintain its functional integrity during any postulated design event, including protection against missiles from internal or external sources, excessive motion of pipes, and jet forces associated with the flow from the postulated rupture of any pipe within containment.

HPCI System

The HPCI system consists of a steam turbine assembly driving a constant-flow pump assembly and system piping, valves, controls, and instrumentation. The HPCI turbine is driven by steam from the RPV which, after reactor shutdown, is generated by decay and residual heat. The principal HPCI equipment is installed in the reactor building (RB), which is a Seismic Category structure. The turbine-pump assembly is located in a shielded area to ensure that personnel access to adjacent areas is not restricted during operation of the HPCI system and to be protected from the physical effects of design-basis accidents (DBAs) such as pipe whip, flooding, and high temperature. The pump assembly is located below the level of the condensate storage tank and below the water level in the suppression pool to ensure positive suction head to the pumps.

Circulating Water Reservoir

The CW open pond reservoir is provided as a collection basin from the natural draft cooling tower discharge to the circulating water pump house. The reservoir is not part of a Category I system. This CW pond will be the controlled location for letdown bleed from the suppression pool as well as the preferred source for FLEX pumps to draw suction for feeding the suppression pool. The overall inventory of the 5.5 acre CW pond is $23x10^6$ gallons with an assumed high temperature of 100°F.

The licensee performed calculation DC-6601, "Robustness and Stability Evaluation of the Circ Water Pond During and After Safe Shutdown Earthquake Effects," Revision 0 [Reference 76], which assessed the seismic robustness of the CW pond and Cooling Tower overflow canal dykes in order to demonstrate its structural adequacy to remain stable during and after the postulated Safe Shutdown Earthquake (SSE) event at Fermi. The calculation addressed liquefaction susceptibility and slope stability assessment of the dykes at the CW pond and Cooling Tower overflow canals when subjected to postulated SSE. The licensee's evaluation concluded that the CW pond and Cooling Tower overflow canal dykes remain stable during and after the postulated SSE event at Fermi.

Based on the above UFSAR qualifications, calculations, and the implementation of the described plant strategy, the SSCs essential to the containment heat removal and containment integrity protection strategies are robust, as defined by NEI 12-06 [Reference 6], and should be available following an ELAP-inducing event.

3.4.4.1.2 Plant Instrumentation

In NEI 12-06 [Reference 6], Table 3-1, specifies that containment pressure, SP level, and SP temperature are key containment parameters which should be monitored by repowering the appropriate instruments.

Suppression chamber pressure, drywell pressure, suppression chamber water level, suppression chamber temperature, drywell temperature, and HPCI suction/discharge pressure instrumentation is credited for all phases of the containment integrity strategy. Instrumentation indication is available in the MCR.

The Fermi FIP states that these key parameters are available prior to and after load stripping of the dc and ac buses during Phase 1. The instrumentation is powered by rectified 120 VAC fed from the station batteries. Availability during Phases 2 and 3 is dependent on the strategy to re-power the vital 120VAC buses including the station battery chargers.

Portable beyond-design-basis (BDB) equipment is supplied with the local instrumentation needed to operate the equipment. The use of these instruments is detailed in the associated FSGs for use of the equipment. These procedures are based on inputs from the equipment suppliers, operating experience, including site testing and training, and expected equipment function in an ELAP.

Based on this information, the licensee should have the ability to appropriately monitor the key containment parameters as delineated in NEI 12-06 [Reference 6], Table 3-1.

3.4.4.2 Thermal-Hydraulic Analyses

The licensee performed calculation CN-BWR-ENG-14-009, "DTE Fermi 2 MAAP Analysis for FLEX Coping Strategy," Revision 1 [Reference 75], to demonstrate the effectiveness of the proposed primary and backup containment heat removal strategies. The calculation utilized the MAAP computer code, Version 4.0.7, to model the heat-up and pressurization of the containment under ELAP conditions.

Base Case B1 (primary strategy) of this calculation models the containment response with the effect of using a FLEX feed and HPCI bleed (F/B) strategy to maintain torus pressure and temperature low enough for continued RCIC operation. It assumes that the reactor has been operating at 100 percent power for 100 days (as specified in NEI 12-06 [Reference 6], Section 2) when the ELAP event occurs. During an ELAP event, the containment will begin to heat up and pressurize due to the discharge of the SRVs, leakage from the recirculation system, and the RCIC system exhaust steam as described in the core cooling strategy of Section 3.2.1. The HPCI is not used at all for the first 5 hours of the event and is assumed to be non-functional until this time. At 5 hours, FLEX equipment is available and the F/B begins. For this case, it is assumed that the initial flow rates for both the feed (FLEX) and bleed (HPCI) pumps is a constant 3,500 gpm, that the FLEX injection water is 100°F, and that the F/B operation is available 5 hours after the start of the event. The licensee performed a hydraulic calculation, DC-0367 Volume VIII, "FLEX RHR Injection Configuration-Pressure Drop Calculation," [Reference 67] which determined that the FLEX pumps have adequate flow capabilities to provide water to the makeup locations. Seal leakage from the reactor coolant pumps (RCPs) at full pressure is assumed to be a total of 41 gpm for the first 2 hours and is reduced to approximately 5 gpm afterwards at operating pressure and approximately 2 gpm at lower pressures.

Under these conditions and with the employment of the primary heat removal strategy, Case B1 concludes that the containment parameters of pressure and temperature in the Drywell reach maximum values of 22 psig and 312°F and then stabilize or decrease in the first 72 hours following an ELAP-inducing event. Furthermore, it concludes that the pressure in the Torus reaches a maximum value of 20 psig, and the water temperature in the Torus reaches 196°F. The containment remains below the design limits for both the drywell and the torus for Case B1 and the temperature limits for RCIC are not exceeded.

Base Case C1 (backup strategy) of this calculation models the containment response with the effect of using the hardened containment vent strategy. It assumes that the reactor has been operating at 100 percent power for 100 days (as specified in NEI 12-06 [Reference 6], Section 2) when the ELAP event occurs. During an ELAP event, the containment will begin to heat up and pressurize due to the discharge of the SRVs, leakage from the recirculation system, and the RCIC (and HPCI, if used) exhaust steam as described in the core cooling strategy of Section 3.2.1. At 6.2 hours, when torus water temperature reaches 220°F, the containment vent is opened. At this time suppression pool pressure is high (approximately 17 psig) and the flow through the vent is choked. After an initial drop in SP pressure, due to the flow still being choked, SP pressure continues to trend upwards. The overall increase in torus pressure results in the rise in torus water temperature. At approximately 12.4 hours, torus water temperature is above 250°F and RCIC is tripped off (analysis assumption). At the same time, in order to maintain RPV water level, the RPV is completely depressurized and the FLEX pumps are initialized. The result is a spike in containment pressure and temperature due to the fast depressurization of the RPV; three SRVs are forced open simultaneously. FLEX injection begins when RPV pressure falls below the cutoff pressure (111 psig) at approximately 12.5 hours and continues cycling to maintain water level for the duration of the sequence. In the event of RCIC operation failure at a lower temperature than expected, the licensee has demonstrated that the FLEX pumps are available for RPV injection as early as 5 hours following an ELAP-inducing event. Seal leakage from the RCPs at full pressure is assumed to be a total of 41 gpm for the first 2 hours and is reduced to approximately 5 gpm afterwards at operating pressure and approximately 2 gpm at lower pressures.

Under these conditions and with the employment of the backup heat removal strategy (containment venting), maximum containment pressure and temperatures occur before the vent is opened and are reduced to saturated conditions at about 10 psig. Case B1 concludes that the containment parameters of pressure and temperature in the Drywell reach maximum values of 24 psig and 277°F and then decrease in the first 72 hours following an ELAP-inducing event. Furthermore, it concludes that the pressure in the Torus reaches a maximum value of 24 psig, and the water temperature in the Torus reaches 260°F. The containment remains below the design limits for both the drywell and the torus.

3.4.4.3 FLEX Pumps and Water Supplies

Capability is provided to pump cooling water from the CW reservoir to either Division 1 or Division 2 of the RHR System in order to restore core cooling, containment cooling, and SFP cooling functions. The supply of cooling water from the CW reservoir to Division 1 or 2 RHR System is provided by a two-stage, diesel engine powered, arrangement consisting of a lift pump system (Neptune pump system) and booster pump (Dominator pump). The Neptune lift pump system includes a hydraulically driven source pump that floats in the CW reservoir and feeds to the diesel driven lift pump.

The NSRC is providing a high capacity low pressure pump which will be used to supplement FLEX portable equipment, if required, to provide cooling loads. The water supply is the Circulating Water reservoir or General Service Water Intake (Lake Erie).

3.4.4.4 Electrical Analyses

In its FIP [Reference 18], DTE stated that during an ELAP, containment cooling is lost and, over an extended period of time, drywell temperature and pressure will increase. Additionally, SRV operation will add heat resulting in an increase in torus temperature and pressure. The licensee plans to use containment heat removal strategies such as "feed and bleed" (primary) and containment venting (secondary) to maintain containment pressure and temperature within design limits.

In its FIP [Reference 18], DTE stated that during Phase 1, Primary Containment integrity is maintained by normal design features of the containment, including the containment isolation valves. In accordance with NEI 12-06 [Reference 6], the containment is assumed to be isolated following the event. The SRV actuation and RCIC system operation will remove energy from the RPV and deposit it into the suppression pool. According to the FIP, the suppression pool water level, Drywell and suppression pool pressure and temperature indication will remain powered and be available to the operators for the duration of the ELAP. Based on the NRC staff's evaluation in Section 3.2.3.6 of this SE, the Fermi Class 1E station batteries will have adequate capacity and capability to supply power to the required containment instrumentation during Phase 1.

The licensee's Phase 2 coping strategy is to monitor containment temperature and pressure using installed instruments and control containment pressure and temperature by establishing suppression pool cooling using a "feed and bleed" strategy. The HPCI System would be operated to discharge heated water from the suppression chamber.

The licensee plans to utilize the Phase 2 FLEX PDGs to supply power to the required Phase 2 loads. The NRC Staff reviewed the summary of the licensee's calculation DC-6583 [Reference 70] to verify the adequacy of the capacity of the 480 Vac, 550 kW FLEX PDGs. Based on review of the above calculation, the NRC staff finds that the 480 Vac PDGs will have adequate capacity and capability to supply power to the key instrumentation through Division I and Division II Class 1E battery chargers, HPCI/RCIC room coolers, valves, Battery room essential fans for hydrogen control, RB/AB Essential Lighting Transformer, and other required Phase 2 loads to support the licensee's "venting" or "Feed and Bleed" strategy. Licensee procedure 29.FSG.01, "FLEX Plant," Revision 0 [Reference 69], provides operators with guidance on how to align and restore the battery chargers. Licensee procedure 29.FSG.04, "FLEX AC," Revision 0 [Reference 71], provides operators with guidance on how to align the 480 Vac Phase 2 FLEX PDGs to maintain the integrity of the primary containment.

For Phase 3, the licensee noted in its FIP that Phase 2 actions can be continued indefinitely. The licensee expects that additional pumps and electrical generators would be supplied by the NSRC within 24 hours of event initiation that could be used to provide additional capability and redundancy for on-site equipment until such time that normal power to the site can be restored. This capability will include two 1-MW, 4.16 kV CTGs provided from an NSRC to supply power to either of the two Class 1E 4160 Vac Division buses. Additionally, by restoring a Class 1E 4160 Vac bus, power can be restored to the Class 1E 480 Vac equipment via 4160/480 Vac transformers to power selected 480 Vac loads. Based on its review of licensee calculation Technical Evaluation TE-K11-14-007, "FLEX Phase 3 Emergency Response (SAFER) Evaluation," Revision A [Reference 72], the NRC staff finds that two 1 MW, 4160 Vac CTGs have sufficient capacity and capability to supply power to the required loads following a BDBEE.

3.4.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore containment functions following an ELAP event consistent with NEI 12-06 [Reference 6] guidance, as endorsed by JLD-ISG-2012-01, and adequately addresses the requirements of the order.

3.5 Characterization of External Hazards

Sections 4 through 9 of NEI 12-06 [Reference 6], provide the methodology to identify and characterize the applicable BDBEEs for each site. In addition, NEI 12-06 [Reference 6] provides a process to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of site-specific external hazards leading to an ELAP and LUHS.

Characterization of the applicable hazards for a specific site includes the identification of realistic timelines for the hazard, characterization of the functional threats due to the hazard, development of a strategy for responding to events with warning, and development of a strategy for responding to events without warning.

The licensee reviewed the plant site against NEI 12-06 [Reference 6] and determined that FLEX equipment should be protected from the following hazards: seismic; external flooding; severe storms with high winds; snow, ice and extreme cold; and extreme high temperatures.

References to external hazards within the licensee's mitigating strategies and this safety evaluation are consistent with the guidance in NEI-12-06 and the related NRC endorsement of NEI 12-06 in JLD-ISG-2012-01. NEI 12-06 directed licensees to proceed with evaluating external hazards based on currently available information. For most licensees, this meant that the OIP used the current design basis information for hazard evaluation. Coincident with the issuance of Order EA-12-049, on March 12, 2012, the NRC staff issued a Request for Information pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) [Reference 19] (hereafter referred to as the 50.54(f) letter), which requested that licensees reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. Due to the time needed to reevaluate the hazards, and for the NRC to review and approve them, the reevaluated hazards were generally not available until after the mitigation strategies had been developed. The NRC staff has developed a proposed rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was published for comment in the Federal Register on November 13, 2015 [Reference 79]. The proposed MBDBE rule would make the intent of Orders EA-12-049 and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

The NRC staff requested Commission guidance related to the relationship between the reevaluated flooding hazards provided in response to the 50.54(f) letter and the requirements for Order EA-12-049 and the MBDBE rulemaking (see COMSECY-14-0037, Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards" [Reference 47]. The Commission provided guidance in an SRM to COMSECY-14-0037 [Reference 20]. The Commission approved the staff's recommendations that licensees would need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, and that licensees may need to address some specific flooding scenarios that could significantly impact the power plant site by developing scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs. The NRC staff did not request that the Commission consider making a requirement for mitigating strategies capable of addressing the reevaluated flooding hazards be immediately imposed, and the Commission did not require immediate imposition. In a letter to licensees dated September 1, 2015 [Reference 37], the NRC staff informed the licensees that the implementation of mitigation strategies should continue as described in licensee's OIPs, and that the NRC safety evaluations and inspections related to Order EA-12-049 will rely on the guidance provided in JLD-ISG-2012-01, Revision 0, and the related industry guidance in NEI 12-06, Revision 0. The hazard reevaluations may also identify issues to be entered into the licensee's corrective action program consistent with the OIPs submitted in accordance with Order EA-12-049.

As discussed above, licensees are reevaluating the site seismic and flood hazards as requested in the NRC's 50.54(f) letter. After the NRC staff approves the reevaluated hazards, licensees will use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Revision 2, Appendices G and H [Reference 80]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference 81]. The licensee's MSAs will evaluate the mitigating strategies described in this safety evaluation using the revised seismic hazard information and, if necessary, make changes to the strategies or equipment. Licensees will submit the MSAs for NRC staff review.

The licensee developed its OIP for mitigation strategies by considering the guidance in NEI 12-06 and the site's design-basis hazards. Therefore, this safety evaluation makes a determination based on the licensee's OIP and FIP. The characterization of the applicable external hazards for the plant site is discussed below.

3.5.1 Seismic

In its FIP, the licensee stated that seismic hazards are applicable to the site. As desbried in UFSAR Section 2.5.2.10, the Safe Shutdown Earthquake seismic criteria for the site is 15 percent of gravity (0.15 g) peak horizontal ground acceleration acting vertically. It should be noted that the actual seismic hazard involves a spectral graph of the acceleration versus the frequency of the motion. Peak acceleration in a certain frequency range, such as numbers above, is often used as a shortened way to describe the hazard.

As the licensee's seismic reevaluation activities are completed, the licensee is expected to assess the mitigation strategies to ensure they can be implemented under the reevaluated hazard conditions as will potentially be required by the proposed Mitigation of Beyond Design Basis Events rulemaking. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

3.5.2 Flooding

Fermi completed and submitted its FHRR [Reference 21]. The reevaluation represented the most current flooding analysis for Fermi. The reevaluation results were bounded by the original Fermi design-basis flood analysis. The NRC staff completed its review in a letter dated December 20, 2014 [Reference 52], and supplemented by letter dated November 20, 2015 [Reference 53]. The NRC staff confirmed that the reevaluated hazard results for each reevaluated flood-causing mechanism are bounded by the current design-basis flood hazard and an integrated assessment or a focused evaluation was not necessary for Fermi.

The bounding flooding event for Fermi is wind driven storm surge caused by an extended (about 60 hour) storm travelling along the axis of Lake Erie. The resulting wind tide was superimposed on the monthly mean lake level to calculate a resultant flood elevation of 586.9 feet, which is above the site grade of 583.0 feet.

Fermi has entered into a Letter of Agreement with the NWS to provide a minimum 48-hour notification of conditions favorable to this bounding flooding event. This event would flood the Fermi site for up to 17 hours, interfering with deployment of FLEX equipment if an ELAP/LUHS event were to occur during the period when the site is flooded.

Fermi is located on Lake Erie; therefore, downstream dam failure is not a concern.

As discussed in DTE's compliance letter [Reference 18], all major piping systems within the reactor building and auxiliary building are seismic category I or II/I. Similarly, all large volume tanks, such as the standby liquid control tank, reactor building closed cooling water surge tank, and emergency equipment cooling water surge tank, are seismic category I or category II/I. Therefore, the reactor and auxiliary Buildings are not susceptible to large internal flooding from non-seismically robust sources (UFSAR Section 3.7).

DTE's compliance letter [Reference 18] also describes that postulated breaks in the turbine building are bounded by the worst case flooding scenario, which results from the failure of the expansion joints between the circulating water piping and the main condenser water boxes. The basement area may be flooded in this event. This flooding may preclude operation of the HPCI/GSW crosstie valve, which would prevent containment heat rejection ("feed and bleed") to the CW reservoir. In this case, containment heat rejection will occur by venting through the torus-hardened vent.

As described in DTE's compliance letter [Reference 18], Fermi's reactor and auxiliary buildings do not rely on ac power to mitigate ground water in critical locations since Category I structures are designed to protect against/keep out ground water leakage (UFSAR Section 3.4). Regarding the turbine building, similar to the discussion of internal flooding above, should ground water in-leakage prevent access to the HPCI/GSW crosstie valve operator, containment heat rejection will occur by venting through the torus hardened vent.

Therefore, flooding hazards are applicable to the plant site. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

3.5.3 High Winds

In NEI 12-06 [Reference 6], Section 7, it provides the NRC-endorsed screening process for evaluation of high wind hazards. This screening process considers the hazard due to hurricanes and tornadoes. The first part of the evaluation of high wind challenges is determining whether the site is potentially susceptible to different high wind conditions to allow characterization of the applicable high wind hazard. The second part is the characterization of the applicable high wind threat.

The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06 [Reference 6], Figure 7-1 (Figure 3-1 of U.S. NRC, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants," NUREG/CR-7005, December, 2009; if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 miles per hour (mph) exceeds 1E-6 per year, the site should address hazards due to extreme high winds associated with hurricanes.

The screening for high wind hazard associated with tornadoes should be accomplished by comparing the site location to NEI 12-06 [Reference 6], Figure 7-2, from U.S. NRC, "Tornado Climatology of the Contiguous United States," NUREG/CR-4461, Revision 2, February 2007; if the recommended tornado design wind speed for a 1E-6/year probability exceeds 130 mph, the site should address hazards due to extreme high winds associated with tornadoes.

In its FIP [Reference 18], DTE stated that Fermi has less than a 1 in 1 million chance per year of a hurricane induced peak-gust wind speed of greater than 120 mph. Thus, Fermi is not subject to hurricane related winds. However, Fermi does have a 1 in 1 million chance of tornado wind speeds of 185 mph. This is greater than the threshold of 130 mph contained in NEI 12-06 [Reference 6] and Fermi has evaluated tornado hazards, including tornado missiles, impacting FLEX deployment. Therefore, the plant screens in for an assessment for high winds and tornados, including missiles produced by these events.

The NRC staff compared the documented location for Fermi with NEI, Figure 7-1 and verified that the site has less than a 1 in 1 million chance per year of a hurricane induced peak-gust wind speed of greater than 120 mph, which would screen in the high wind hazards.

Therefore, high-wind hazards are applicable to the plant site. The licensee has appropriately screened in the high wind hazard and characterized the hazard in terms of wind velocities and wind-borne missiles.

3.5.4 <u>Snow, Ice, and Extreme Cold</u>

As discussed in NEI 12-06 [Reference 6], Section 8.2.1, all sites should consider the temperature ranges and weather conditions for their site in storing and deploying their FLEX equipment consistent with normal design practices. All sites outside of Southern California, Arizona, the Gulf Coast and Florida are expected to address deployment for conditions of snow, ice, and extreme cold. All sites located north of the 35th Parallel should provide the capability to address extreme snowfall with snow removal equipment. Finally, all sites except for those within Level 1 and 2 of the maximum ice storm severity map contained in Figure 8-2 should address the impact of ice storms.

In its FIP [Reference 18], DTE stated that the site is located above the 35^{th} Parallel; therefore, they need to consider extreme snowfall. In addition, the site is located within the region characterized by EPRI as ice severity level 5 (NEI 12-06, Figure 8-2, Maximum Ice Storm Severity Maps). Consequently, the site is subject to severe icing conditions that could also cause catastrophic destruction to electrical transmission lines. The licensee concludes that the plant screens in for an assessment for snow, ice, and extreme cold hazard. In its FIP, the licensee presented results for maintaining the FSF internal temperatures, based on -19 °F outside temperature. The lowest recorded temperature at or near Fermi is -19°F (UFSAR Section 2.3.1.2).

In summary, based on the available local data and Figures 8-1 and 8-2 of NEI 12-06 [Reference 6], the plant site does experience significant amounts of snow, ice, and extreme cold temperatures; therefore, the hazard is screened in. The licensee has appropriately screened in the hazard and characterized the hazard in terms of expected temperatures.

3.5.5 Extreme Heat

In NEI 12-06 [Reference 6], Section 9 states that all sites will address high temperatures. Virtually every state in the lower 48 contiguous United States has experienced temperatures in excess of 110 °F. Many states have experienced temperatures in excess of 120 °F. In this case, sites should consider the impacts of these conditions on deployment of the FLEX equipment.

In its FIP [Reference 18], the licensee stated that in accordance with NEI 12-06 [Reference 6] Section 9.2, all sites are required to consider the impact of extreme high temperatures. The maximum high temperatures at the site was 105 °F. The plant site screens in for an assessment for extreme high temperature hazard.

In summary, based on the available local data and the guidance in Section 9 of NEI 12-06, the plant site does experience extreme high temperatures. The licensee has appropriately screened in the high temperature hazard and characterized the hazard in terms of expected temperatures.

3.5.6 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed a characterization of external hazards that is consistent with NEI 12-06 [Reference 6] guidance as endorsed by JLD-ISG-2012-01, and adequately addresses the requirements of the order.

3.6 Planned Protection of FLEX Equipment

3.6.1 Protection from External Hazards

Fermi constructed two hardened FLEX storage structures. Each FLEX storage structure is approximately 4,600 square feet and were designed/constructed to satisfy the requirements for the external events identified in NEI 12-06 [Reference 6], such as earthquakes, external floods, storms (high winds, and tornadoes), extreme snow, ice, extreme heat, and cold temperature conditions. The FSF 1 is located inside the protected area (PA) fence on the north side of the reactor building. The FSF 2 is located outside the PA fence south of the CW reservoir.

Below are additional details on how FLEX equipment is protected from each of the external hazards.

3.6.1.1 Seismic

The FSF buildings have been evaluated equivalent to that of a Seismic Category I structure. The building design is based on American Society of Civil Engineers (ASCE) 7-10, *Minimum Design Loads for Buildings and Other Structures,* and the 2009 Michigan Building Code.

Large portable BDB equipment, such as pumps and power supplies, are secured inside the FSFs to protect them during a seismic event. The FSFs have tie downs integrated into the floor slab for this purpose. These tie downs are used to secure any equipment that is not considered stable to ensure the stored BDB equipment remains protected from damage during a seismic event.

As provided in the guidance of NEI 12-06 [Reference 6], all equipment credited for implementation of the FLEX strategies at Fermi is either stored in the FSFs or in a plant structure that meets the station's design bases for SSE, specifically the Fermi Reactor Building and Auxiliary Building.

3.6.1.2 Flooding

In its FIP, the licensee stated that the FSF finish slabs (floor elevation) is 587.0 feet, which is above the design basis flood hazard elevation of 586.9 feet. The FSF buildings were designed and constructed to resist water intrusion (including that from wave run-up).

During the on-site audit, the NRC staff reviewed Engineering Design Package (EDP) – 37124, "EDP Continuation Sheet," Revision 0 [Reference 77]. The licensee noted that the FSF buildings are designed for a wave run-up elevation of 593 feet in accordance with UFSAR on the exposed north faces of the reactor/auxiliary buildings, which bounds the re-evaluation elevation of 591.7 feet. In addition, the FSF buildings will be water resistant in case of a wave run-up design event. Wave debris impact forces are significantly less than tornado missile impact forces.

3.6.1.3 High Winds

During the on-site audit, the NRC staff reviewed EDP-37124 [Reference 77]. During that review, DTE noted that the FSF buildings are designed for a tornado wind including a rotational wind velocity of 300 mph, translational wind velocity of 60 mph and an external pressure drop of 3 pounds per square inch (psi) at the rate of 1 psi per second. These design values are consistent with the UFSAR. In addition, the FSF buildings include electrical power and lighting systems, a heating and ventilation system, fire alarm and sprinkler systems, tornado missile protected equipment doors and personnel doors protected via reinforced concrete labyrinths.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

During the on-site audit, EDP-37124 was reviewed. During that review, it was noted that in accordance with ASCE 7-10, Section 7.2 ground snow loads are based on a 50-year mean recurrence interval. For the FSFs, a 100-year mean recurrence interval is used (28.2 inches – UFSAR Section 2.3.1.3.3). This conservatively equates to a ground snow pressure of about 60 pounds per square foot (psf). The FSF was designed for a 60 psf ground snow load. For comparison, the auxiliary and reactor building roofs are designed for a 30-psf live (snow) load. In addition, the building foundations will go beneath the frost depth of 42" below grade as required by the Michigan building code.

As described in DTE's compliance letter [Reference 18], procedures/guidance do not rely on any systems that are heat-traced to cope with an ELAP at Fermi. Therefore, loss of heat tracing is not a consideration in the Fermi ELAP response. The Fermi ELAP response relies on installed plant equipment and instruments installed within the reactor and auxiliary buildings. The reactor and auxiliary building ventilation system is designed to maintain temperatures greater than 65 °F. Portable equipment for the FLEX response is stored in two FSFs. The FSF heating and ventilation system is designed to maintain the interior temperature of the buildings above 40°F. The Licensee's FIP states that heat tracing is not required.

Each FLEX storage building has its own heating and ventilation, and fire detection and suppression system. During the review of EDP-37124, it was noted that the FSF buildings heating and ventilation system is designed to meet outdoor design conditions of -19°F to 95°F and maintain interior design conditions of 40°F to 105°F. Operating equipment, such as electric heaters and fans, are installed with seismically robust restraints to ensure they do not fall on FLEX equipment.

3.6.2 Reliability of FLEX Equipment

Section 3.2.2 of NEI 12-06 [Reference 6] states, in part, that in order to assure reliability and availability of the FLEX equipment, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare (i.e., an N+1 capability, where "N" is the number of units on site). It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site (e.g., a single pump capable of all water supply functions for a dual unit site). In this case, the N+1 could simply involve a second pump of equivalent capability. In addition, it is also acceptable to have multiple strategies to accomplish a function, in which case the equipment associated with each strategy does not require an additional spare.
In its FIP [Reference 18], DTE described that Fermi has two FSF buildings that are designed to withstand the hazards applicable to Fermi. The FSF buildings contain the FLEX portable N and the N+1 sets of equipment. The equipment list, included as Table 3 of the FIP, describes the N and the N+1 on-site FLEX equipment and its storage location. In addition, Fermi has provided spare cabling and hose of sufficient length and sizing to replace the single longest run needed to support any single FLEX strategy.

3.6.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should protect the FLEX equipment during a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and adequately addresses the requirements of the order.

3.7 Planned Deployment of FLEX Equipment

Pre-determined, preferred haul paths have been identified and documented in the FSGs. These haul paths have been reviewed for potential soil liquefaction and have been determined to be stable following a seismic event. Additionally, the preferred haul paths generally avoid areas with trees, power lines, narrow passages, etc. However, high winds can cause debris from distant sources to interfere with planned haul paths. Debris removal equipment is stored inside the FSFs for protection from the severe storm and high wind hazards such that the equipment remains functional and deployable to clear obstructions from the pathway between the FSFs and its deployment location(s).

3.7.1 Means of Deployment

The FIP [Reference 18] states that debris removal equipment is stored inside the FSFs in order to be reasonably protected from the applicable external events such that the equipment is likely to remain functional and deployable to clear obstructions from the pathway between the BDB equipment's storage location and its deployment location(s). These include mobile equipment such as a FLEX bulldozer and FLEX trucks with front-end blades.

In addition, the FIP describes that the deployment of the FLEX and debris removal equipment from the FSFs are not dependent on off-site power. All actions are accomplished by either use of a backup generator at the building or manually. The doors to the buildings will open in under 5 minutes, reliably, using a compressed air bottle and air ratchet, which is connected to the door via a sling system.

As described in DTE's compliance letter [Reference 18], Fermi does not rely on a dam to maintain its water inventory required for FLEX injection and is not susceptible to dam failures (UFSAR Section 2.4.4).

For high winds, the FIP describes that Fermi may have some warning time prior to the event, in which a significant tornado event could occur within the vicinity of the site. The most probable approach direction is from the southwest. Site debris would most likely include all types of building material (metal siding, roofing, lumber, etc.), power lines and poles, Sea-vans, vehicles, light poles, trees and stored material. Minimal debris impacting deployment routes would be generated from offsite sources. As stated previously, FLEX portable N and N+1 equipment is stored in the FSF buildings. Travel routes for FLEX deployment are considerably wide in most areas providing a drivable path even with debris. FLEX trucks and trailers should be able to travel over small debris such as sheet metal, vegetation and other similar objects. FLEX hoses, cables, and connection points for FLEX Pumps and DGs are located in designated areas protected from tornados and tornado missiles. Deployment pathways blocked by tornado debris can be cleared using the FLEX vehicles and bulldozer, and other debris removal tools such as chainsaws, disaster saw, tow chains, etc., which are stored in the FSFs.

As described in the FIP [Reference 18], snow and ice storms can provide enough buildup to affect travel within the site. However, reasonable warning time should provide enough time for progressive snow and ice removal by normal means. Clearing of FLEX deployment pathways has been incorporated into the Fermi snow removal plan. The FLEX bulldozer could be used for snow removal of FLEX deployment pathways along with the FLEX trucks, which are equipped with a snow removal blade. The FLEX bulldozer, trucks, DGs, and pumps are stored in the FSFs, which are temperature controlled. Each of the vehicles, DGs, and pumps are also equipped with a starting battery trickle charger to maintain the batteries at full charge for cold weather starts.

3.7.2 Deployment Strategies

As stated in its FIP, DTE performed an evaluation for potential liquefaction at Fermi. The evaluation determined that the potential for liquefaction for FLEX water supply (CW reservoir) and FLEX access and deployment paths was minimal. As described in the compliance letter [Reference 18], the results from calculations show no susceptibility to liquefaction that impacts the CW reservoir, Phase 2 equipment deployment, or Phase 3 NSRC equipment travel paths inside the owner controlled area. Cyclic softening in areas with clay fill is predicted to result in settlements of a maximum of two inches, which does not impact deployment capability.

For a site flooding event, the FIP describes that notification of a predicted event from NWS will occur at least 48 hours prior to the predicted site flooding. Upon notification, the plant is shut down and placed in cold shutdown mode. Personnel are stationed at the location of the portable DGs in FSF 1 in order to be in place to deploy the DGs as soon as possible after high wind and wave action subsides (approximately 17 hours), should an ELAP occur. Upon the occurrence of an ELAP, an extensive shedding of dc loads is performed.

The FIP states that the CW reservoir is normally the heat sink for water that has passed through the main condenser. Therefore, the water temperature in the CW reservoir would be greater than 32°F at the start of the BDBEE. Since frazil ice formation requires supercooled liquid, the initial BDBEE conditions would inhibit the formation of frazil ice. Under conditions where CW reservoir may approach freezing, the low flow conditions in the reservoir in comparison to the total volume would inhibit the formation of frazil ice in favor of formation of a surface ice layer.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling, RPV, and SFP Makeup Connections

The licensee described in its FIP [Reference 18], that the diesel driven FLEX pumps, the Neptune and Dominator, being connected in series to provide water from the CW reservoir. The CW reservoir is a seismically robust earthen structure that is protected from all of the external hazards. The Neptune pump is deployed from FSF 2 and into the CW reservoir. The Neptune pump discharge is routed using about 700 feet of hose to the suction of the Dominator pump. The Dominator is deployed from FSF 1 to the east building apron. The discharge from the Dominator is fed to using about 500 feet of hose to a discharge manifold staged on the west side of the Reactor Building and into one of two exterior connections to the RHR system. The licensee indicated that the FLEX water flow can be directed to the RPV, suppression pool, or SFP as implemented throughout the overall FLEX strategy. The Reactor Building is a seismically robust building that is protected from all external hazards. The alternate method for containment heat removal will be accomplished using the Torus Hardened Vent system. Supplemental cooling water for the RCIC and HPCI system is established and these systems used to supply cooling to the reactor. Air and electrical support needed for operation of the Torus Hardened Vent are restored as part of the FLEX response. If necessary, due to loss of RCIC and HPCI, the CW water can be injected into the RPV through the RHR system. The licensee further described the alternate SFP makeup strategy as using the 10 CFR 50.54(hh) monitor nozzles with sufficient hose to spray the SFP. The equipment is stored in FSF 2 and is deployed around the 8.4 hour timeframe after ELAP is declared if needed.

3.7.3.2 Electrical Connection Points

Either 480 Vac FLEX PDG could supply power to the 480 Vac Switchgear in the Auxiliary Building (AB) through a transfer switch and cables pre-staged in a permanent Civil Electrical Chase (CEC). The CEC is a concrete duct bank that is installed in the ground and contains three electrical circuits/cables. The CEC/duct bank runs from FSF 1 to the Auxiliary Building penetration. The connection in the Auxiliary Building switchgear room is made using pre-staged cables from a connection box in the switchgear room to a breaker insert device (BID). The BID would be inserted into a designated spare motor control center and load center position prior making the cable connection. Using a pre-staged electrical distribution system through a permanent CEC is considered an alternative to the conditions endorsed by the NRC in NEI 12-06, Revision 0 [Reference 6]. The CEC between FSF 1 and the Auxiliary Building contains 3 independent circuits, one for power supply to the FLEX X-Tie 480 Vac Power Panel installed inside the Auxiliary Building, the second circuit is for the Division I 480 Vac bus, and the third circuit is for Division II 480 Vac bus.

The licensee's primary strategy to supply power to the Class 1E battery chargers involves use of a 480 Vac PDG, the FLEX Transfer Switch, pre-staged cables in the CEC, the FLEX X-Tie 480 Vac Power Panel, and the Division I and/or Division II 480 Vac MCC buses. The second cable/circuit from the 480 Vac PDG would supply power to the Division I 480 Vac MCC buses to energize RCIC and HPCI pumps and valves and other required loads. The alternate strategy for supplying power to the Class 1E battery chargers involves use of the other 480 Vac PDG, the FLEX Transfer Switch, pre-staged cables in the CEC, the FLEX 480 Vac X-Tie bus, and the Division I and/or Division II Battery Chargers. A second cable/circuit from the other 480 Vac PDG would supply power to the Division II 480 Vac MCC buses to energize RCIC and HPCI pumps and valves and other required loads. The licensee stated that there is also an option to supply power to the Division I and/or Division II battery chargers and other loads by running cables to connect the Division I, 480 Vac, 600 Ampere (A) bus to the Division I 480 Vac, 200 A MCC bus and similarly to connect the Division II, 480 Vac, 600 A bus to the Division II 480 Vac, 200 A MCC bus. These options provide electrical diversity and redundancy to supply power to the Class 1E battery chargers in case a single cable/circuit in the CEC or the FLEX X-Tie 480 Vac Power Panel is not available during an ELAP event. Licensee procedures 29.FSG.01 and 29.FSG.04 contain steps to establish an alternate circuit if necessary.

In the event that a 480 Vac PDG is unavailable, the second 480 Vac PDG would be deployed to the FSF 1 Building apron area and connected to the 480 Vac switchgear inside the Auxiliary Building through the common transfer switch and CEC. During the site audit, the NRC staff confirmed that the cables routed in the CEC will be monitored under the Plant Cable Monitoring Program for cable aging, water or moisture accumulation.

The NRC staff requested DTE provide additional information on how it would connect the Phase 3 (NSRC) CTGs. In its response dated June 15, 2016, the licensee noted that Procedure 29.FSG.15, "FLEX Phase 3 Preparations," Revision 0 [Reference 73], includes guidance on connecting the Phase 3 NSRC 4160 Vac FLEX CTGs to the plant's electrical distribution system. Specifically, this procedure provides guidance to the plant operators to hook up Phase 3 FLEX CTGs in accordance with procedures 35.321.002, "SAFER Supplied Temporary Generators to SST-64 Buses," Revision 0, and 35.321.003, "SAFER Supplied Temporary Generators to SST-65 Buses," Revision 0, respectively. The licensee also stated these procedures direct the plant operators to perform a post-connection phase rotation check by 'bumping' an applicable load to ensure that phase rotation is correct. The NRC staff finds this approach acceptable.

3.7.4 Accessibility and Lighting

As described in the FIP [Reference 18], an evaluation of the tasks to be performed and the available lighting in the designated task areas was completed. Based on that evaluation, existing battery powered (Appendix "R") emergency lights and helmet mounted lamps were determined to be adequate lighting for most tasks. For some areas, DTE provided additional portable, battery powered lighting. These emergency lights are inventoried and periodically tested to insure their availability.

The licensee's FIP [Reference 18], states that a 60 kW DG is provided for each FSF to provide power to building services including lighting. Additionally, portable light towers are provided in the FSF 1 (two light towers) and FSF 2 (one light tower). This lighting is sufficient to support nighttime operations to implement FLEX.

In addition, the FIP states that for Phase 3, the NSRC is deploying portable lighting towers in accordance with the Fermi SAFER Response Plan. The deployment of six 6 kW, 440,000 lumens, diesel-driven lighting towers from SAFER will support Fermi exterior lighting for equipment staging areas and FLEX deployment locations.

3.7.5 Access to Protected and Vital Areas

The licensee has contingencies in place to provide access to areas required for the ELAP response if the normal access control systems are without power.

The FIP describes that doors and gates serve a variety of barrier functions on the site. One primary function is security and is discussed below. However, other barrier functions include fire, flood, radiation, ventilation, tornado, and a high energy line break. As barriers, these doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following an a BDBEE and subsequent ELAP event, FLEX coping strategies may require the routing of hoses and cables to be run through various barriers in order to connect BDB equipment to station fluid and electric systems and to provide air flow for area ventilation. For this reason, certain barriers (gates and doors) may be opened and may need to remain open. This deviation from normal administrative controls is acknowledged and is acceptable during the implementation of FLEX coping strategies.

The FIP further describes that the ability to open doors for ingress and egress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies. Security doors and gates that rely on electric power to operate opening and/or locking mechanisms are barriers of concern. The security force will initiate an access contingency upon loss of the security diesel and all ac/dc power as part of the Security Plan. Access to the owner controlled area, site PA, and areas within the plant structures will be controlled under this access contingency as implemented by security personnel.

3.7.6 Fueling of FLEX Equipment

The FLEX strategies for maintenance and/or support of safety functions include the supply of fuel to necessary diesel powered generators, pumps, compressors, etc. The coping strategy for supplying fuel oil to diesel driven portable equipment, i.e., pumps and generators, is to draw fuel oil out of the four Fermi emergency diesel generator (EDG) fuel oil storage tanks (FOSTs). The FOSTs are located in separate rooms above grade in the RHR complex, a Category I structure.

These four FOSTs contain 42,000 gallons of diesel fuel each (a technical specification minimum is 35,280 gallons). Fuel can be obtained using a tank drain valve and a flexible hose. Additional sources of fuel are the combustion turbine generator fuel storage tank and the auxiliary boiler fuel oil storage tank, if intact.

Diesel fuel in the fuel oil storage tanks is routinely sampled and tested to assure fuel oil quality is maintained to American Society for Testing and Materials standards. This sampling and testing surveillance program also assures the fuel oil quality is maintained for operation of the station EDGs.

The above fuel oil sources will be used to fill the fuel oil tank on one of the two fuel trailers. A fuel trailer is stored in each of the FSFs. It has a capacity of approximately 1000 gallons and has a self-powered transfer pump for trailer tank filling or equipment fueling operations. The fuel trailers will be deployed from the FSFs to refill the fuel oil tanks of the BDB equipment and to the various fuel oil tank locations where it will be filled from the FOSTs.

Based on a fuel consumption calculation, the fuel consumption for 7 days of operation of Phase 2 FLEX equipment is approximately 24,000 gallons. At this conservative fuel consumption rate, the four 42,000 gallon FOSTs, which are protected from BDB hazards, have adequate capacity to provide the on-site FLEX equipment with diesel fuel for greater than 30 days.

The diesel fuel consumption information above does not include fuel requirements for the portable 4kV generators to be received from the NSRC. The Phase 3 re-powering strategy for use of the 4kV diesel generators will be developed based on the specific event circumstances and will include assessment of on-site and off-site fuel availability.

The BDBEE response equipment includes a chain saw and chop saw that are powered by gasoline engines. These components will be re-fueled using portable containers of fuel. Additional gasoline can be obtained from the station's underground gasoline fuel storage tanks or from private vehicles on site.

3.7.7 Conclusions

The NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow deploying the FLEX equipment following a BDBEE consistent with NEI 12-06 [Reference 6] guidance, as endorsed by JLD-ISG-2012-01, and adequately addresses the requirements of the order.

3.8 Considerations in Using Offsite Resources

3.8.1 Fermi SAFER Plan

There are two NSRCs (Memphis area and Phoenix area) established to support nuclear power plants in the event of a BDBEE. In its FIP, the licensee stated that it has established contracts with Pooled Equipment Inventory Corporation to participate in the process for support from the NSRCs as required. Each NSRC holds five sets of equipment, four of which will be able to be fully deployed to the plant when requested. The fifth set allows removal of equipment from availability to conduct maintenance cycles. In addition, the plant's FLEX equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

The SAFER Response Plan for Fermi [Reference 78], contains (1) SAFER control center procedures, (2) NSRC procedures, (3) logistics and transportation procedures, (4) staging area procedures, which includes travel routes between staging areas to the site, (5) guidance for site interface procedure development, and (6) a listing of site-specific equipment (generic and non-generic) to be deployed for FLEX Phase 3.

By letter dated September 26, 2014 [Reference 23], the NRC staff issued its staff assessment of the NSRCs established in response to Order EA-12-049. In its assessment, the NRC staff concluded that SAFER has procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06 [Reference 6] guidance; therefore, the NRC staff concluded in its assessment that licensees can reference the SAFER program and implement their SAFER Response Plans to meet the Phase 3 requirements of Order EA-12-049.

3.8.2 Staging Areas

In general, up to four staging areas for NSRC supplied Phase 3 equipment are identified in the SAFER Plans for each reactor site. These are a Primary (Area C) and an Alternate (Area D, if needed), which are offsite areas (within about 25 miles of the plant) for receipt of ground transported or airlifted equipment from the SAFER centers in Phoenix, Arizona or Memphis, Tennessee. From Staging Areas C and/or D, a near- or on-site Staging Area B is established for interim staging of equipment prior to it being transported to the final location for implementation in Phase 3 at Staging Area A.

Alternate Staging Area D is not used at Fermi. Staging Area C is the DTE Western Wayne Service Center or Willow Run Airport if helicopter operations are needed. Staging Area B is the site helipad and Staging Area A is the main entrance. The use of helicopters to transport equipment from Staging Area C to Staging Area B is discussed in the Fermi SAFER Plan.

3.8.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow utilization of offsite resources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

3.9.1.1 Loss of Ventilation and Cooling

Following a BDBEE and subsequent ELAP event at Fermi, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. In accordance with the guidance given in NEI 12-06 [Reference 6], FLEX strategies must be capable of execution under the adverse conditions expected following a BDBEE resulting in an ELAP/LUHS. The primary concern with regard to ventilation is the heat buildup, which occurs with the loss of forced ventilation, in areas that continue to have heat loads. The licensee performed several loss of ventilation analyses to quantify the maximum steady state temperature expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability and within equipment qualification limits. These calculations use the GOTHIC (Generation of Thermal-Hydraulic Information for Containments) Version 7.2b computer program.

Electrical

The key areas identified for all phases of execution of the FLEX strategy activities are the HPCI/RCIC Pump Room, Containment, MCR, dc MCC Rooms, Class 1E Station Battery Rooms, Division I and Division II Switchgear Rooms. The licensee reviewed the temperature profiles against equipment capabilities and applicable mitigation actions, and determined that the equipment required for a FLEX response is capable of operation under these conditions.

HPCI/RCIC Pump Rooms

The NRC staff reviewed the summary of Calculation DC-6587, Vol 1, "Loss of HVAC – Room Environmental Analysis in Support of FLEX – HPCI, RCIC Room Temperature & Water Level Analysis," Revision A. The results of this analysis show that the maximum temperature over 72 hours would be 147.6°F in the RCIC Pump Room and 163.4°F in the HPCI Pump Room. The Electronic Governor Module (EGMs) for the RCIC and HPCI Pump controls are located in the Relay Room. Table 2 of Calculation DC-6385, Volume I, "Loss of HVAC – Room Environmental Analysis in Support of FLEX RB/AB/TB Temperature Profile Analysis," Revision A, determined that the maximum expected temperature in the Relay Room is 111.2°F. Based on the Relay Room temperature remaining below 120°F (the temperature limit, as identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, for equipment to be able to survive indefinitely), the NRC staff finds that the EGM performance will not be adversely impacted by the loss of ventilation as a result of an ELAP event. Furthermore, Procedure 29.FSG.ToolBox, provides guidance to the plant operators to run the HPCI/RCIC Room Cooler fan when power is restored to Division II ESF buses and run the RBHVAC from the MCR to cool the room to ensure continued functionality of the required equipment. Based on the above, the NRC staff concludes that the higher expected temperature in the RCIC and HPCI Pump rooms due to loss of ventilation during ELAP should not have any adverse impact on the functioning of electrical and electronic equipment or component of the RCIC and HPCI Pump systems.

Containment

In its response dated June 15, 2016, the licensee clarified that all temperatures and pressures are maintained within the containment limits except for the 50+ hours during flood scenario. Mitigation actions are required and the Fermi plant personnel will take mitigating actions prior to the drywell peak temperature of 340°F which will occur approximately 50 hours into an ELAP. The licensee's mitigating actions include using FLEX water in the RHR system and spraying it into the drywell to lower the drywell temperature. The SRVs are located in the drywell and therefore the electrical components (solenoid, controls etc.) of the SRV would be exposed to this temperature. The licensee's evaluation of the effects of higher temperature on SRV operation due to a loss of ventilation during an ELAP event showed that the most susceptible component of the SRV is the solenoid insulation. The licensee stated that the solenoid valve is qualified for 342°F temperature for a period of 56.5 days based on the vendor's thermal aging test. This testing provided assurance that the functionality of the SRVs will be maintained during the ELAP, where peak temperatures are expected to be bounded by the 340°F design value. The licensee's conclusion was based on Fermi documents EQ1-EF2-155, "EEQ Qualification Evaluation Report," Revision D, and Vendor Qualification Report, "Target Rock Qualification Test Report No. 5074," that qualified the operation of the solenoid valves at elevated temperatures up to 340°F. The licensee's mitigating strategy to use FLEX water in the RHR system to spray the drywell to lower drywell temperature is discussed in EOPs 29.100.01, Sheet 2, "Primary Containment Control," Revision 13. Based on above, the NRC staff finds that the electrical controls and electronic components of the SRVs will remain qualified for the peak drywell temperature of 340°F during an ELAP event with implementation of the above mitigating actions. The NRC staff also finds that it is reasonable to expect that offsite resources and support will be available several days after event initiation to monitor and reduce temperature and pressure within containment, if necessary.

As part of its evaluation, the licensee reviewed equipment subjected to FLEX post BDBEE ambient conditions in the drywell and containment to assess the functionality of the selected instruments/devices under elevated temperatures and pressures for an extended duration. The selected devices are those that FLEX strategies depend on to be functional after a BDBEE. The licensee's evaluation showed that the equipment meets the required DBA conditions, but also have shown capabilities, either through testing or analysis, that exceed those conditions and can be expected to perform their required functions under post beyond-design-basis conditions for an extended period of time.

MCR

The licensee evaluated the MCR to determine the temperature profiles following an ELAP/LUHS event in Calculation DC-6585, Volume 1, "Loss of HVAC – Room Environment Analysis in Support of FLEX: RB/AB/TB Temperature Profile," Revision A. This calculation determined that the maximum expected temperature in the MCR would be 116.4°F. Based on MCR Room temperature remaining below 120°F (the temperature limit, as identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, for equipment to be able to survive indefinitely), the NRC staff finds that the electrical and electronic equipment and components in the MCR will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

DC MCC Rooms

The NRC staff reviewed the summary of licensee calculation DC-6586, Volume 1, "Loss of HVAC - Room Environmental Analysis in Support of FLEX: Battery Room Temperature and Hydrogen Concentration," Revision 0. This calculation shows that the expected temperatures (during scenario 1 - worst summer conditions with no actions) in the Division II battery charger rooms would be 161.1°F after 72 hours of the initiation of an ELAP. The Class 1E battery chargers are installed in the dc MCC area in the AB. The licensee's evaluation of the effects of higher room temperatures on battery chargers identified that the most susceptible components in the Class 1E battery charger are digital electronic devices which used metal-oxide semiconductor (MOS) that are rated for at least 158°F. The above calculation (DC-6586) showed that the Division II battery charger room temperature of 158°F is expected to reach 60 hours into the event. Licensee procedure 29.FSG.ToolBox provides guidance to the plant operators to energize the Switchgear Room air conditioner (A/C) unit to cool the dc MCC area 4-6 hours after the Phase 2 PDG is deployed. This procedure also directs plant operators to restore cooling to the Reactor Building Component Cooling Water (RBCCW) system as part of Phase 3 which would support dc MCC area cooling in 24-30 hours. Furthermore, the procedure directs plant operators to open specific doors. Based on above, the NRC staff concludes that the electrical equipment in the battery charger rooms should remain functional during an ELAP event.

Class 1E Station Battery Rooms

The NRC staff reviewed licensee calculation DC-6586. This calculation analyzed temperature profiles for Division I and Division II Battery Rooms. Table 2.1 of this calculation shows the worst-case maximum temperatures (worst summer conditions) for the Division I and Division II Battery Rooms to be 114.0°F and 116.4°F, respectively after 72 hours of initiation of an ELAP event.

Maximum battery room temperature is based on cell charging temperature limit of 120°F. The Fermi Class 1E station batteries were manufactured by C&D Technologies. The qualification testing performed by C&D Technologies demonstrated the ability to perform under elevated operating temperature environments. The testing results indicate that the battery cells will perform as required in excess of 200 days under an estimated 122°F.

The elevated temperature also has an impact by increasing the charging current required to maintain the float charging voltage set by the charger. The elevated charging current will in turn increase cell water loss through an increase in gassing. Based on this, periodic water addition may be required or the float charging voltage reduced per the guidance contained in the C&D Technologies vendor manual. If battery cell plate uncovery were to occur, failure issues associated with plates being exposed would involve the potential development of sulfation and a subsequent reduction in capacity. If loss or failure of a battery string were to occur, the battery charger has the capability to carry the anticipated loads indefinitely provided ac power remains available to power the charger.

Division I and Division II Switchgear Rooms

The NRC Staff reviewed the summary of licensee calculation DC-6585, Volume 1, "Loss of HVAC – Room Environment Analysis in Support of FLEX: RB/AB/TB Temperature Profile Analysis," Revision A. Division I and Division II Switchgear Rooms are located in the AB. This calculation determined that the worst-case maximum expected temperature would be 125.6°F (for the Division II Switchgear Room) at approximately 55 hours after initiation of the ELAP event with no actions taken. The expected temperature in the Division I Switchgear room is less than 120°F. Procedure 29.FSG.ToolBox provides guidance to the plant operators to energize the Switchgear Room A/C unit to cool the Switchgear Rooms 4-6 hours after the Phase 2 PDG is deployed and to restore water based cooling to the rooms in 24-30 hours by restoring cooling to the RBCCW system as part of Phase 3. It is reasonable to assume that the licensee's actions in procedure 29.FSG.ToolBox would reduce temperature below 120°F. Based on the above, the NRC staff concludes that the electrical equipment in the Switchgear rooms should remain functional during an ELAP event.

Based on its review of the essential station equipment required to support the FLEX mitigation strategy, which are primarily located in the HPCI/RCIC Pump Rooms, Containment, MCR, Electrical Switchgear Rooms, dc MCC Rooms, and Class 1E Station Battery Rooms, the NRC staff finds that the equipment should perform their required functions at the expected temperatures as a result of loss of ventilation during an ELAP/LUHS event.

3.9.1.2 Loss of Heating

The Fermi Class 1E station battery rooms are located in the interior of the AB. The licensee's calculation DC-6586 determined that the worst case minimum expected temperature for both Division I and Division II battery rooms is 64.1°F. Licensee calculation DC-6584 Volume I conservatively assumed a 60°F room temperature in the analysis of the battery coping duration and determined that the station batteries will provide sufficient voltage to support all connected loads for at least 12 hours. Therefore, the assumed temperature of 60°F in calculation DC-6584 bounds the analyzed minimum expected temperature of 64.1°F for the Division I and Division II Battery Rooms analyzed in calculation DC-6586.

Based on its review of the licensee's battery room assessment, the NRC staff finds that the Fermi Class 1E station batteries should perform their required functions at the expected temperatures as a result of loss of heating during an ELAP event.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

An additional ventilation concern that is applicable to Phases 2 and 3, is the potential buildup of hydrogen in the battery rooms as a result of loss of ventilation during an ELAP event. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging.

The NRC staff reviewed licensee calculation DC-6586 Volume I. Based on its review, the NRC staff finds that hydrogen concentration level should remain below 2 percent by volume for 39 hours for the Division II Battery Room and 36 hours for the Division I Battery Room. The calculation showed that after 72 hours both battery compartments maintain hydrogen concentration less than 4 percent (the combustibility limit for hydrogen). Within 36 hours, Fermi plant operators would restore RB HVAC using 29.FSG.Toolbox. This mitigating action will maintain hydrogen concentration level in the battery rooms below 4 percent.

Based on the above, the NRC staff concludes that hydrogen accumulation in the Fermi Class 1E station battery rooms should not reach the combustibility limit for hydrogen during an ELAP.

3.9.2 Personnel Habitability

3.9.2.1 Main Control Room

As described above in Section 3.9.1.1, calculation DC-6585, Volume 1 predicts that the maximum temperature reached in the MCR to be 116.4°F with no mitigating actions taken other than opening specific doors. It is expected that building ventilation flow can be re-established approximately 8 hours into the event, at which time the MCR temperature is approximately

100°F. Operators have the option to start RBHVAC to mitigate these higher temperatures in accordance with Procedure 29.FSG.Toolbox - RBHVAC Local Operations and 29.FSG.Toolbox Ventilation and Building Heat Control, if needed. Based on the licensee being able to re-establish RBHVAC, to control MCR temperatures below 110°F (the temperature limit, as identified in NUMARC-87-00, for personnel habitability), the NRC staff finds that personnel in the MCR will not be adversely impacted by the initial loss of ventilation as a result of an ELAP event.

3.9.2.2 Spent Fuel Pool Area

As discussed in NEI 12-06 guidance [Reference 6], a baseline capability for Spent Fuel Cooling is to provide a vent pathway for steam and condensate from the SFP. In order to establish a vent pathway for steam and condensate, specific doors are manually opened within 4 hours to prevent the siding on the RB fifth floor from blowing out due to excessive internal pressure. Because cooler air will be allowed to enter the reactor building through the floor doors, a chimney effect will be established through the roof doors. Procedure 29.FSG.Toolbox Ventilation and Heat Control includes steps to open doors to allow ventilation prior to degraded conditions on the RB fifth floor to the point that it affects habitability, due to boiling in the SFP.

In addition, the licensee plans to complete hose deployment and spay nozzle setup on the RB fifth floor before conditions degrade to the point that it affects habitability, due to boiling in the SFP.

3.9.2.3 Other Plant Areas

FLEX Support Facility

The FLEX portable equipment is stored in two robust structures, FSF 1 and FSF 2. The FSF Buildings have their own heating and ventilation system. In accordance with the building design (EDP 37124, "FLEX Storage Facilities for Phase 2 Equipment," Index Item No. 004, Revision 0, "Scope"), the HVAC systems will maintain interior design conditions of 40°F to 105°F, which is within the tolerable equipment temperature range indicated by the equipment vendors.

3.9.3 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions following a BDBEE consistent with NEI 12-06 [Reference 6] guidance as endorsed by JLD-ISG-2012-01, and adequately addresses the requirements of the order.

3.10 Water Sources

Condition 3 of NEI 12-06 [Reference 6], Section 3.2.1.3, states that cooling and makeup water inventories are considered available if they are contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles. The NRC staff reviewed DTE's planned water sources to verify that each water source was robust as defined in NEI 12-06.

The licensee described in its FIP, that the CW reservoir provides approximately 33 million gallons of water that can used to supply the FLEX water systems. The CW reservoir is a seismically robust earthen structure that will remain available for any of the external hazards. A lift pump system and booster pump, used to restore core cooling, containment cooling, and SFP pool cooling functions, are utilized to pump cooling water from the CW reservoir to either division 1 or division 2 of the RHR system (low pressure coolant injection).

3.10.1 RPV Make-Up

Phase 1

The licensee described in its FIP [Reference 18], that the CST or the suppression pool (torus) would provide the initial cooling water to the reactor coolant system. Because the CST is not sufficiently qualified, it is not considered available for the BDBEE. If the CST is available, it is the preferred suction source for HPCI and RCIC. The RCIC suction would be switched to the suppression pool if the CST is not available or upon low level in the CST. The suppression pool is located within the reactor building and is classified as a Seismically Category I structure.

Phase 2

In its FIP [Reference 18], DTE stated that the Phase 2 FLEX strategy, implemented after approximately five hours, core cooling would continue to use RCIC, taking suction from the suppression pool. However, Phase 2 FLEX water would be needed to remove heat from the suppression pool water supply to support RCIC operation.

FLEX Water from the CW reservoir would be supplied to the suppression pool to provide the "feed" for containment cooling. Water from the suppression pool will be rejected to the CW reservoir by operation of the HPCI system ("bleed water"). The flow path is through the HPCI test line to a cross-connect to the GSW system which discharges to the CW reservoir. This "feed and bleed" operation will act to maintain suppression pool temperature sufficiently low to support on-going RCIC operation supplying water to the RPV.

Phase 3

Phase 3 uses the same water sources as in Phase 2.

3.10.2 Suppression Pool Make-Up

The suppression pool does not need any makeup for Phase 1.

In its FIP [Reference 18], DTE described that for the Phase 2 FLEX strategy, implemented after approximately five hours, FLEX water from the CW Reservoir would be supplied to the suppression pool to provide the "feed" for containment cooling. Water from the suppression pool will be rejected to the CW reservoir by operation of the HPCI system ("bleed water"). The flow path is through the HPCI test line to a cross-connect to the GSW system which discharges to the CW reservoir. This "feed and bleed" operation will act to maintain suppression pool temperature sufficiently low to support on-going RCIC operation supplying water to the RPV. Phase 3 uses the same water sources as in Phase 2.

3.10.3 Spent Fuel Pool Make-Up

The Phase 2 strategy is to initiate SFP makeup using the FLEX pumps taking suction from the CW Reservoir and connecting to the RHR system and repositioning RHR system fuel pool cooling assist mode valves. Phase 3 uses the same water sources as in Phase 2.

3.10.4 Containment Cooling

In its FIP [Reference 18], DTE described that after approximately 5 hours after the BDBEE, FLEX water from the CW Reservoir would be needed and supplied to the suppression pool to provide the "feed" for containment cooling. Water from the suppression pool will be rejected to the CW reservoir by operation of the HPCI system ("bleed water"). The flow path is through the HPCI test line to a cross-connect to the GSW system which discharges to the CW reservoir. Phase 3 uses the same water sources as in Phase 2.

3.10.5 Conclusions

The NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain satisfactory water sources following a BDBEE consistent with NEI 12-06 [Reference 6] guidance, as endorsed by JLD-ISG-2012-01, and adequately addresses the requirements of the order.

3.11 Shutdown and Refueling Analyses

Order EA-12-049 requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on an ELAP occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the ELAP occurs with the plant at power, the mitigation strategy initially focuses on the use of the steam-driven RCIC pump to provide the water initially needed for decay heat removal. If the plant has been shut down and all or most of the fuel has been removed from the RPV and placed in the SFP, there may be a shorter timeline to implement the makeup of water to the SFP. However, this is balanced by the fact that if immediate cooling is not required for the fuel in the reactor vessel, the operators can concentrate on providing makeup to the SFP. The licensee's analysis shows that following a full core offload to the SFP, about 28 hours are available to implement makeup before boil-off results in the water level in the SFP dropping to a level 10 feet above the fuel assemblies, and the licensee has stated that it has the ability to implement makeup to the SFP within that time.

When a plant is in a shutdown mode in which steam is not available to operate a steam-powered pump such as RCIC (which typically occurs when the RPV has been cooled below about 300 °F), another strategy must be used for decay heat removal. On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown/Refueling Modes" [Reference 38], which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 [Reference 38], the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

The position paper provides guidance to licensees for reducing shutdown risk by incorporating FLEX equipment in the shutdown risk process and procedures. Considerations in the shutdown risk assessment process includes maintaining necessary FLEX equipment readily available and potentially pre-deploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling. The NRC staff concludes that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. By letter dated January 20, 2016 [Reference 18], the licensee informed the NRC staff of its plans to follow the guidance in this position paper.

Based on the information above, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore core cooling, SFP cooling, and containment following a BDBEE in shutdown and refueling modes consistent with NEI 12-06 [Reference 6] guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.12 Procedures and Training

Procedures

The licensee stated in its FIP [Reference 18], that the inability to predict actual plant conditions that require the use of BDB equipment makes it impossible to provide specific procedural guidance. As such, the FSGs provide guidance that can be employed for a variety of conditions. The plant procedures provide clear criteria for entry into FSGs to ensure that FLEX strategies are used only as directed for BDBEE conditions, and are not used inappropriately in lieu of existing procedures. When BDB equipment is needed to supplement EOPs or Abnormal Operating Procedures (AOPs) strategies, the EOP or AOP, Severe Accident Mitigation Guidelines (SAMGs), or Extreme Damage Mitigation Guidelines (EDGMs) direct the entry into and exit from the appropriate FSG procedure.

The licensee stated, in its FIP, that FLEX strategy support guidelines have been developed in accordance with BWROG guidelines. The FSGs provide available, preplanned FLEX strategies for accomplishing specific tasks in the EOPs or AOPs. The FSGs are used to supplement and not replace the existing procedure structure that establishes command and control for the event.

In addition, DTE stated that changes to FSGs are controlled by the Fermi 2 Conduct Manual MGA02, Procedures, Manuals and orders. The FSG changes will be reviewed and validated by the involved groups to the extent necessary to ensure the strategy remains feasible. Validation for existing FSGs has been accomplished in accordance with the guidelines provided in NEI's FLEX Validation Process.

Training

In its FIP [Reference 18], the licensee stated that the Fermi's Nuclear Training Program has been revised to assure that personnel proficiency in the mitigation of a BDBEE is adequate and will be maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training (SAT) Process or similar processes.

The licensee also stated, that initial training has been provided and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and guidelines. Personnel assigned to direct the execution of mitigation strategies for BDBEE have received the necessary training to ensure familiarity with the associated tasks, available job aids, instructions, and mitigating strategy time constraints.

The FIP [Reference 18] describes that by using the SAT process, job and task analyses were completed for the new tasks identified as applicable to the FLEX mitigation strategies. Based on the analysis, training for Operations was designed, developed and implemented for Operations continuing training. "ANSI/ANS 3.5, Nuclear Power Plant Simulators for use in Operator Training" is a certification of simulator fidelity that is considered to be sufficient for the initial stages of the BDBEE scenario training. As described in NEI 12-06 [Reference 6], Section 11.6, step 4, full scope simulator models will not be upgraded to accommodate FLEX training or drills. DTE has provided training on FLEX Phase 3 and associated equipment from the NSRCs to Fermi operators. Upon deployment and installation of NSRC equipment, turnover and familiarization briefings on each piece of NSRC equipment will be provided to station operators by the NSRC deployment and operating staff.

In addition, the FIP stated that where appropriate, integrated FLEX drills will be organized on a team or crew basis and conducted periodically; with all time-sensitive actions to be evaluated over a period of not more than 8 years. As described in NEI 12-06 [Reference 6], Section 11.6, step 5, It is not required to connect or operate permanently installed equipment during these drills.

Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has adequately addressed the procedures and training associated with FLEX because the procedures have been issued and a training program has been established and will be maintained consistent with NEI 12-06 [Reference 6], as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.13 Maintenance and Testing of FLEX Equipment

As a generic issue, NEI submitted a letter to the NRC dated October 3, 2013 [Reference 39], which included EPRI Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." By letter dated October 7, 2013 [Reference 40], the NRC endorsed the use of the EPRI report and the EPRI database as providing a useful input for licensees to use in developing their maintenance and testing programs.

In its FIP [Reference 18], the licensee stated that Conduct Manual MES51 defines the Fermi Preventive Maintenance (PM) program, which includes the FLEX-related components. The technical requirements for the FLEX component PM activities are based on input from EPRI templates, vendor recommendations and industry practices. The PM technical requirements include the maintenance, inspection and testing activities and frequencies appropriate for the specific piece of equipment to maintain system readiness. The EPRI has completed and has issued “Preventive Maintenance Basis for FLEX Equipment – Project Overview Report” (Report 3002000623). Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

The licensee stated that the PM templates include activities such as:

- Periodic inspections of stand-by equipment
- Fluid analysis
- Periodic operational verifications
- Periodic functional verifications with performance tests

In addition, the FIP stated that the EPRI PM templates for FLEX equipment conform to the guidance of NEI 12- 06 by providing assurance that stored or pre-staged FLEX equipment are being properly maintained and tested. Fermi used the EPRI templates as an input for the development of FLEX maintenance and testing programs. In those cases where EPRI templates were not available, PM actions were developed based on manufacturer provided information/recommendations.

The FIP also stated that additionally, the ERO performs periodic facility readiness checks for equipment that is outside the jurisdiction of the normal PM program and considered a functional aspect of the specific facility (EP communications equipment such as uninterruptable power supplies, radios, batteries, battery chargers, satellite phones, etc.). These facility functional readiness checks provide assurance that the EP communications equipment outside the jurisdiction of the PM Program is being properly maintained and tested.

The licensee also stated in its FIP, that the unavailability of equipment and applicable connections that directly perform a FLEX mitigation strategy for core, containment, and SFP will be managed such that risk to mitigating strategy capability is minimized. The licensee added that the maintenance/risk guidance conforms to the guidance of NEI 12-06 [Reference 6] as follows:

- Portable FLEX equipment may be unavailable for 90 days provided that the site FLEX capability (N) is available.

- If portable equipment becomes unavailable such that the site FLEX capability (N) is not maintained, initiate actions within 24 hours to restore the site FLEX capability (N) and implement compensatory measures (e.g., repair equipment, use of alternate suitable equipment or supplemental personnel) within 72 hours.

Conclusions

The NRC staff finds that the licensee has adequately addressed equipment maintenance and testing activities associated with FLEX equipment because a maintenance and testing program has been established and will be maintained consistent with NEI 12-06 [Reference 6], Section 11.5, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.14 Alternatives to NEI 12-06, Revision 0

In its FIP, DTE took an alternative approach to the NEI 12-06 [Reference 6], Section 3.2.2 guidance regarding electrical diversity. This guidance describes diversity for portable FLEX equipment. NEI 12-06, Section 3.2.2 adds that electrical diversity is to be accomplished by providing a primary and alternate methods to repower equipment and instruments that will be used as part of the FLEX strategies.

The licensee stated that the FSF 1 contains two portable FLEX PDGs. Either 480 Vac FLEX PDG could supply power to the 480 Vac Switchgear in the Auxiliary Building (AB) through a transfer switch and cables pre-staged in a permanent Civil Electrical Chase (CEC). The CEC is a concrete duct bank that is installed in the ground and contains three electrical circuits/cables. The CEC/duct bank runs from FSF 1 to the Auxiliary Building penetration. The connection in the Auxiliary Building switchgear room is made using pre-staged cables from a connection box in the switchgear room to a breaker insert device (BID). The BID would be inserted into a designated spare motor control center and load center position prior making the cable connection. Using a pre-staged electrical distribution system through a permanent CEC is considered an alternative to the conditions endorsed by the NRC in NEI 12-06, Revision 0 [Reference 6]. The CEC between FSF 1 and the Auxiliary Building contains three independent circuits, one for power supply to the FLEX X-Tie 480 Vac Power Panel installed inside the Auxiliary Building, the second circuit is for the Division I 480 Vac bus, and the third circuit is for Division II 480 Vac bus.

The licensee's primary strategy to supply power to the Class 1E battery chargers involves use of a 480 Vac PDG, the FLEX Transfer Switch, pre-staged cables in the CEC, the FLEX X-Tie 480 Vac Power Panel, and the Division I and/or Division II 480 Vac MCC buses. The second cable/circuit from the 480 Vac PDG would supply power to the Division I 480 Vac MCC buses to energize RCIC and HPCI pumps and valves and other required loads. The alternate strategy for supplying power to the Class 1E battery chargers involves use of the other 480 Vac PDG, the FLEX Transfer Switch, pre-staged cables in the CEC, the FLEX 480 Vac X-Tie bus, and the Division I and/or Division II Battery Chargers. A second cable/circuit from the other 480 Vac PDG would supply power to the Division II 480 Vac MCC buses to energize RCIC and HPCI pumps and valves and other required loads. The licensee stated that there is also an option to supply power to the Division I and/or Division II battery chargers and other loads by running cables to connect the Division I, 480 Vac, 600 Ampere (A) bus to the Division I 480 Vac, 200 A MCC bus and similarly to connect the Division II, 480 Vac, 600 A bus to the Division II 480 Vac, 200 A MCC bus. These options provide electrical diversity and redundancy to supply power to the Class 1E battery chargers in case a single cable/circuit in the CEC or the FLEX X-Tie 480 Vac Power Panel is not available during an ELAP event. Licensee Procedures 29.FSG.01 and 29.FSG.04 contain steps to establish an alternate circuit if necessary.

In the event that a 480 Vac PDG is unavailable, the second 480 Vac PDG would be deployed to the FSF 1 Building apron area and connected to the 480 Vac switchgear inside the Auxiliary Building through the common transfer switch and CEC. During the site audit, the NRC staff confirmed that the cables routed in the CEC will be monitored under the Plant Cable Monitoring Program for cable aging, water or moisture accumulation.

The licensee stated that the benefit of using a permanently installed FLEX electrical distribution equipment is that it allows DTE to reenergize the critical plant electrical loads more quickly and efficiently than the use of extensive portable cables and lengthy deployment paths of the portable FLEX DGs from FSF 1.

The NRC staff finds that although the guidance of NEI 12-06 has not been met, this alternative is acceptable to the NRC staff based on the robust nature of the CEC, the maintenance of the

CEC cabling used for FLEX, and the diversity of equipment and connection points in FSF 1 and the AB.

3.15 Conclusions for Order EA-12-049

Based on the information above, the NRC staff concludes that the licensee has developed guidance to maintain or restore core cooling, SFP cooling, and containment following a BDBEE which, if implemented appropriately, will adequately address the requirements of Order EA-12-049.

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated February 28, 2013 [Reference 24], DTE submitted its OIP for Fermi in response to Order EA-12-051. By email dated July 29, 2013 [Reference 25], the NRC staff sent a request for additional information (RAI) to DTE. By letters dated August 19, 2013 [Reference 26], August 26, 2013 [Reference 27], February 27, 2014 [Reference 28], August 28, 2014 [Reference 29], and February 23, 2015 [Reference 30], DTE submitted its RAI responses and the first four six-month updates to the OIP. The NRC staff's review led to the issuance of the Fermi ISE dated November 21, 2013 [Reference 31].

The OIP describes the strategies and guidance to be implemented by DTE for the installation of reliable SFPLI, which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated January 20, 2016 [Reference 32], DTE reported that full compliance with the requirements of Order EA-12-051 was achieved.

The licensee has installed a SFPLI system designed by MOHR. The NRC staff reviewed the vendor's SFPLI system design specifications, calculations and analyses, test plans, and test reports. The NRC staff issued an audit report on August 27, 2014 [Reference 33].

The NRC staff performed an onsite audit to review the implementation of SFPLI related to Order EA-12-051. The scope of the audit included verification of (a) site's seismic and environmental conditions enveloped by the equipment qualifications, (b) equipment installation met the requirements and vendor's recommendations, and (c) program features met the requirements. By letter dated October 1, 2015 [Reference 17], the NRC issued an audit report on the licensee's progress. Refer to Section 2.2 above for the regulatory background for this section.

4.1 Levels of Required Monitoring

In its OIP, DTE stated that Level 1 would be set at an elevation of 683 feet (ft.) 6 inches (in.) based on the surface of the water maintained by scuppers. Level 2 would be set at an elevation of 671 ft. 1/8 in. which is 10 ft. above the top of the fuel racks. In its letter dated August 19, 2013 [Reference 26], DTE provided a sketch depicting the elevations identified as Levels 1, 2, and 3 and the proposed SFPLI sensor range. The licensee stated that in addition to the spent fuel racks in the SFP, DTE also stores materials that could affect radiation doses in the SFP area at Fermi. The licensee will develop plant procedures to address the stored radioactive material, the associated pool level monitoring, and the personnel access requirements to the SFP. The licensee further stated that Level 2 is established as ten feet above Level 3, which is the highest point of any fuel rack seated in the SFP. This is consistent with the guidance of NEI 12-02 [Reference 8], where ten feet of water would provide substantial radiation protection from the spent fuel stored in the fuel racks. The radiation from other materials stored in the SFP area may be less shielded if the SFP water level drops down to Level 2. The dose from both the spent fuel in the racks and that from other stored materials will be assessed in a calculation for habitability and equipment qualification as part of the design of the SFPLI system. An adjustment to the elevation designated as Level 2 may be necessary to meet the guidance of NEI 12-02 [Reference 8]. The licensee stated that Level 3 would be set at an elevation of 661 ft. 1/8 in. based on the elevation of the top of the Fermi tallest fuel rack.

In its letter dated January 20, 2016 [Reference 32], DTE stated that Design Calculation DC-6543, "Total Integrated Radiation Dose to Spent Fuel, Volume I, Revision 0 was developed to determine the dose rate associated with varying SFP levels and considering both the storage of spent fuel and other equipment in the pool. This design calculation also determined a bounding total integrated dose (TID) for the SFP probe over a 40 year remaining plant life and a 6 hour drop in SFP level to the top of the fuel racks. This is consistent with the NEI 12-02 Revision 1 [Reference 8] guideline to consider the impact of FLEX mitigating strategies for equipment qualification. Based on the calculation, DTE selected a Level 2 position as 18 ft. above the top of the spent fuel racks (elevation 679 ft. 1/8 in.). This water level corresponds to a dose rate to personnel on the refueling floor of 10 millirem per hour (mR/hr). This allows personnel to be present on the refueling floor without significant dose consequences. The normal SFP level (Level 1) is elevation 683 ft. 6 in. The Level 2 elevation allows more than four feet of margin between normal pool level and a level where personnel dose becomes of significant concern. DTE also stated that the TID for the SFP predicted by DC-6543 is enveloped by the vendor's equipment qualification. The licensee, in Calculation CD-6534 Vol. 1, Revision 0, Section 2.1.1, concluded that the SFP probe total integrated dose would be 1.325×10^6 Rad, which is below the probe's acceptable TID of 2×10^9 Rad.

The NRC staff found that Level 1 of 683 ft. 6 in. is adequate for normal SFP cooling system operation. It is also sufficient for Net Positive Suction Head and represents the higher of the two points. Level 2 of 679 ft. 1/8 in. is approximately 18 ft. above the top of fuel rack and represents the water level where any necessary operation in the vicinity of the SFP can be performed without significant dose consequences. Level 3 of 661 ft. 1/8 in. is aligned with the highest point of any spent fuel storage rack seated in the SFP. At this level, fuel remains covered.

The NRC staff finds that the licensee's proposed Levels 1, 2, and 3 appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2 <u>Evaluation of Design Features</u>

Order EA-12-051 required that the SFPLI shall include specific design features, including specifications on the instruments, arrangement, mounting, qualification, independence, power supplies, accuracy, testing, and display. The specific requirements are outlined in Section 2.2 of this safety evaluation and are evaluated below.

4.2.1 Design Features: Instruments

In its OIP, DTE stated that both the primary and backup instrument channels would be fixed and that the instrument's range provides continuous indication from 0 ft. to 22 ft. and encompasses Level 3 up to Level 1. In its letter dated August 19, 2013 [Reference 26], DTE provided a simplified elevation sketch depicting the elevations identified as Levels 1, 2, and 3 and the proposed SFPLI sensor range. The NRC staff reviewed this sketch and noted that proposed sensor range covers the elevations identified as Levels 1, 2, and 3 as described in Section 4.1 above.

The NRC staff finds that licensee's design, with respect to the number of channels and measurement range for its SFP, appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.2 Design Features: Arrangement

In its OIP, DTE stated the fixed primary level instrument would be located in the northeast corner of the SFP and its associated signal processor in the auxiliary building, and the fixed backup level instrument would be in the northwest corner of the SFP and its associated signal processor in the reactor building. The licensee also stated that sensors would be located as close to the corners as possible to maintain maximum separation and to provide best protection against a single missile damaging both channels. The licensee provided a sketch, in its OIP, depicting the sensor locations and cable routings for the two redundant channels. In addition, DTE stated that cabling for the primary and backup channel instruments would be routed in raceways separately and seismically mounted, and that cables from the sensors in the SFP area would be in dedicated rigid steel conduits routed in covered recess in the floor to avoid interference with fuel handling activities.

In its letter dated August 19, 2013 [Reference 26], DTE provided additional sketches showing the planned locations/placement of the primary and backup SFP level sensors, and the proposed routing of the cables from the SFP to the local display panels and remote indication panels. The NRC staff reviewed these sketches and noted the proposed arrangement has the instrument probes and cable routing for the SFP instrument channels, running separately from each other.

During the onsite audit, the NRC staff walked down the SFP area, and the primary and back-up cable route. The NRC staff found that there is sufficient channel separation within the SFP area between the primary and back-up level instruments, sensor electronics, and routing cables to provide reasonable protection against loss of indication from the SFP level due to missiles that may result from damage to the structure over the SFP.

The NRC staff finds that, if implemented appropriately, the licensee's proposed arrangement for the SFPLI appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.3 Design Features: Mounting

Regarding the SFP level instrument's seismic qualification, in its letter dated January 20, 2016 [Reference 32], DTE stated that the SFP probe was qualified to the requirements of IEEE 344-2004, Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations. The original generic analysis applied to 3-D acceleration time history excitation, based on a composite response spectra (5.384g peak horizontal acceleration) from a number of other nuclear plants. SFP hydrodynamics were modeled in analysis system (ANSYS), including sloshing effects. To account for potential inventory loss, DTE considered water level 18" below and 48" below flange. Additionally, DTE verified that the hydrodynamic loads were acceptable, by separate analysis. The peak stresses on the flange and probe body are below the yield stress of the SFP probe tube material. A site specific analysis was performed for Fermi, using mounting configuration of the probe used at Fermi, a response spectra based on Fermi Design-Basis Earthquakes, and Fermi SFP parameters (3.2g peak horizontal acceleration). The analysis applied a 3-D acceleration time history excitation derived to meet the applicable Fermi Operating Earthquake Required Response Spectra (RRS), which bounds the Fermi Safe-Shut down Earthquake RRS. As was done in the original qualification, hydrodynamic loads developed in ANSYS were verified by a separate analysis of the Fermi SFP using Site Specific RRS and SFP geometry. The stresses calculated in the site specific analysis were much smaller than those calculated in the original generic analysis. According to the licensee, based on these reports, the SFP is capable of withstanding seismic events beyond Fermi Design-Basis Earthquakes while maintaining its structural integrity.

Regarding SFP signal processor and battery rack, DTE stated that Report 1-0410-6 Revision 1, "MOHR EFP-IL SFPI System Test Report" contains the results of seismic qualification tests of the SFP signal processor and battery pack. The OTEK LBD-N23 Series Digital Panel Meter (SFP Level Indicator) was seismically tested by application of random multi-frequency vibration at a level, which enveloped the Fermi operating-basis earthquake (OBE)/SSE Horizontal and Vertical Response Spectra provided. Testing met the requirements of IEEE-344-2004, the applicable requirements of NEI 12-02, Revision 1 [Reference 8], and Fermi Specification 3071-296 “Seismic Qualification of Equipment.” The NRC staff reviewed Calculation NAI 1791 009, "Seismic Induced Hydraulic Response in the Enrico Fermi Power Plant 2 Spent Fuel Pool," Revision 1 [Reference 53], and verified that the seismic condition for the probe installed at Fermi will have significant hydrodynamic margins compared to the environment for which the probe is designed for. The seismic qualification for SFP signal processor and battery pack was reviewed by the NRC staff during the MOHR vendor audit and found to be acceptable.

Regarding the SFP level instrument's mounting qualification, in its letter dated January 20, 2016 [Reference 32], DTE stated that the mounting of the SFP probe was evaluated and found to be acceptable in DC-6557 Volume 1, "Structural Evaluation of Spent Fuel Pool Probe Mounting Brackets," Revision B. The mounting components were analyzed using equivalent static analysis and Allowable Stress Design methodology form American Institute of Steel Construction , Manual of Steel Construction 7th edition. Seismic and hydrodynamic loads are obtained from the MOHR analyses for the SFP probe and applied to the components of the bracket and its anchorage. The minimum design margin of the bracket, other associated steel members and anchorage (calculated stresses compared to allowable stresses) is 65.3 percent. The brackets and its anchorage have sufficient capacity to withstand Fermi Design Basis Earthquakes while maintaining their structure integrity. Loads imposed by the bracket on the North wall of the pool are relatively minor. The North wall of the pool was designed to support 79,000 lbs of miscellaneous dead load. Collectively, the two probes with brackets weigh 192 lbs. Including probe and brackets, actual miscellaneous dead loads on the pool's North wall are bounded by the design loads considered in the original MOHR analysis. SFP signal processors with battery racks have been mounted on new instrument racks located on the third floor of the Rector Building (RB) and Fourth Floor of the Auxiliary Building (AB). The new racks and anchor bolts were analyzed with SFP instruments in place and found capable of withstanding loads due to self and instrument weight and seismic forces. Considering all loads combinations, the installed rack's design margin is 84 percent, and anchorage for the rack has a design margin of 50.8 percent. Considering the peak SSE acceleration for the worst floor response spectra, as well as a 1.5 multi factor, the worst anticipated seismic acceleration experienced by the signal processor and battery pack would be 5.55g horizontally. This is well below the seismic acceleration analysis the instruments experienced during the vendor testing. During fragility tests the equipment was tested accelerations of over 50g, and still remain functional. The net weight of the rack, with instrument, is 621 lbs. The ability of plant floors to support this additional weight during a seismic event was evaluated at each of the two locations where new racks will be installed. On the third floor of the RB, the design margin was 41 percent and, on the Fourth Floor of the AB, it was 23 percent. Ultimate Strength Design methodology and the 1971 Edition of American Concrete Institute Building Code 318, Building code Requirement for Reinforced Concrete, was used to evaluate the two floors. The primary level indicator is mounted as it was tested in its seismic qualification report. It is mounted on the door of Panel H11P601 in the MCR. The RRS provided for testing was a composite of the worst case horizontal and vertical floor response spectra for OBE and SSE for the installed equipment, which were increased by 10 percent margin, and then amplified by 1.5 to account for in panel amplification. The test report spectrum for OBE and SSE far exceed the RRS, by more than 10g at most frequencies. The indicator and its mounting hardware remained functional following testing. Therefore, the mounting for the indicator is capable of maintaining its structural integrity following Fermi design basis earthquake. The impact of the indicator on panel is evaluated as acceptable in Engineered Designed Package (EDP) 37088, "Install SPF level Instrumentation to Comply with NRC Order EA-12-051 Guidance" and is included in DC-5152, "Seismic Cumulative Change Evaluation Package (SEP) for Control Room Panels H11P601, H11P602, H11P603," Volume 1 for panel H11P601. The licensee stated that the impact of this indicator is very minimal, as it represents an increase in weight of 2.5 lbs. to a panel that weight 5,000 lbs. The backup level indicator is mounted to an electrical box on the 2rd floor of the RB. This does not match the configuration in the test report, where the indicator was mounted to a 48"x32", 3/16" steel plate, to simulate being mounted to the cabinet door in the control room. The electrical box is smaller than the door and consequently should have a higher natural frequency than the door, resulting in less amplification of seismic acceleration. In addition, the indicator was tested well beyond the RRS provided to the testing vendor. The licensee added that the installed configuration is conservative with respect to the test configuration. The indicator, the electrical box, and mounting brackets impose a 32 lb. load on the RB wall. The wall has an area of 403 square feet (sf), resulting in an average load of 32/403 = 0.08 pound per square foot (psf). As discussed in DC-SE-01-EF, "Structural Design Criteria RX/Aux Building and RHR Complex," Revision 9, RB concrete walls are designed for an attachment load of 20 psf. The actual attachment load on the wall is 7.8 psf. Therefore, the margin in 20.0 - 7.8 = 12.2 psf. of which the Backup Water Level Indicator will use 0.1 psf.

During the onsite audit, the NRC staff reviewed Drawing 6C721-2349-01, "SFP Probe Mounting Bracket and Electrical Cable Trench," Revision 0 [Reference 66]; DC-6557 Volume 1, "Structural Evaluation of Spent Fuel Pool Probe Mounting Brackets"; and walked down to SFP level instrument and found the SFPLI system's mounting design acceptable. The licensee has described the design inputs, and the methodology used to qualify the structural integrity of the affected structures/equipment. The NRC staff also walked down the SFP area and the primary and back-up cable route. The walk down started at the MCR where the displays, control boxes and uninterruptible power supply are located. From the MCR, the NRC staff visited the AB and RB where the electronic transmitter equipment is mounted and then the SFP area which is the location for the SFPLI sensor probe and the exit point from the SFP area to the AB and RB. The NRC staff finds that the licensee's proposed mounting design appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.4 Design Features: Qualification

Regarding the SFP level instrument's radiation qualification, in its letter dated August 19, 2013 [Reference 26], DTE stated that the area above and around the SFP will be subject to large amounts of radiation in the event that the fuel becomes uncovered. The only parts of the measurement channel in the pool radiation environment are the level sensor probes, which are not susceptible to the expected levels of radiation. The remote display electronics will be located in a location outside the SFP area that does not exceed the analyzed limit for the electronics.

In its letter dated January 20, 2016 [Reference 32], DTE further stated that the SFPLI electronics are expected to operate satisfactorily since the radiological conditions will be below 1×10^3 rad TID criteria. The specific information regarding the radiological conditions in the area of the SFPLI equipment location is based on the radiological assessment documented in the Fermi Equipment Qualification (EQ) Program. The radiological dose of 1×10^3 Rad TID is the radiation threshold postulated for the commercial-off-the-shelf circuits. In order to calculate a 40 year integrated dose from the radiation protection program dose rate for an EQ zone, the dose rate (mrem/hr) is converted to a TID for 40 years. The primary indicator is located in the MCR which is a low dose area. The backup signal processor located in RB on the third floor will be exposed to TID of 1.46×10^2 rad for 40 years of normal operations. Consistent with SFPLI system design and assuming the SFP water level is at the top of the fuel racks, dose rates associated with all SFPLI electronic equipment will not be changed provided that the electronic equipment is located below the water level elevation in the SFP. This is due to the fact that a free-path (line-of-sight) thickness of normal concrete shielding between the electronics and the SFP fuel array for the SFPLI electronics will be changed from normal plant operation. In case where items located on the rack associated with the primary channel power conditioner (G4100S002A) reach an elevation of approximately 666 ft. which is 5 feet above the top of the rack, the equipment is protected by approximately 20' of concrete shielding it from the SFP at its location at AB fourth floor near grid F-11. Under normal operating conditions, the dose rate at the SFP wall (6 foot thickness) are less than 1 mRem/hr. Since the equipment's free-path is shielded by nominally 20 ft. of concrete (vs. 6 feet calculated), the dose to the equipment will not be significantly impacted by the reduction of water level. The licensee concluded that during BDB conditions, the SFPLI electronic equipment is exposed to the same dose rates that are expected under the normal plant conditions and, therefore, the SFPLI electronics functions as design. During the onsite audit, the NRC staff reviewed Calculation EQ0-EF2-018, "Summary of Environmental Parameters Used for Fermi EQ Program," Revision L [Reference 56], and verified that the TID at the locations where the SFPLI located are bounded by the acceptable limits.

Regarding the SFP level instrument's environmental qualification, in its letter dated August 19, 2013 [Reference 26], DTE stated that the SFPLI system electronics (including back-up power supplies, signal processor, and display) are located outside of the SFP area, and, therefore, operate in the normal and ELAP BDB environment. The SFP electronics and batteries are installed remotely from the SFP areas in various location in AB, RB and MCR each having different expected BDB environment conditions. In addition to the MOHR-EFP-IL SFPLI system components, OTEK digital indicators are used for the primary and backup level indication; power conditioners/filters were used in the power input lines to the signal processors and level indicator. In the same letter above, DTE provided a table summarizing the environmental temperature and humidity. The licensee further stated that the expected temperature and humidity conditions for the SFPLI electronics and batteries installed in Fermi are below the environmental qualification temperature and humidity of 131°F and 95 percent relative humidity (RH), respectively.

During the an onsite audit at another power station, the NRC staff learned that the SFP level instrument, supplied by MOHR Test and Measurement LLC., experienced a failure. The NRC staff, via that licensee, requested MOHR to address the root cause of the equipment failure and a solution to maintain the qualification requirement of the NRC Order 12-051. In its Root Cause Analysis Report, Revision 1, dated June 1, 2015, MOHR stated that the source of the failures is a miniature surface mount common-mode choke component used on the Video and Digicomp printed circuit boards within the EFP-IL Signal Processor. In accordance with MOHR's recommendation, the two boards will be replaced in both EFP-IL Signal Processors at the station. The new boards will have equivalent substitute components that are less susceptible to transient electrical events. According to MOHR, the substitute components have equivalent size, mass, and solder attachment technique as the original component such that there is no impact to the system mechanical characteristics. The components demonstrate equivalent electrical performance such that EMC characteristics are not significantly changed. The NRC staff found the vendor adequately addressed the NRC staff's concern with regard to the modified equipment qualifications. The NRC staff will verify the licensee corrective actions to address the failure of MOHR equipment in its future inspections.

The NRC staff also inquired about an assessment of potential susceptibilities of Electromagnetic Interferences (EMI) and Radio-Frequency Interference (RFI) in the areas where the SFP instruments are located and how to mitigate those susceptibilities. In response, DTE stated that the potential susceptibility of the SFP instruments to the EMI/RFI interference has been addressed in the MOHR EFP-IL System EMC reports and OTEK water level indicator qualification report. The components of the SFP signal processing instrumentation were installed at various plant locations, including the MCR, the AB 4th floor, and the RB 2nd and 3rd Floors. An electromagnetic emission mapping of selected plant areas was conducted in support of the installation of the SFP instrumentation system. Based on the information presented in the vendor reports, the MOHR EFP-IL SFPLI System and OTEK digital indicators meet EMI/RFI requirements for Non-Safety Related equipment. The test report contains a justification for exemption from the MOHR EFP-IL SFPLI system from low frequency conducted and radiated emission testing based on the industry guidance. Based on the results of the high frequency conducted and radiated emission testing presented in the test report, the MOHR EFP-IL SFPLI system meets the applicable requirements for the industry Guideline for EMI Testing of power plant equipment. The OTEK digital panel meter qualification report demonstrates that the SFP water level indicators meet EMI/RFI requirements for installation in the MCR on panel H11P601 and on the 2nd floor of the Reactor Building (RB). The OTEK digital panel meters EMI/RFI testing consisted of conducted and radiated susceptibility testing. The emission levels for all test were performed in accordance with the requirements of EPRI TR-10223 "Guidelines for Electromagnetic Interference Testing of Power Plant Equipment," Revision 3. The assessment of the SFP level probes susceptibility to the EMI/RFI interference concluded that personnel operating radios in the vicinity of the probes will also be able to determine visually the SFP water level. The licensee concluded that the SFPLI system components met the applicable EMI/RFI testing requirements for the power plant equipment as described above, and therefore, the SFPLI system components are not susceptible to the EMI/RFI interference in their areas of installation.

During the onsite audit, the NRC staff reviewed DTE's response and expressed concerns about wireless communication devices that could emit radiated emission that could exceed some of the EMI/RFI limits on SFPLI system. Following a discussion between the NRC staff and DTE, DTE initiated CARD 15-24386 to establish a restricted zone near SFPLI instrument rack and/or probes. The NRC staff finds that licensee response acceptable because DTE has assessed the potential susceptibilities of EMI/RFI in the areas where the SFP instrument is located. For those SFPLI equipment which are susceptible to EMI/RFI, DTE will establish a restricted zone to preclude bringing wireless communication devices to those areas.

The NRC staff finds the licensee's proposed instrument qualification process appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.5 Design Features: Independence

In its letter dated August 19, 2013 [Reference 26], DTE stated, in part, that the primary and backup level sensors are physically separated by the width of the SFP. Cabling to the respective signal processors and the associated remote indicators will also be separate due to the separate locations of the backup and primary level indicators. The primary channel signal processor and the associated remote indicator are located in the Auxiliary Building; whereas the backup channel signal processor and the associated remote indicator are located in the Reactor Building. The proposed plans call for power to the primary and backup channels using Balance of Plant (BOP) 120 Vac normal power. Both power sources are independent such that no one single failure will interrupt power to both channels. In addition, in its letter, DTE also stated that that an electronic signal is sent from the sensor electronic panels located on the Auxiliary Building (AB) 4th floor and RB 3rd floor via separate independent wiring for each channel to the readout display panels located at different locations in the RB 2nd floor and in the MCR.

In its letter dated January 20, 2016 [Reference 32], DTE further stated that the 120 VAC, 1 phase, 60 Hz power supply is provided to the primary channel SFPLI primary and backup channel equipment. The 120 VAC power for the SFPLI equipment is provided from Non-Class 1E 120 VAC Instrument Control Power (ICP) Modular Power Unit (MPUs) 3 and 4 via Distribution Panels H21P550 and H21P554, respectively. The instrument power distribution panels H21P550 and H21P554 are classified as non-safety, balance of plant (BOP) equipment. The primary channel 120 VAC, instrument power distribution panel H21P550 is located on the AB 5th floor. The SFPLI power conditioner, signal processors and power supplies are located in the AB, fourth floor. The power supply cable is run in conduit and has a different routing the backup channel power supply conduit routing. The backup channel SFPLI is power from a BOP, 120 VAC, instrument power distribution panel H21P554 located in the RB, 2nd floor. The

SFPLI power conditioner, signal processors and power supplies are located in the RB, 3rd floor. The power supply cable is run in conduit and has a different routing than the primary channel power supply conduit routing. The distribution panels H21P550 and H21P554 receive power from MPUs that provide 120 VAC regulated power for Fermi BOP instrument and are powered by 15 kilo Volt- Amperes (KVA), 480-120/240 Volt (V) transformers. The source to H21P550 (primary channel) is a 480 V primary power supply via a 15 KVA 480-120 volt transformer that is connected to a Class 1E, Division 2 MCC. The source to H21P554 (backup channel) is a 480 V primary power supply via a 15 KVA 480-120 volt transformer that is connected to a Class 1E, Division 1 MCC. The two power supply panels are independent of each other since their power sources are fed from separate independent divisional power sources.

The NRC staff verified during the onsite audit that the power supply sources for each channel is independent by reviewing Drawings EDP-37088.A021, "One Line Diagram Reactor Building 120 VAC Distribution Local B.O.P Panels," Revision 0 [Reference 58]; 6SD721-2530-02 "One Line Diagram 120 VAC Inst. & Cont. Power Feeders BOP-1 & BOP-2 Reactor Building," Revision Z [Reference 59]; 4SD721-2513-60A "Inter-cabling Diagram 480 V Distribution Cabinet 72C-2C," Revision R [Reference 60]; 4SD721-2513-91, "Inter-cabling Diagram 480 V Distribution Cabinet 72F-4B Reactor Building," Revision P [Reference 61]; 6SD721-2510-01, "One Line Diagram 480V E.S.S Bus #72B, 72C, 72E & 72F," Revision AO [Reference 62]; 6SD721-2530-17, "One Line Diagram 48/24 VDC Instrumentation Batteries Distribution," Revision AL [Reference 63]; and 6SD721-2500-01, "One Line Diagram Plant 4160 V & 480V System Service," Revision BB [Reference 64]. The NRC staff also walked down the SFP area and the route for the primary and back-up cables. The NRC staff noted that with this arrangement, the loss of one backup power supply will not affect the operation of the independent channel under BDB event conditions.

The NRC staff finds that the licensee's proposed design, with respect to instrument channel independence, appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.6 Design Features: Power Supplies

In its OIP, DTE stated, in part, that instrumentation channels will each be powered by a separate local 120V ac power source. Each channel will be provided with external backup power using replaceable batteries with a minimum duration/capacity of 72 hours. Each channel will automatically switch over to backup power on loss of normal power. For extended battery operation, each channel will have an "On Demand" operation feature. Backup power will be provided by Phase 2 and/or Phase 3 generators within 72 hours. FLEX power will have sufficient capacity to sustain the level indication function indefinitely consistent with NEI 12-06 [Reference 6]. In addition, a manual transfer switch and an auxiliary power disconnect switch will also be installed for each instrument channel so that a portable FLEX generator can be connected, providing robustness within 72 hours on loss of normal channel power.

In its letter dated January 20, 2016 [Reference 32], DTE further stated that each SFP instrumentation channel is provided with backup power with replaceable batteries for a minimum of 72 hours operation. Backup power for each channel is automatically switched "on" following the loss of the normal power source. For extended battery operation, each channel has "On Demand" operation features. An additional backup power source is provided using a FLEX Power Source, which is available within 72 hours. The battery has the capability to power the

EFP-IL SFPLI for at least 7 days with a 25 percent duty cycle (e.g., 15 samples per hour with 60 second sample duration).

The NRC staff finds that the licensee's proposed power supply design appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.7 Design Features: Accuracy

In its letter dated January 20, 2016 [Reference 32], DTE stated that each SFP instrument channel is expected to be accurate to within an estimated +/-0.2 percent of calibrated span during normal SFP level condition. The SFP instrument channels are expected to retain this estimated accuracy after being subjected to BDB condition. Power interruption testing has been performed on the EFP-IL signal processor and backup battery power source. Test results indicate that no deficits were identified with respect to maintenance of reliable function, accuracy, or calibration as a result of power interruption. The results of testing provided evidence of reliable transition from the normal ac power source to the backup battery without affecting accuracy or calibration. The results of the tests are provided in MOHR EFP-IL SFPLI system power interruption report. The Acceptable Performance Tolerance for Fermi's SFPLI is 5.02 inches. The EFP-IL has a local indication that displays to two decimals, so the display does not factor in to the channels readability. However, the OTEK indicator's faceplate has major division every five feet (e.g. 15, 20, etc.) and minor division every foot. The readability of analog indication is considered to be equal to a half of the minor division. Therefore, the channel APT was rounded to 6 inches. Even with the readability rounding, the resulting channel APT of 6 inches is equal to a half of the acceptance criteria established in NEI 12-02, Revision 1 [Reference 8] for the SFP instrument channel accuracy.

The NRC staff finds that the licensee's proposed instrument accuracy appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.8 Design Features: Testing

In its letter dated January 20, 2016 [Reference 32], DTE stated that the signal processor (MOHR EFP-IL) system provides real-time in-situ auto-calibration of the water level and high-resolution Time Domain Reflectometry (TDR) health check of the cable and probe system attached to the instrument test port. The LED indicator uses a two blink protocol to continuously indicate battery level, liquid level range and system diagnostic status. The level equipment is capable of being calibration checked where it is installed with minimal test equipment. To perform the calibration check, access to the signal processor located in the AB fourth floor and the RB third floor is required. The level probe transmission cable is disconnected and the MOHR CT100 TDR cable tester is connected. The signal processor is accessed in the same location and a system check is performed. The test requires authorized access, the use of the signal processor's screen, control buttons on the signal processor and a USB keyboard. The calibration check for the "remote" OTEK indicator, located on the RB second floor and the MCR is performed by applying a 4-20 mV signal to the device and verifying the full range of the indicator. There are two potentiometers found on the back of the unit that can be used to adjust the zero and span if necessary. The PMs for diagnostic checks are performed in accordance with the following procedures: 46.635.001, "Spent Fuel Pool Level Indication, Primary System, Diagnostic Checks;" and 46.635.002, "Spent Fuel Pool Level Indication, Backup System, Diagnostic Checks." In addition, DTE stated that the following surveillances have been created: G456, G457 (6 year frequency): "Calibration Check of Remote Indicator from Spent Fuel Pool Level Signal Processor;" G458, G459 (2 years frequency): "Calibration Check of the Spent Fuel Pool Level Signal processor and Level Probe;" G460, G461 (6 month frequency): "System Check/Inspection of the Spent Fuel Pool Level Signal Processor;" G463, G464 (550 day frequency, within 60 days of a refuel outage): "System Check/Inspection of the Spent Fuel Pool Level Signal Processor." These events are in the Fermi PM process as defined by MES51, "Preventive Maintenance," which will control the completion of the activities rather than the plant surveillance procedure.

During the onsite audit, the NRC staff expressed a concern that a channel check would not be performed between the SFP level indicators. Following a discussion between the NRC staff and DTE, DTE wrote CARD 15-24385 to create periodic channel check for SFP level Indicators. The NRC staff found DTE's response acceptable as DTE will perform periodic calibration, test, and maintenance as recommended by the vendor. By comparing the levels in the instrument channels and the acceptance criteria described above, the operators can determine if recalibration or troubleshooting is needed.

The NRC staff finds that the licensee's proposed SFP instrumentation design allows for testing appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.9 Design Features: Display

In its OIP, DTE stated that the primary instrument channel remote display will be located in the control room and the backup instrument channel remote display will be located on the RB, second floor, near the FLEX SFP refill station. The licensee also stated that the SFPLI signal processors located in the AB and the RB will have display screens showing SFP level numerical read out with continuous indication. In its letter dated August 19, 2013 [Reference 26], DTE further stated, in part, that the backup display location allows operators controlling emergency pool filling operation to directly monitor pool level. This arrangement also increases the physical separation of indication cabling between the two channels. Adequate operation resources are available on shift to periodically monitor the backup indication. The FLEX Fuel Pool fill station is located in an area that is accessible to plant operators both from the AB and an outside RB entrance. Both the AB and the RB are seismic Class 1, safety related structures and the FLEX Fuel Pool fill station, inside the RB, is a considerable distance from the SFP. Communications between the control room and the plant operators is provided by a variety of means including radios and the plant phone system. The planning for FLEX is on-going and the resource needs to monitor the back-up channels during a beyond design bases event is being considered in this planning.

The NRC staff noted that the NEI guidance for "Display" specifically mentions the control room as an acceptable location for SFP instrumentation displays, as it is occupied or promptly accessible, outside the area surrounding the SFP, inside a structure providing protection against adverse weather, and outside of any very high radiation areas or LOCKED HIGH RAD AREA during normal operation. The licensee's proposed location for the primary SFP instrumentation display is consistent with NEI 12-02 [Reference 8], as endorsed by the ISG. However, the NRC staff had concerns with DTE's lack of information regarding the accessibility, habitability, availability of personnel and communications related to the location for the SFPLI backup display.

In response to the NRC staff's concerns, in its letter dated January 20, 2016 [Reference 32], DTE stated that the backup display for SFP level is located on RB second floor (RB-2). Post ELAP environmental evaluation of this area shows this area remains below 122°F or 72 hours. The FLEX SFP Injection procedure (29.FSG.12) shifts the FLEX water supply for SFP cooling (where this remote display is used to meet FLEX Phase 2 SFP cooling action). The time for this action is approximately 5 hours and the predicted temperature at this time is 108° F. The 5 hour time for this action has been validated as part of Fermi's conformance with the FLEX Validation Plan promulgated by NEI. Pathways to this location were also evaluated for temperature and show less than 110° F. Transit time from the MCR to the local alternate instrument readout (G41-R601B) is estimated to be five minutes or less. According to DTE, humidity effects at the location are acceptable, the indicator is qualified to 95 percent RH and predicted local area humidity during BDB event is 51 percent RH. Radiation is not expected to be a concern as no fuel damage occurs during FLEX event. The water level of the SFP at Level 1 will not impact the shielding provided by the water given the equipment is below water level. The backup display location is on RB-2 (613 feet above sea level), which is below the water level of approximately 661 feet above the sea level (Level 3). Hence the normal operating dose rate for the area is applicable to the BDB event (i.e., 0.5 mrem/hr for a general area). Personnel are not expected to continuously man this station as changes will occur slowly based on SFP injection and expected heat load/water evaporation rate. During the walk down, the NRC staff questioned whether MCR staff would be able to relate the indicated level from G41R601A/B to the level of SFP. The licensee created Condition Assessment Resolution Document (CARD) 15-24400 to modify appropriate procedures to provide correlation between value indicated and the SFP level. The NRC staff found DTE's response acceptable and verified during a walk down. The NRC staff found that the display location will be promptly accessible and will remains habitable.

The NRC staff finds that the licensee's proposed location and design of the SFP instrumentation displays appear to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3 Evaluation of Programmatic Controls

Order EA-12-051 specified that the SFP instrumentation shall be maintained available and reliable through appropriate development and implementation programmatic controls, including training, procedures, and testing and calibration. Below is the NRC staff's assessment of the programmatic controls for the SFP instrumentation.

4.3.1 Programmatic Controls: Training

In its OIP, the licensee stated, in part, that the Systematic Approach to Training (SAT) will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. The program criteria will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02 [Reference 8]. Personnel will complete training prior to placing the instrumentation in service.

The NRC staff finds that the licensee's proposed plan to train personnel in the operation, maintenance, calibration, and surveillance of the SFPLI and the provision of alternate power to the primary and backup instrument channels, including the approach to identify the population to be trained appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.2 Programmatic Controls: Procedures

In its letter dated January 20, 2016 [Reference 32], the licensee stated that for normal response, System Operating Procedure 23.708, "Fuel Pool Cooling and Cleanup System," has been revised to incorporate the SFP level instruments. This procedure provides direction for placing instrument in service per the electrical and instrumentation lineup sections (Attachments 2 and 3 of 23.708). For abnormal response, Extreme Damage Mitigation (EDM) guidelines, 29.EDM.01, "SFP Makeup-Internal Strategy" and 29.EDM.03, "SFP Makeup- Spray-External Strategy" for SFP makeup and spray with Fire Main water (internal strategy) or EDM Truck Water (external strategy) have been modified to direct the operator to monitor SFP level using the new SFP level instruments while adding water to the SFP using EDM methods. Similarly, procedure 29.FSG.12, "FLEX SFP Injection," has been issued to include monitoring SFP level using the new SFP Level Instruments when adding water to the SFP using the FLEX water supply. A system check/inspection/cleaning is performed every 6-months (including once within 60 days of a refueling outage). The conduct of this PM is directed by steps placed in the automatically generated work order by the work planner using a work plan template.

The NRC staff finds that the licensee's proposed procedure development appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.3 Programmatic Controls: Testing and Calibration

In its letter dated January 20, 2016 [Reference 32], the licensee stated that Conduct Manual MES51 defines the PM program, which is used for the calibration and functional checks of the SFPLI. Specific tasks were developed and specified, with frequencies, to maintain the SFPLI. The Signal processor (MOHR EFP-IL) system provides real time in-situ auto-calibration of the water and high resolution TDR health check of the cable and probe system attached to the instrument test port. In addition, specified system checks are performed. The LED indicator uses a two blink protocol to continuously indicate battery level, liquid level range and system diagnostic status. The current Fermi PM program, as described in MES51, is being used to perform the required maintenance and testing of the SFPLI equipment to ensure regular testing and calibration is performed to maintain system readiness. The PM activities have been created to man and check the calibration and stored errors from the equipment. They include: G456, G457 (6 year frequency) – "Calibration check of remote indicator from Spent Fuel Pool Level Signal Processor;" G458, G459 (2 year frequency) – "Calibration check of the Spent Fuel Pool Level Signal Processor and Level Probe, Replacement of Spent Fuel Pool Level Signal Processor and Remote Indicator batteries, Replacement of Spent Fuel Pool Level Signal Processor memory card;" G460, G461 (6 month frequency) – "System check/inspection of the Spent Fuel Pool Level Signal Processor, Clean the Spent Fuel Pool Level Signal Processor display screen." The PMs for diagnostic checks are performed in accordance with the following procedures: 46.635.001, "Spent Fuel Pool Level Indication, Primary System, Diagnostic Checks;" 46.635.002, "Spent Fuel Pool Level Indicator, Backup System, Diagnostic Checks."

These PMs have been created based on vendor recommendation, EPRI templates, and benchmarking. System check PMs have also been created to be completed 60 days prior to a refuel outage: G463, G464 (550 day frequency, within 60 days prior to a refuel outage) - System check/inspection of the Spent Fuel Pool Level Signal Processor, Clean the Spent Fuel Pool Level Signal Processor display screen. The licensee also stated that Conduct Manual MOP25, "Beyond Design-Basis Event Coping Strategies Program Manual, Revision 1, Section 6.3.2.1, provides that one channel may be out of service for testing maintenance and/or calibration for up to 90 days provided the other channel is functional. The out-of-service components is expected to be restored under most circumstances within 45 days. MOP25 Section 6.3.3.3 requires that if both channels become non-functioning then actions are to be initiated within 24 hours to restore one of the channels and implement compensatory actions within 72 hours. In addition, contingency work orders will be initiated to install a spare level indication system from stock and to install a temporary modification to provide temporary level indication.

The NRC staff noted that the licensee adequately addressed the SFPLI programmatic controls with respect to testing and calibration as they will perform periodic calibration, test, and maintenance as recommended by the vendor and will consider provision for out of service or non-functional equipment including allowed outage time and the specific compensatory actions.

The NRC staff finds that the licensee's proposed testing and calibration plan appear to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.4 Conclusions for Order EA-12-051

By letter dated January 20, 2016 [Reference 32], the licensee stated that they would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02 [Reference 8], as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFPLI is installed at Fermi according to the licensee's proposed design, it should adequately address the requirements of Order EA-12-051.

5.0 CONCLUSION

In August 2013, the NRC staff started auditing the licensee's progress on Orders EA-12-049 and EA-12-051. The NRC staff conducted its onsite audit in June 2015. The licensee reached its final compliance date in November 2015, and has declared that Fermi is in compliance with the orders. The purpose of this safety evaluation is to document the strategies and implementation features that the licensee is using to comply with the orders. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and proposed designs that, if implemented appropriately, will adequately address the requirements of Orders EA-12-049 and EA-12-051. The NRC staff will conduct an onsite inspection to verify that the licensee has implemented the strategies and equipment to demonstrate compliance with the orders.

6.0 REFERENCES

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2. SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," February 17, 2012 (ADAMS Accession No. ML12039A103)

3. SRM-SECY-12-0025, "Staff Requirements – SECY-12-0025 - Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," March 9, 2012 (ADAMS Accession No. ML120690347)

4. Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," March 12, 2012 (ADAMS Accession No. ML12054A736)

5. Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," March 12, 2012 (ADAMS Accession No. ML12054A679)

6. Nuclear Energy Institute document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 21, 2012 (ADAMS Accession No. ML12242A378)

7. JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," August 29, 2012 (ADAMS Accession No. ML12229A174)

8. Nuclear Energy Institute document NEI 12-02, "Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1, August 24, 2012 (ADAMS Accession No. ML12240A307)

9. JLD-ISG-2012-03, "Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," August 29, 2012 (ADAMS Accession No. ML12221A339)

10. DTE letter to NRC, Fermi 2, "DTE Electric Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis-External-Events (Order Number EA-12-049)," February 28, 2013 (ADAMS Accession No. ML13063A262)

11. DTE letter to NRC, "Fermi 2, DTE Electric Company's First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," August 26, 2013 (ADAMS Accession No. ML13239A121)

12. DTE letter to NRC, Fermi 2, "DTE Electric Company's Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," February 27, 2014 (ADAMS Accession No. ML14059A350)

13. DTE letter to NRC, "Fermi 2, DTE Electric Company's Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order EA-12-049)," August 28, 2014 (ADAMS Accession No. ML14241A298)

14. DTE letter to NRC, "Fermi, Unit 2, Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (EA-12-049)," February 23, 2015 (ADAMS Accession No. ML15056A399)

15. Letter from Jack R. Davis (NRC) to All Operating Reactor Licensees and Holders of Construction Permits, "Nuclear Regulatory Commission Audits of Licensee Responses to Mitigation Strategies Order EA-12-049," August 28, 2013 (ADAMS Accession No. ML13234A503)

16. Letter from Jeremy S. Bowen (NRC) to Joseph H. Plona (DTE), "Fermi, Unit 2 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC NO. MF0770)," November 25, 2013 (ADAMS Accession No. ML13220A133)

17. Letter from Stephen R. Monarque (NRC) to Paul Fessler (DTE), "Fermi, Unit 2 – Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051," October 1, 2015 (ADAMS Accession No. ML15245A287)

18. DTE letter to NRC, "Fermi 2 - Compliance with March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events (Order Number EA-12-049),"January 20, 2016 (ADAMS Accession No. ML16022A118)

19. U.S. Nuclear Regulatory Commission, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 12, 2012, (ADAMS Accession No. ML12053A340)

20. SRM-COMSECY-14-0037, "Staff Requirements – COMSECY-14-0037 – Integration of Mitigating Strategies For Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," March 30, 2015, (ADAMS Accession No. ML15089A236)

21. DTE letter to NRC, Fermi 2, "DTE Electric Submittal of Flooding Hazard Reevaluation Report in Response to March 12, 2012 Information Request Regarding Flood Protection Evaluations," March 8, 2013 (ADAMS Accession No. ML13070A199)

22. DTE letter to NRC, Fermi 2, "DTE Electric Company's Seismic Hazard and Screening Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 31, 2014 (ADAMS Accession No. ML14090A326)

23. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), "Staff Assessment of National SAFER Response Centers Established In Response to Order EA-12-049," September 26, 2014 (ADAMS Accession No. ML14265A107)

24. DTE letter to NRC, "Fermi 2 - Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 28, 2013 (ADAMS Accession No. ML13063A285)

25. 2013/07/29 NRR E-mail Capture – Fermi 2 – Requests for Additional Information Regarding Overall Integrated Plan for Reliable Spent Fuel Pool Instrumentation (TAC MF0771), dated July 29, 2013 (ADAMS Accession No. ML13210A220)

26. DTE letter to NRC, "Fermi 2, Response to Request for Additional Information Regarding Overall Integrated Plan in Response to Order EA-12-051, "Reliable Spent Fuel Pool Instrumentation." dated August 19, 2013 (ADAMS Accession No. ML13231A233)

27. DTE letter to NRC "Fermi, Unit 2, DTE Electric Company First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated August 26, 2013 (ADAMS Accession No. ML13239A118)

28. DTE letter to NRC, "Fermi 2, DTE Electric Company Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 27, 2014 (ADAMS Accession No. ML14059A277)

29. DTE letter to NRC, "DTE Electric Company Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated August 28, 2014 (ADAMS Accession No. ML14241A288)

30. DTE letter to NRC, "DTE Electric Company – Fermi, Unit 2 - Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 23, 2015 (ADAMS Accession No. ML15056A067)

31. Letter from Thomas Wengert (NRC) regarding Fermi, Unit 2 – Interim Staff evaluation and request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, dated November 21, 2013 (ADAMS Accession No. ML13309B129)

32. DTE letter to NRC, “Fermi 2 - Compliance with March 12, 2012 Commission Order Modifying licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) and Response to Request for Additional Information,” dated January 20, 2016 (ADAMS Accession No. ML16022A117)

33. Letter from John Boska (NRC) to Lawrence J. Weber, dated August 27, 2014, regarding Donald C. Cook Nuclear Plant, Units 1 and 2 – Report for the Onsite Audit of MOHR Regarding Implementation of Reliable Spent Fuel Instrumentation Related to Order EA-12-051 (ADAMS Accession No. ML14216A362)

34. Design Calculation DC-6543, "Total Integrated Radiation Dose to Spent Fuel Pool Level Probe and Dose Rates on the Refueling Floor for Reduced Pool Water Levels," Revision 0

35. NRC Office of Nuclear Reactor Regulation Office Instruction LIC-111, Regulatory Audits, December 16, 2008 (ADAMS Accession No. ML082900195).

36. Letter from William Dean (NRC) to Power Reactor Licensees, “Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design Bases External Events,” September 1, 2015 (ADAMS Accession No. ML15174A257).

37. NEI Position Paper: “Shutdown/Refueling Modes”, September 18, 2013 (ADAMS Accession No. ML13273A514)

38. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding NRC endorsement of NEI Position Paper: “Shutdown/Refueling Modes,” September 30, 2013 (ADAMS Accession No. ML13267A382)

39. Letter from Nicholas Pappas (NEI) to Jack R. Davis (NRC) regarding FLEX Equipment Maintenance and Testing, October 3, 2013 (ADAMS Accession No. ML13276A573)

40. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding NRC endorsement of the use of the EPRI FLEX equipment maintenance report, October 7, 2013 (ADAMS Accession No. ML13276A224)

41. EPRI Draft Report, 3002000704, “Seismic Evaluation Guidance: Augmented Approach for the Resolution of Near-Term Task Force Recommendation 2.1: Seismic,” (ADAMS Accession No. ML13102A142)

42. Letter from Eric Leeds (NRC) to Joseph Pollock (NEI), Electric Power Research Institute Final Draft Report, “Seismic Evaluation Guidance: Augmented Approach for Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic,” As An Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations,” May 7, 2013 (ADAMS Accession No. ML13106A331)

43. EPRI Report 1025287, “Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic,” (ADAMS Accession No. ML12333A170)

44. Letter from Frankie Vega (NRC) to Paul Fessler (DTE), "Fermi, Unit 2 - Staff Assessment of Information Provided Pursuant to Title 10 of the Code of Federal Regulations Part 50, Section 50.54(f), Seismic Hazard Reevaluations for Recommendation 2.1 of the Near-Term Task Force Review of Insights," October 5, 2015 (ADAMS Accession No. ML15077A028)

45. DTE letter to to NRC, Fermi 2, "Fermi 2 Expedited Seismic Evaluation Process Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," December 9, 2014 (ADAMS Accession No. ML14345A469)

46. Letter from Nicholas Pappas (NEI) to Jack R. Davis (NRC) regarding alternate approach to NEI 12-06 guidance for hoses and cables, May 1, 2015 (ADAMS Accession No. ML15126A135)

47. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI) regarding NRC endorsement of NEI's alternative approach to NEI 12-06 guidance for hoses and cables, May 18, 2015 (ADAMS Accession No. ML15125A442)

48. DTE letter to NRC, "Fermi 2, Fifth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," August 27, 2015 (ADAMS Accession No. ML15239A798)

49. DTE letter to NRC, "Fermi 2, Detroit Edison's Initial Status Report in Response to March 12, 2012 Commission Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," October 19, 2012 (ADAMS Accession No. ML12296A041)

50. Letter from Frankie Vega (NRC) to Paul Fessler (DTE), "Fermi Unit 2 - Staff Review of Interim Evaluation Associated With Reevaluated Seismic Hazard Implementing Near-Term Task Force Recommendation 2.1," November 6, 2015 (ADAMS Accession No. ML15310A197)

51. Letter from Victor Hall (NRC) to Joseph H. Plana (DTE), "Fermi 2 Nuclear Power Station- Staff Assessment of Response to 10 CFR 50.54(f) Information Request- Flood-Causing Mechanism Reevaluation (TAC NO. MF1101)," December 30, 2014 (ADAMS Accession No. ML14351A438)

52. Letter from Victor Hall (NRC) to Paul Fessler (DTE), "Fermi, Unit 2 – Mitigating Strategies Assessment with Respect to the Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," November 20, 2015 (ADAMS Accession No. ML15313A470)

53. Calculation NAI 1791 009, "Seismic Induced Hydraulic Response in the Enrico Fermi Power Plant 2 Spent Fuel Pool," Revision 1

54. Drawing 6C721-2349-01, "SFP Probe Mounting Bracket and Electrical Cable Trench," Revision 0

55. Design Calculation DC-6557 Volume 1, "Structural Evaluation of Spent Fuel Pool Probe Mounting Brackets," Revision B

56. Calculation EQ0-EF2-018, "Summary of Environmental Parameters Used for Fermi 2 EQ Program," Revision L

57. Design Calculation DC-6585 Volume 1, "Loss of HVAC - Room Environmental Analysis," Revision A

58. Drawing EDP-37088.A021, "One Line Diagram Reactor Building 120 VAC Distribution Local B.O.P Panels," Revision 0

59. 6SD721-2530-02, "One Line Diagram 120 VAC Inst. & Cont. Power Feeders BOP-1 and & BOP-2 Reactor Building," Revision Z

60. 4SD721-2513-60A, "Inter-cabling Diagram 480 V Distribution Cabinet 72C-2C," Revision R

61. 4SD721-2513-91, "Inter-cabling Diagram 480 V Distribution Cabinet 72F-4B Reactor Building," Revision P

62. 6SD721-2510-01, "One Line Diagram 480V E.S.S Bus #72B, 72C, 72E & 72F," Revision AO

63. 6SD721-2530-17, "One Line Diagram 48/24 VDC Instrumentation Batteries Distribution," Revision AL

64. 6SD721-2500-01, "One Line Diagram Plant 4160 V & 480V System Service." Revision BB

65. Procedure 46.635.001, "Spent Fuel Pool Level Indication, Primary System, Diagnostic Checks," Revision 0

66. Drawing 6C721-2349-01, "SFP Probe Mounting Bracket and Electrical Cable Trench," Revision 0

67. Calculation DC-0367 Volume VIII, “FLEX RHR Injection Configuration – Pressure Drop Calculation,” Revision B

68. Calculation DC-6584, “FLEX DC Calculations,” Revision 0

69. DTE Operation Procedure 29.FSG.01, “FLEX Plant,” Revision 0

70. DC-6583, “FLEX AC Calculations,” Revision 0

71. FLEX Support Guideline 29.FSG.04, “FLEX AC,” Revision 0

72. Technical Evaluation TE-K11-14-007, “FLEX Phase 3 Emergency Response (SAFER) Evaluation,” Revision A

73. DTE Operation Procedure 29.FGS.15, “Toolbox Phase 3 Preparation,” Revision 0

74. Calculation HI992207, “Bulk SFP Thermal-Hydraulic Analysis for Reracking of Fermi Unit 2,” Revision 5

75. CN-BWR-ENG-14-009, “DTE Fermi 2 MAAP Analysis for FLEX Coping Strategy,” Revision 1

76. DC-6601, “Robustness and Stability Evaluation of the Circ Water Pond During and After Safe Shutdown Earthquake Effects,” Revision 0

77. Engineering Design Package (EDP) – 37124, “FLEX – Storage Facilities for Phase 2 Equipment,” Revision 0

78. SAFER Response Plan for ENRICO Fermi Nuclear generating Station, AREVA, Revision 0, dated May 26, 2015

79. U.S. Nuclear Regulatory Commission, "Mitigation of Beyond-Design-Basis Events," *Federal Register*, Vol. 80, No. 219, November 13, 2015, pp. 70610-70647

80. Nuclear Energy Institute document NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” Revision 2, December 31, 2015 (ADAMS Accession No. ML16005A625)

81. JLD-ISG-2012-01, “Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” Revision 1, January 22, 2012 (ADAMS Accession No. ML15357A163)

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Date: September 29, 2016

These reports were required by the order, and are listed in the attached SE. By letters dated November 21, 2013 (ADAMS Accession No. ML13309B129), and October 1, 2015 (ADAMS Accession No. ML15245A287), the NRC staff issued an ISE and audit report, respectively, on DTE's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all operating power licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated January 20, 2016 (ADAMS Accession No. ML16022A117), DTE submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of DTE's strategies for Fermi. The intent of the safety evaluation is to inform DTE on whether or not its integrated plans, if implemented as described, provide a reasonable path for compliance with Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515/191, "Inspection of the Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans," Revision 1 (ADAMS Accession No. ML15257A188). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact Stephen Monarque, Orders Management Branch, Fermi Project Manager, at 301-415-1544 or at Stephen.Monarque@nrc.gov.

Sincerely,
/RA/
Mandy K. Halter, Chief
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Office of Nuclear Reactor Regulation

Docket No.: 50-341
Enclosure:
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ADAMS Accession No. ML16258A040 * via email

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