8.0 ELECTRIC POWER

The electric power system is the source of power for station auxiliaries during normal operation and for the reactor protection system and engineered safety features during abnormal and accident conditions. This chapter provides information on the functional adequacy of offsite power systems and safety-related onsite electric power systems, as applicable to the Economic Simplified Boiling-Water Reactors (ESBWR) design, and ensures that these systems have adequate redundancy, independence, and testability in conformance with the current criteria established by the U.S. Nuclear Regulatory Commission (NRC).

8.1 Electric Power - Introduction

8.1.1 Introduction

This section of the combined license (COL) Final Safety Analysis Report (FSAR) describes the transmission grid and its interconnection to the nuclear unit and other grid interconnections. This discussion also describes those onsite alternating and direct current (AC and DC) loads that are added to the certified ESBWR design and the function provided by these loads.

The section also includes a regulatory requirements applicability matrix that lists the design bases, criteria, regulatory guides (RGs), standards, and other documents to be implemented in the design of the electrical systems that are beyond the scope of the design certification (i.e., site-specific). The review under this section is coordinated closely with the reviews described in Sections 8.2, 8.3.1, 8.3.2, and 8.4 below.

8.1.2 Summary of Application

Section 8.1 of the Fermi 3 COL FSAR, Revision 3, incorporates by reference Section 8.1 of the ESBWR design control document (DCD), Revision 9. In addition, in FSAR Section 8.1, the applicant provides the following:

Supplemental Information

- EF3 SUP 8.1-1 Utility Power Grid Description

This supplemental information relates to a general overview of the output from the Enrico Fermi 3 (EF3) main generator, the system connections of the International Transmission Company transmission (ITC Transmission) to the EF3 switchyard from the Milan Substation, and the configuration of the normal preferred and the alternate preferred transmission lines.

8.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–XXXX, the Final Safety Evaluation Report (FSER) related to the certified ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the “Electric Power – Introduction,” and the associated acceptance criteria, are in Section 8.1 of NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition).”

The regulatory basis for accepting the COL supplemental information is established in General Design Criterion (GDC) 17, “Electric power systems,” of Appendix A, “General Design

Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities."

8.1.4 Technical Evaluation

As documented in NUREG–XXXX, NRC staff reviewed and approved Section 8.1 of the certified ESBWR DCD. The staff reviewed Section 8.1 of the Fermi 3 COL FSAR, Revision 3, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to the review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to this section.

The staff reviewed the following information in the COL FSAR:

Supplemental Information

- EF3 SUP 8.1-1 Utility Power Grid Description

The staff reviewed the applicant's supplemental information modifying Subsection 8.1.2.1, "Utility Power Grid Description." In Subsection 8.1.2.1, the applicant provides the following supplemental information:

> The output of Fermi 3 is delivered to a 345 kV switchyard through the unit main step-up transformers. Fermi 3 is connected to the switchyard by a 345 kV normal preferred transmission line that supplies power to the two unit auxiliary transformers and a 345 kV alternate preferred transmission line that supplies power to the two reserve auxiliary transformers. The switchyard for Fermi 3 serves three 345 kV transmission lines which connect this switchyard to the Milan substation.

The staff found that the applicant has adequately described the Fermi 3 electrical connection to the utility grid and that the connection conforms to the requirements of GDC 17.

8.1.5 Post Combined License Activities

There are no post COL activities related to this section.

8.1.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–XXXX. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix [x], Section VI.B.1, all nuclear safety issues relating to "Electric Power - Introduction" that were incorporated by reference have been resolved.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

In addition, the staff compared the additional COL supplemental information in the application to the relevant NRC regulations, the guidance in Section 8.1 of NUREG–0800, and other NRC RGs. The staff's review concluded that the applicant has provided sufficient information to satisfy the requirements of GDC 17 for this section.

8.2 Offsite Power System

8.2.1 Introduction

This section of the FSAR describes analyses and referenced documents that include electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the offsite power system. Industry standards and RGs refer to the offsite power system as the "preferred power system." This system includes two or more physically independent circuits capable of operating independently of the onsite standby power sources and encompasses the grid, transmission lines (overhead or underground), transmission line towers, transformers, switchyard components and control systems and switchyard battery systems, in addition to the main generator and generator circuit breakers, disconnect switches, and other switchyard equipment such as the capacitor banks and volt amperes reactive compensators, which supply electric power to safety-related and other equipment.

By not requiring ac power sources for design-basis events for 72 hours, the ESBWR passive reactor design used at Fermi 3 minimizes the potential risk contribution of a station blackout (SBO) (the loss of all ac power). The plant's safety-related passive systems automatically establish and maintain safe-shutdown conditions for the plant following design-basis events, including the extended loss of ac power sources. The passive systems can maintain these safe-shutdown conditions after design-basis events for 72 hours without operator action, following the loss of both onsite and offsite ac power sources.

8.2.2 Summary of Application

Section 8.2 of the Fermi 3 COL FSAR, Revision 3, incorporates by reference Section 8.2 of the certified ESBWR DCD, Revision 9.

In addition, in FSAR Section 8.2, the applicant provides site-specific supplemental information to resolve COL Items 8.2.4-1-A through 8.2.4-10-A. The applicant adds the following site-specific supplemental information:

COL Items

- EF3 COL 8.2.4-1-A Transmission System Description

In FSAR Subsection 8.2.1.1, the applicant provides detailed information on the plant site designs for the 345-kilovolt (kV) switchyard; the three 345-kV transmission lines connecting the plant switchyard to the Milan substation and to the ITC transmission system; and the interface of the switchyard with the transmission grid. The applicant also provides Figures 8.2-201 through 8.2-203. These figures show a one-line diagram of the Fermi 3 switchyard with transmission lines to the Milan substation and to the onsite electrical system, a physical arrangement of the 345-kV switchyard, and a map of the offsite transmission lines, respectively.

- EF3 COL 8.2.4-3-A Normal Preferred Power
- EF3 COL 8.2.4-4-A Alternate Preferred Power

In FSAR Subsection 8.2.1.2, the applicant provides additional information describing details of normal and alternate preferred power.

- EF3 COL 8.2.4-2-A Switchyard Description
- EF3 COL 8.2.4-6-A Switchyard DC Power
- EF3 COL 8.2.4-7-A Switchyard AC Power
- EF3 COL 8.2.4-8-A Switchyard Transformer Protection

In FSAR Subsection 8.2.1.2.1, the applicant provides additional information describing details of the switchyard, the switchyard DC and AC power, and switchyard transformer protection.

- EF3 COL 8.2.4-5-A Protective Relaying

The applicant provides additional information in a new FSAR section, Subsection 8.2.1.2.2, "Protective Relaying." This subsection describes the existing relay schemes that protect the 345-kV transmission lines, switchyard buses, generating unit tie-line, and auxiliary transformers.

- EF3 COL 8.2.4-9-A Stability and Reliability of the Offsite Transmission Power System
- EF3 COL 8.2.4-10-A Interface Requirements

In FSAR Subsection 8.2.2.1, the applicant provides additional information describing the transmission system study that was performed to verify grid stability, switchyard voltage, and frequency. This section also discusses the formal agreement between the control room and the transmission operator.

Supplemental Information

- EF3 SUP 8.2-2 Testing and Inspection

The applicant provides a new FSAR section, Subsection 8.2.1.2.3, "Testing and Inspection," which provides details for testing and inspecting the switchyard components.

- EF3 SUP 8.2-3 Failure Mode and Effects Analysis

The applicant provides a new FSAR Subsection 8.2.2.3, "Failure Modes and Effects Analysis," which describes details of the failure modes and effect analysis of transmission system and switchyard components.

8.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in the FSER related to the ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the offsite power system, and associated acceptance criteria, are in Section 8.2 of NUREG–0800. Specifically, the regulatory bases for accepting the supplemental COL information items are established in the following:

- For EF3 COL 8.2.4-1-A, the requirements of GDC 17.

- For EF3 COL 8.2.4-3-A and 8.2.4-4-A, the requirements of GDC 17.

- For EF3 COL 8.2.4-2-A, 8.2.4-6-A, 8.2.4-7-A, and 8.2.4-8-A, the requirements of GDC 17 and GDC 5, "Sharing of structures, systems, and components," recommendations of GL 2007-01, "Inaccessible or Underground Power Cable failures that Disabled Accident Mitigation Systems or cause Plant Transients," and guidance of NUREG/CR 7000, "Essential Elements of an Electric Cable Condition Monitoring Program" and SRP Section 8.2, Review Procedure 1.L.

- For EF3 COL 8.2.4-5-A, the requirements of GDC 17.

- For EF3 COL 8.2.4-9-A and 8.2.4-10-A, the requirements of GDC 17 and the guidelines of RG 1.32, "Criteria for Power Systems for Nuclear Power Plants"; RG 1.206 (2007), "Combined License Applications for Nuclear Power Plants (LWR Edition)"; Branch Technical Position (BTP) 8-3 (2007), "Stability of Offsite Power Systems"; BTP 8-6 (2007), "Adequacy of Station Electric Distribution System Voltages"; RG 1.160 (1997), "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"; and RG 1.182 (2000), "Assessing and Monitoring Risk Before Maintenance Activities at Nuclear Power Plants."

- For EF3 SUP 8.2-2, the requirements of GDC 18, "Inspection and testing of electric power and protective systems," and the guidelines of RG 1.118 (1995), "Periodic Testing of Electric Power and Protection Systems."

- For EF3 SUP 8.2-3, the guidance of RG 1.206.

8.2.4 Technical Evaluation

As documented in NUREG–XXXX, NRC staff reviewed and approved Section 8.2 of the certified ESBWR DCD. The staff reviewed Section 8.2 of the Fermi 3 COL FSAR, Revision 3, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to the offsite power system.

The staff reviewed the following information in the COL FSAR:

COL Items

- EF3 COL 8.2.4-1-A Transmission System Description

The applicant provides new information in Subsection 8.2.1.1 to address COL Item 8.2.4-1-A. In this subsection, the applicant states the following:

> Fermi 3, is connected to the ITC Transmission system by three 345 kV lines. These lines are designed and located to minimize the likelihood of simultaneous failure.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

> The Fermi 3 main generator feeds electric power through a 27 kV isolated-phase bus to a bank of three single-phase transformers, stepping the generator voltage up to the transmission voltage of 345 kV.
>
> The three 345 kV lines for Fermi 3 run in a common corridor. Transmission tower and steel pole separation, line installation, and clearances are consistent with applicable regulatory standards, typically the National Electrical Safety Code, and ITC Transmission line standards. Design standards and parameters, including number of wires, structure heights, materials and finish are consistent with ITC Transmission line design standards.

The staff's review of FSAR Subsection 8.2.1.1 and applicable Figures 8.2-201, 8.2.202, and 8.2-203 observed that all three lines between Fermi 3 and the Milan substation are routed though the same transmission corridor. In view of the common corridor for all transmission lines, the staff issued **RAI 08.02-04** requesting the applicant to discuss why the phenomenon of galloping conductors will not be accentuated in the corridor under the required environmental conditions, such as wind and ice loading, which result in flashovers and structural damage to multiple transmission line conductors and hardware. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), cites the Electric Power Research Institute (EPRI) Technical Report No.1010223, "Updating the EPRI Transmission Line Reference Book: "Wind-Induced Conductor Motion ("The Orange Book")." The applicant states that the frequency with which galloping occurs is closely related to environmental conditions, such as the frequency of icing, smooth countered terrain with few large obstacles, and localized areas near lakes and rivers. The applicant adds that a search of industry operating experience found no identifiable relationship with the number of transmission lines in a transmission corridor.

Because all three transmission lines are routed through a common corridor and are therefore exposed to the same environmental conditions, the staff issued **RAI 08.02-14** requesting the applicant to indicate whether any of the EPRI-evaluated environmental conditions could result in the galloping conductor phenomenon impacting multiple lines at the same time, thus causing a complete loss of offsite power. The staff also requested the applicant to discuss any direct experiences with this phenomenon at Fermi Units 1 and 2.

The applicant's response to this RAI, dated January 29, 2010 (ML100331450), clarifies that regional galloping conductors could occur in a common transmission corridor or independent corridors exposed to similar situational weather conditions. The applicant states that there are no reported occurrences of galloping conductors or of any related outages on the existing lines that would be sharing the Fermi 3 to Milan transmission corridor in the ITC Transmission operating history, which began in February 2003. The applicant adds that ITC Transmission design practices to space the towers to preclude contact with an adjacent tower's conductors if any galloping phenomenon occurs. The staff reviewed the applicant's responses to RAI 08.02.04. Based on the ITC Transmission design practices, the installation of transmission line towers, and the lack of galloping conductor occurrences or outages due to such phenomena, the staff found that the Fermi 3 offsite power transmission line system meets the requirements of GDC 17 and, hence, the applicant's response is acceptable. **RAI 08.02-04** and **RAI 08.02-14** are therefore resolved.

The staff found that COL Item 8.2-4-1-A conforms to the requirements of GDC 17.

- EF3 COL 8.2.4-3-A Normal Preferred Power
- EF3 COL 8.2.4-4-A Alternate Preferred Power

The applicant provides additional information on the normal and alternate preferred power to address COL Items 8.2.4-3-A and 8.2.4-4-A. The applicant replaces the first paragraph of DCD Subsection 8.2.1.2 with the following:

> The offsite power system is a non-safety-related system. Power is supplied to Fermi 3 from three independent and physically separate offsite power sources. The normal preferred power source is any one of the three 345 kV lines and the alternate preferred power source is any other one of the three 345 kV lines.

In addition, the applicant deletes the last paragraph of this subsection and replaces it with the following paragraph:

> Normal and alternate preferred power to the UATs and RATs, respectively, is via overhead conductors. To maintain their independence from each other, the conductors are routed such that they are physically and electrically separate from each other.

The staff found that the applicant has adequately resolved COL Items 8.2.4-3-A and 8.2.4-4-A. The staff found that the applicant's description of the offsite normal and alternate preferred power is reasonable and conforms to the requirements of GDC 17.

- EF3 COL 8.2.4-2-A Switchyard Description
- EF3 COL 8.2.4-6-A Switchyard DC Power
- EF3 COL 8.2.4-7-A Switchyard AC Power
- EF3 COL 8.2.4-8-A Switchyard Transformer Protection

The applicant provides additional information in FSAR Subsection 8.2.1.2.1 to address COL Items 8.2.4-2-A, 8.2.4-6-A, 8.2.4-7-A, and 8.2.4-8-A. The applicant replaces the last paragraph of DCD Subsection 8.2.1.2.1 with new supplemental information that, in part, states the following:

> The Fermi 3 switchyard is a 345 kV, air-insulated, breaker-and-a-half bus arrangement. The 345 kV switchyard for Fermi 3 receives two sources of AC auxiliary power from the 6.9 kV Plant Investment Protection (PIP) buses for the normal and alternate preferred switchyard power centers. The switchyard auxiliary power system is designed with adequate equipment, standby power, and protection to provide maximum continuity of service for operation of the essential switchyard equipment during both normal and abnormal conditions. There are two independent sets of 125 V DC batteries, chargers, and DC panels for the switchyard relay and control systems DC supply requirements. Each charger is powered from a separate AC source with an automatic switchover to the alternate source, in the event the preferred source is lost. The distribution systems for the two battery systems are physically separated.
>
> Control and relay protection systems are provided. Support systems, such as grounding, raceway, lighting, AC/DC station service, and switchyard lightning protection, are also provided.

The staff's review of FSAR Subsection 8.2.1.2.1 noted that the subsection includes a resolution for COL Item 8.2.4-8-A, "Switchyard Transformer Protection," but does not include a discussion

of transformer protection. Therefore, the staff issued **RAI 08.02-13** requesting the applicant to review the subsection and make the appropriate corrections. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), emphasizes a description already in FSAR Subsection 8.2.1.2.2 stating that the 345 kV for EF3 does not require any transformers. Therefore, transformer protection is not required. To address the omission, the applicant proposes to include in FSAR Subsection 8.2.1.2.1 a discussion of switchyard transformer protection similar to that in FSAR Subsection 8.2.1.2.2. The staff's review of the applicant's response found that the proposed FSAR revision is reasonable and adequately addresses the staff's issue. **RAI 08.02-13** is therefore resolved. The staff confirmed that the applicant has included the proposed changes in Revision 3 of the COL application.

As stated in FSAR Subsection 8.2.1.2.1 and in DCD Figure 8.1-1, the switchyard receives two sources of AC auxiliary power from the 6.9-kV PIP buses for both the normal and alternate preferred switchyard power centers. Additionally, the design utilizes two 125 VDC power to meet the requirements of the switchyard relay and control systems. In **RAI 08.02-07,** the staff asked the applicant to describe how medium voltage power and low voltage power control and instrumentation cables that are expected to be partially or continuously submerged in manholes, trenches, and duct banks are specified and qualified. The staff also asked the applicant to provide the design features and/or in situ monitoring programs that will be implemented to avoid or arrest the degradation of cable insulation from the effects of moisture. In addition, the staff requested the applicant to include the cables that traverse the switchyard as well as those that extend from the switchyard to the Fermi 3 unit.

The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that periodic monitoring of cable insulation for underground medium voltage cable will be conducted to detect potential cable insulation degradation from moisture intrusion. Such monitoring of medium voltage cables will be conducted in a manner similar to that described in the Fermi 2 Electrical Cable Monitoring Program based on the recommendations of the EPRI Cable Task Force. Additionally, the applicant states that "Detroit Edison does not believe that a testing program is necessary for low-voltage power, control, or instrumentation cables in underground circuits."

The staff's review of Detroit Edison's response to GL 2007-01 found that the three failed cables they identified at Fermi 2 were low-voltage (480 VAC and 260 VDC) cables. Additionally, the staff noted that for Fermi 2, Detroit Edison had committed to inspecting, testing, and monitoring all power cables—not only the medium voltage cables. Based on the Fermi 2 operating experience with low voltage underground cables and the scope of the program described in the Fermi 2 response to GL 2007-01, the staff issued **RAI 08.02-17** requesting the applicant to indicate why a program for inspecting, testing, and monitoring low voltage underground power cables is not required for Fermi 3.

The applicant's response to **RAI 08.02-17**, dated January 29, 2010 (ML100331450), reiterates the response provided by Detroit Edison to GL 2007-01 for Fermi 2 and clarifies that Detroit Edison had not made a commitment to inspect, test, and monitor all Fermi 2 power cables in the response to GL 2007-01. The applicant adds that Fermi 2 currently has an electrical cable monitoring program with the purpose "to detect and trend the degradation of significant cables and connections located in challenged environments." The applicant points out that by monitoring those cables, the program helps to protect the safe-shutdown capability of the plant; increases equipment reliability; and ensures compliance with the appropriate equipment qualification maintenance and surveillance for cables. The scope of the program regarding cables in a wet environment (such as an underground raceway) includes inspecting significant

medium voltage cables in those areas, as well as monitoring underground raceway manholes for cable submergence and for overall condition, such as the condition of supporting and dewatering the equipment. Additionally, the applicant clarifies that the periodic monitoring of underground medium voltage cable insulation to detect potential cable degradation from moisture intrusion, which the applicant proposed in the original response, is consistent with the monitoring approach currently followed at Fermi 2. Therefore, the applicant does not believe that a monitoring program for Fermi 3 that extends beyond the Fermi 2 program described above is necessary.

As described in GL 2007-01, various regulations including GDC 4, 17, and 18 require monitoring for those cables that are important to safety to assure that they can perform their intended safety functions. GL 2007-01 discusses all cables within the scope of 10 CFR 50.65 and does not differentiate between low voltage and medium voltage cables or between AC and DC cables. 10 CFR 50.65(a)(1) states that "Each holder of a license to operate a nuclear plant…shall monitor the performance or condition of structures, systems, or components…in a manner sufficient to provide reasonable assurance that such structures, systems, and components…are capable of fulfilling their intended functions." Additionally, NUREG–0800, Section 8.2, Review Procedure 1.L states that "Operating experience has shown that undetected degradation of underground…could result in multiple equipment failures. Underground or inaccessible power and control cable runs that are susceptible to protracted exposure to wetted environments or submergence" should be reviewed. Further, guidance on the selection of electric cable condition monitoring can be found in Sections 3 and 4.5 of NUREG/CR–7000. RG 1.160 states that the electrical distribution equipment out of the first inter-tie with the offsite distribution system (i.e., equipment in the switchyard) should be considered for inclusion, as defined in 10 CFR 50.65(b).

As indicated previously, the staff's review of the applicant's response to GL 2007-01 for Fermi 2 did not conclude that the scope of the cable monitoring program was intended for medium voltage cables only, particularly in consideration of the Fermi 2 operating experience with three low voltage cable failures. In addition, the applicant's description of the Fermi 2 electrical cable monitoring program in the response to RAI 08.02-17 is also not exclusive of low-voltage cables (i.e., the staff understands that for "significant cables" the applicant intends to encompass all cables within the scope of 10 CFR 50.65). Therefore, the staff requested the applicant to describe the EF3 cable monitoring program for all medium and low voltage power and control cables that will be implemented to avoid or arrest the degradation of cable insulation from the effects of moisture. The proposed cable monitoring program must include cable testing and inspections of manholes. The frequency of the testing and inspections and any corrective action to be implemented should be mentioned. The applicant should either provide the details of an appropriate condition monitoring program for detecting incipient degradation in cables based on industry standards (EPRI, Institute of Electrical and Electronic Engineers [IEEE], and nuclear entities including regulatory bodies) and recommended practices, or the applicant should justify and support the stated position in the RAI response.

In the supplemental responses to RAI 08.02-17, dated July 9, 2010 (ML101930518), and August 4, 2010 (ML102180176), the applicant states that the underground cable monitoring program will be based on guidance from the appropriate industry operating experience, regardless of the voltage (e.g., NRC GL 2007-01, NUREG/CR–7000, and the recently released Draft Regulatory Guide DG–1240). This program will be considered part of the 10 CFR 50.65 Maintenance Rule (MR) program, which will be implemented in accordance with FSAR Section 13.4. FSAR Table 13.4-201 provides the milestones for implementation of the inservice inspection program (prior to commercial service) and for the inservice testing program (after the

generator is online on nuclear heat). A review of detailed design and procurement information will determine the appropriate inspections, tests, and monitoring frequency to support implementation. The following description of the MR Program was added to FSAR Section 17.6.4 to address DCD COL Item 8.3.4-2-A:

> Condition monitoring of underground or inaccessible cables is incorporated into the MR program. The cable condition monitoring program incorporates lesson learned from industry operating experience (e.g., GL 2007-01, NUREG/CR-7000), address regulatory guidance, and utilizes information from detailed design and procurement documents to determine the appropriate inspections, tests, and monitoring criteria for underground and inaccessible cables within the scope of the MR (10 CFR 50.65).

The applicant's responses also include proposed revisions to COL application Part 2, Tier 2, FSAR, Table 1.10-201, FSAR Subsection 8.2.1.2.1, Section 8.3, and Section 17.6.4.

Based on the above information, the staff found that the applicant's condition monitoring program for underground or inaccessible cables satisfies the recommendations of GL 2007-01; the guidance of NUREG/CR–7000; and the guidance of SRP Section 8.2, Review Procedure 1.L. Therefore, **RAI 08.02-07** and **RAI 08.02-17** are resolved. Hence, the COL Item 8.3.4-2-A is resolved. The staff confirmed that the applicant has included the proposed changes in Revision 3 of the COL application.

EF3 is a single-unit plant with a switchyard that is not shared with any other units. Therefore, the requirement of GDC 5 is not applicable to Fermi 3.

Based on the above information, the staff found that the applicant has adequately addressed COL Items 8.2.4-2-A, 8.2.4-6-A, 8.2.4-7-A, and 8.2.4-8-A, which are all in conformance with the requirements of GDC 17, recommendations of GL 2007-01, guidance of NUREG/CR 7000, and SRP Section 8.2, Review Procedure 1.L.

- EF3 COL 8.2.4-5-A Protective Relaying

In Subsection 8.2.1.2.2, the applicant provides additional information to address COL Item 8.2.4-5-A. Specifically, the applicant adds a new subsection as follows:

> The 345 kV transmission lines are protected with redundant high-speed communications-assisted relay schemes and include automatic breaker reclosing. The 345 kV switchyard buses have redundant differential protection using separate and independent current and control circuits. Normal and alternate preferred power conductors between the Fermi 3 UATs and RATs and the 345 kV switchyard buses are protected by dual high-speed current differential schemes.
>
> The 345 kV switchyard circuit breakers are equipped with breaker failure protection and have dual trip coils. There are two independent DC supply systems, each with a 125 V battery and battery charger. Each redundant protection scheme that supplies a trip signal is powered from its redundant DC power supply and connected to a separate trip coil.

> The 345 kV switchyard for Fermi 3 does not require any transformers for Fermi 3. Therefore, Fermi 3 switchyard transformer protection is not required.

In Revision 0 of the COL FSAR, the applicant designates Subsection 8.2.1.2.2 as Supplemental Information Item EF3 SUP 8.2-1 and indicates that Subsection 8.2.2.1 addresses COL Item EF3 COL 8.2.4-5-A. Because protective relaying is discussed in Subsection 8.2.1.2.2 and not in Subsection 8.2.2.1, the staff issued **RAI 08.02-12** requesting the applicant to identify the correct FSAR subsections and to make the appropriate modifications. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that Detroit Edison had submitted Revision 1 of the COL application indicating that EF3 COL Information Item 8.2.4-5A is addressed in Subsection 8.2.1.2.2. The staff confirmed that in Revision 1 of the FSAR, the applicant had deleted EF3 SUP 8.2-1 in Subsection 8.2.2.1 and had revised the two subsections appropriately. On the basis of this review, the staff found that the applicant has adequately addressed the staff's issue. **RAI 08.02-12** is therefore resolved.

The staff found that COL Item 8.2.4-5-A is in conformance with the requirements of GDC 17.

- EF3 COL 8.2.4-9-A — Stability and Reliability of the Offsite Transmission Power Systems.
- EF3 COL 8.2.4-10-A — Interface Requirements

The applicant provides additional information in Subsection 8.2.2.1 to address COL Items 8.2.4-9-A and 8.2.4-10-A. The applicant provides new information to replace DCD Subsection 8.2.2.1 that, in part, states the following:

> A system impact study performed by ITC Transmission analyzed load flow, transient stability, and fault analysis for the addition of Fermi 3. Stability analysis was performed on both the 2017 summer peak base model and the 2017 eighty percent model with Fermi 3 and projected network upgrades included.
>
> The ITC Transmission system was analyzed for thermal and voltage limitations for normal and post contingency conditions. The analysis examined potential constraints such as thermal equipment overloads, voltage criteria violations, breakers that exceed their rated capabilities as well as constraints related to maintaining system stability and the sudden loss of single critical generation.
>
> Normal operating and abnormal procedures exist to maintain the switchyard voltage schedule and address challenges to the maximum and minimum limits. Upon approaching or exceeding a limit, these procedures verify the availability of required and contingency equipment and materials, direct notifications to outside agencies, and address unit Technical Specifications actions until the normal voltage schedule can be maintained. Detroit Edison will establish a Generator Interconnection and Operation Agreement with ITC Transmission and protocols for maintenance, communications, switchyard control, and system analysis sufficient to safely operate and maintain the power station interconnection to the transmission system.
>
> ITC Transmission in conjunction with the Midwest ISO provides analysis capabilities for both Long Term Planning and Real Time Operations. A Real Time State Estimator is used to assist in the evaluation of actual system conditions.

> The study concluded that with the additional generating capacity of Fermi 3, the transmission system remains stable under the analyzed conditions, preserving the grid connection and supporting the normal and shutdown power requirements of Fermi 3.
>
> The reliability of the overall system design is indicated by the fact that there have been no widespread system interruptions. Failure rates of individual facilities are low. Most lightning-caused outages are momentary, with few instances of line damage.
>
> Grid availability in the region over the past 20 years has been highly reliable with minimal outages due to equipment failures.
>
> Grid stability is evaluated on an ongoing basis based on load growth, the addition of new transmission lines, or new generation capacity.

In accordance with Regulatory Position C.I.8.2.2 of RG 1.206, the FSAR should discuss grid availability—including frequency, duration, and causes of outages over the past 20 years—for both the transmission system accepting the unit's output and the transmission system providing the preferred power to the unit's loads. In **RAI 08.02-03**, the staff asked the applicant to discuss historical outages of the 345-kV transmission lines and substation and to provide failure data for the ITC Transmission network for the past 20 years. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), provides the results of a review of equipment failures related to the Milan substation that occurred between 1988 and 2008. This review, which was limited to major equipment at the 345-kV voltage level that could affect the reliability of Fermi 3, determined that such equipment had experienced relatively few outages. Regarding transmission lines, the applicant reported that the Lemoyne-Majestic Line had experienced two momentary outages and two sustained outages. The two sustained outages were caused by a breaker failure and a stray radio frequency signal, respectively. Additionally, a Majestic breaker experienced a sustained outage due to an SF6 differential operation. The applicant also states that the local transmission system experienced only one complete loss of power due to a grid disturbance on August 14, 2003. During that event, some power became available within 6.5 hours and was fully restored after 21.5 hours. The staff reviewed the applicant's response and found it consistent with the requirements of GDC 17, the guidance of BTP 8-3, "Stability of Offsite Power Systems", and the guidance in IEEE Std 765-2006, "IEEE Standard for Preferred Power Supply (PPS) for Nuclear Power Generating Stations." Therefore, **RAI 08.02-03** is resolved.

In **RAI 08.02-05**, the staff asked the applicant to identify how the lightning protection mentioned in FSAR Subsection 8.2.2.1 and in DCD Section 8.2.3 would be implemented for the transmission system and the switchyard. The staff also requested the applicant to indicate how the lightning protection system would be periodically maintained and tested to assure functionality and effectiveness throughout the life of Fermi 3. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that the Fermi 3 lightning protection system will be designed in accordance with IEEE Std 998–1996 (reaffirmed in 2002), "IEEE Guide for Direct Lightning Stroke Shielding of Substations," using the Rolling Sphere Method provided by the transmission operator. The applicant adds that periodic monitoring, maintenance, and testing of the switchyard lightning protection system will include an annual thermal scanning of the lightning surge arresters using infrared technology. There will also be a power factor testing of the same arresters on a 10-year cycle. The applicant notes that Subsection 8.2.1.2.1 will be

revised accordingly. The staff confirmed that the applicant has revised Subsection 8.2.1.2.1 to address switchyard lightning protection system.

The staff's review of Section 8.1 of the DCD observed that the DCD endorses RG 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants." Additionally, Table 1.9-202, "Conformance with Regulatory Guides," of the FSAR shows that Fermi 3 conforms to the guidance of RG 1.204. Because the applicant's reply fails to indicate conformance with the guidance of RG 1.204, the staff issued **RAI 08.02-15**. This RAI asks the applicant to explain why the following are not applicable to Fermi 3 and to justify not using such guidance: RG 1.204 and IEEE Std 665–1995 (reaffirmed in 2001), "IEEE Guide for Generating Station Grounding"; IEEE Std 666–1991 (reaffirmed in 1996), "IEEE Design Guide for Electric Power Service Systems for Generating Stations"; IEEE Std 1050–1996, "IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations"; and IEEE Std C62-23–1995 (reaffirmed in 2001), "IEEE Application Guide for Surge Protection of Electric Generating Plants," endorsed by RG 1.204. The applicant's response to RAI 08.02-15, dated January 29, 2010 (ML100331450), clarifies that IEEE Std 998–1996 (reaffirmed in 2002) deals with physical and spatial relationships of equipment, masts, and shield wires in a switchyard to minimize direct lightning strokes to the equipment and the buswork. The applicant also confirms that as stated in COL FSAR Table 1.9-202, EF3 will conform to the guidance of RG 1.204. The applicant also states that if any conflicts arise between the guidance of IEEE Std 998–1996 (reaffirmed in 2002) and RG 1.204, the RG will take precedence. Based on the above information, the staff found the applicant's response acceptable because the EF3 offsite power lightning protection system is consistent with the guidance of RG 1.204. Therefore, **RAI 08.02-5** and **RAI 08.02-15** are resolved.

The staff's review of FSAR Subsection 8.2.2.1 determined that it does not identify the maximum and minimum switchyard voltage limits of the 345-kV transmission systems. In **RAI 08.02-08,** the staff requested the applicant to (1) provide the maximum and minimum switchyard voltage limits; (2) discuss how these limits were established; and (3) confirm that these voltage limits are acceptable for auxiliary power system equipment operation, including safety-related battery chargers and safety-related uninterruptible power supplies, during different operating conditions. The staff also requested the applicant to address assumptions; acceptance criteria; and a summary of results related to the load flow analysis (bus and load terminal voltages of the station auxiliary system), short circuit analysis, equipment sizing studies, protective relay setting and coordination, and motor starting with minimum and maximum grid voltage conditions. Additionally, the staff noted that the applicant should perform a separate set of calculations for each available connection to the offsite power supply and discuss how the results of the calculations will be verified.

The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that ITC Transmission typically plans for a voltage range of 97 to 105 percent of nominal voltage, and the same range will be applied to the switchyard. The applicant adds that specific transformer impedance and tap settings will be determined during a detailed design of the plant's power distribution system. At that time, the system will be optimized to supply power within the required range of the plant equipment. Analyses of the as-built onsite power system will be performed to determine load requirements during design-basis operating modes and will address the required attributes. These analyses will be completed as part of the plant-specific inspections, tests, analyses, and acceptance criteria (ITAAC) and will ensure that each as-built offsite circuit has sufficient capacity and capability. Based on the above information, the staff found the applicant's response consistent with the requirements of GDC 17, the guidance of RG 1.32 and BTP 8-6, and IEEE Std 765-2006. Therefore, **RAI 08.02-08** is resolved.

Regarding existing ITC Transmission procedures related to switchyard operating voltages and network contingencies, FSAR Subsection 8.2.2.1 states that "Upon approaching or exceeding a limit, these procedures verify availability of required and contingency equipment and materials, direct notifications to outside agencies and address unit technical specifications (TS) actions until the normal voltage schedule can be maintained." Because the FSAR does not identify TS for the offsite power system, the staff issued **RAI 08.02-10** requesting the applicant to clarify the reference to the TS in the FSAR subsection. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that Fermi 3 will implement operating procedures to maintain the switchyard voltage schedule and to address challenges to the maximum and minimum voltage limits. These procedures, however, will not reference any TS for offsite power, because that is not required. The applicant adds that FSAR Subsection 8.2.2.1 will be revised to delete the reference to the TS. Since the ESBWR design does not require TS for offsite power system, the staff found that the applicant has adequately addressed the staff's concerns. **RAI 08.02-10** is therefore resolved. The staff confirmed that the applicant has included the proposed changes in Revision 3 of the COL application.

FSAR Chapter 1 Table 1.9-201, "Conformance with Standard Review Plan," for SRP Section 8.2 indicates that Fermi 3 complies with the requirements of 10 CFR 50.65(a)(4) (SRP Section 8.2, Acceptance Criteria II.8). The staff's review of FSAR Chapter 8 found no discussion regarding 10 CFR 50.65. The staff issued **RAI 08.02-11** requesting the applicant to clarify compliance with the requirements of 10 CFR 50.65(a)(4). The staff clarified that the subject regulation is one aspect of the "Maintenance Rule" (10 CFR 50.65), an operational program, the implementation of which is addressed in Item 17 in FSAR Table 13.4-201 and the content is discussed in FSAR Section 17.6. Additionally, the staff requested the applicant to (1) address the applicability of the MR to switchyard components; (2) identify actions to be taken to limit the risk associated with transmission system degradation; and (3) identify actions that are required before performing grid risk-sensitive maintenance activities on switchyard components, as discussed in NRC GL 2006-02, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," referenced in SRP Section 8.2.

The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that the Fermi 3 offsite power system complies with the requirements of 10 CFR 50.65(a)(4) by the stated conformance to the guidance of SRP Section 8.2 in FSAR Table 1.9-201. The implementation of 10 CFR 50.65, as addressed in Item 17 of FSAR Table 13.4-201, is scheduled to occur before fuel loading authorization. The applicant adds that the MR Program implementation, discussed in FSAR Section 17.6, incorporates by reference Nuclear Energy Institute (NEI) Technical Report 07–02A, "Generic FSAR Template Guidance for Maintenance Rule Program Description for Plants Licensed under 10 CFR Part 52," as shown in Table 1.6-201 of the Fermi 3 COL FSAR, Revision 1. This NEI document will be used to evaluate for inclusion the offsite power system and components. Regarding risk assessment and risk management per 10 CFR 50.65(a)(4), the applicant states that NEI 07–02A includes considerations associated with grid/offsite power system reliability identified in NRC GL 2006-02. Therefore, the applicant considers the performance of grid reliability evaluations as part of the maintenance risk assessment, a necessary consideration of the program, which needs to be performed before performing grid-risk-sensitive maintenance activities. Based on the above clarifications, the staff found the applicant's response consistent with the requirements of 10 CFR 50.65(a)(4). Therefore, **RAI 08.02-11** is resolved.

In addition, based on the above review, the staff found that COL Items 8.2.4-9-A and 8.2.4-10-A are in conformance with the requirements of GDC 17 and the guidelines of RGs 1.32, 1.206, 1.160, and 1.182, BTPs 8-3 and 8-6.

- EF3 SUP 8.2-2 Testing and Inspection

In FSAR Subsection 8.2.1.2.3, the applicant provides the following supplemental information relating to testing and inspecting the offsite power system and components:

> Transmission lines are periodically inspected via an aerial inspection program in accordance with the ITC Transmission inspection plan. The inspection focuses on such items as right-of-way encroachment, vegetation management, conductor and line hardware condition, and the condition of supporting structures.
>
> Routine switchyard inspection activities include, but are not necessarily limited to the following:
>
> - Periodic inspection of circuit breakers
> - Semi-annual infrared scan of substation equipment
>
> - Semi-annual inspection of substation equipment
> - Periodic relay inspections
>
> Routine switchyard testing activities include, but are not necessarily limited to, the following:
>
> - 5-year relay calibration
> - 10-year ground grid testing
> - Semi-annual battery/charger inspection w/annual preventative maintenance

The staff's review of Subsection 8.2.1.2.3 noted that the applicant has provided a partial list of routine inspections and test activities that will be performed on switchyard equipment and components. In **RAI 08.02-06**, the staff requested the applicant to describe the periodic surveillance and maintenance tests that will be performed on the batteries and battery chargers located in the 345-kV switchyard and the criteria for battery replacement. Additionally, the staff requested the applicant to describe the periodic surveillance and maintenance tests that will be performed on the circuit breakers, potential transformers, lighting arrestors, capacitive coupling voltage transformers, current transformers, protective relays, microwave channels, communication equipment, annunciator panels, security equipment, switchyard grounding system, and surge arrestors in the 345-kV switchyard.

The applicant's response to this RAI, dated August 26, 2009 (ML092450483), provides a more comprehensive listing of switchyard equipment and components that will be subjected to routine inspections and tests and the frequency that each component will undergo such testing. Regarding the batteries, the applicant states that the transmission operator has no established criteria for the replacement of switchyard batteries, but that the need for battery replacement will be evaluated by considering the age and the condition of the equipment based upon the inspection and test results. The applicant also agrees to revise the FSAR subsection accordingly.

The staff reviewed the applicant's response and observed that the applicant's list did not include lightning and surge arresters. The staff then issued **RAI 08.02-16** requesting the applicant to address the omitted items. The applicant's response to **RAI 08.02-16**, dated January 29, 2010 (ML100331450), clarifies that the lightning protection system and its periodic monitoring,

maintenance, and testing have already been described in the applicant's response to NRC **RAI 08.02-5**. Specifically, the applicant emphasizes that lightning surge arresters are thermally scanned annually using infrared technology, and power factor tested during bus inspections and/or relay control scheme testing on a 10-year cycle. The applicant adds that FSAR Subsection 8.2.1.2.3 will be revised to include a description of the routine testing and maintenance for the lightning surge arresters. Based on the above clarifications, the staff found the applicant's response acceptable because the periodic monitoring, maintenance, and testing of switchyard equipment important to safety conform to the requirements of GDC 18 and the guidance of RG. 1.118. Therefore, **RAI 08.02-6** and **RAI 08.02-16** are resolved. The staff confirmed that the applicant's proposed changes are included in Revision 3 of the COL application.

In **RAI 08.02-9,** the staff requested the applicant to discuss the industry standards that will be followed (i.e., the Federal Energy Regulatory Commission [FERC], National Electric Reliability Council [NERC], and IEEE) for monitoring, testing, and maintaining the switchyard protection system. The applicant's response to this RAI, dated August 26, 2009 (ML092450483), states that the transmission operator will monitor, test, and maintain the switchyard protection system under NERC Standard PRC-005-1, "Transmission and Generation Protection System Maintenance and Testing." The applicant adds that the FSAR subsection will be revised to include a discussion of the industry standards used to monitor, test, and maintain the switchyard protection system. Based the above clarifications, the staff found that the applicant's commitment to the NERC standards provides reasonable assurance that the switchyard components will be adequately tested and maintained. Therefore, **RAI 08.02-9** is resolved. The staff confirmed that the applicant's proposed changes are included in Revision 3 of the COL application.

Based on the above review, the staff found that Supplemental Information Item EF3 SUP 8.2-2 is in conformance with the requirements of GDC 18 and the guidelines of RG 1.118.

- EF3 SUP 8.2-3 Failure Modes and Effect Analysis

In FSAR Subsection 8.2.2.3, the applicant addresses failure modes of the offsite power system and provides the supplemental information described below. In particular, in Subsection 8.2.2.3.1, "Introduction," the applicant states the following conclusion:

> There are no single failures that can prevent the Fermi offsite power system from performing its function to provide power to Fermi 3.

Additionally, in Subsection 8.2.2.3.2, "Transmission System Evaluation," the applicant states:

> Fermi 3 is connected to the ITC Transmission system via three 345 kV overhead transmission lines. Each 345 kV transmission line occupies a common right-of-way and traverses from the Fermi site within an anticipated 91 m (300 ft) right-of-way. The 345 kV towers and poles provide clearances consistent with applicable regulatory standards. The towers and poles are grounded to achieve 15 ohms or less per structure. Failure of any one 345 kV tower or pole due to structural failure can at most disrupt and cause a loss of power distribution to itself and the adjacent line, if one is present.

Failure of a line conductor would cause the loss of one of the three 345 kV lines, with the other two lines remaining available as normal and alternate preferred power sources.

Regarding switchyard components, FSAR Subsection 8.2.2.3.3, "Switchyard Evaluation," states the following:

The equipment in this switchyard is rated and positioned within the bus configuration according to the following criteria:

- Equipment continuous current ratings are such that no single contingency in the switchyard results in current exceeding 100 percent of the continuous current rating of the equipment.
- Interrupting duties are such that no faults occurring on the system exceed the equipment rating.
- Momentary ratings are such that no faults occurring on the system exceed the equipment momentary rating.
- Voltage ratings for the equipment are specified to be greater than the maximum expected operating voltage.

The breaker-and-a-half switchyard arrangement offers the following flexibility to control a failed condition within the switchyard:

- Any faulted transmission line can be isolated without affecting any other transmission line.
- Either bus can be isolated without interruption of any transmission line or other bus.
- Relay schemes include primary and backup protection features. All breakers are equipped with dual trip coils. Each protection circuit that supplies a trip signal is connected to a separate trip coil.

The normal preferred and alternate preferred power supplies are electrically independent and physically separate from each other, as indicated in DCD Section 8.2.3. This power source independence and physical separation along with the isolation flexibility described above to control failed conditions ensures that a minimum of one preferred source of power remains available to supply the load during all plant conditions.

ESBWR DCD Revision 5, Section 8.2.3 states that separate transmission systems feed the normal and the alternate preferred circuits, and each system is capable of supplying the shutdown loads. The staff also noted that although FSAR Subsection 8.2.2.3.3 implies compliance with the DCD, the subsection makes no mention of how the design meets the DCD requirement for separate transmission systems. In particular, the staff noted that both the normal and alternate preferred circuits at EF3 have the same termination points (the site switchyard at one end and the Milan substation at the other) and are in the same transmission corridor for 29.4 miles. Therefore, the staff issued **RAI 08.02-02** requesting the applicant to identify how the EF3 design complies with the DCD requirement for separate transmission systems, if there is no diversity in the transmission systems between the normal and the alternate preferred circuits from and to the termination points. The applicant's response to this

RAI, dated August 26, 2009 (ML092450483), acknowledges that an inconsistency exists between the design bases in Subsection 8.1.5.1 and Section 8.2.3 of DCD Revision 5. Specifically, Subsection 8.1.5.1 (DCD Revision 5) states, "Electric power from the utility grid to the offsite power system is provided by transmission lines designed and located to minimize the likelihood of failure while ensuring grid reliability. The transmission system serves the main offsite power circuit (Normal Preferred Power), and the reserve offsite power circuit (Alternate Preferred Power) through the site switchyard(s)." This description of a single transmission system serving the normal and the alternate preferred power supply circuits conflicts with the statement in DCD Section 8.2.3, which describes more than one transmission system. The applicant adds that the ESBWR vendor has corrected DCD Revision 6 to make the language in DCD Section 8.2.3 consistent with that in DCD Subsection 8.1.5.1. The staff found that this change is acceptable because GDC 17 does not require the normal and alternate preferred power be provided from separate transmission systems. The staff verified that the ESBWR vendor has modified Section 8.2.3 in DCD Revision 6 by replacing separate transmission systems with separate transmission lines. The staff found that the applicant has addressed the issue adequately, and **RAI 08.02-02** is resolved.

Based on the above, the staff found that the applicant's information adequately addresses Supplemental Information Item EF3 SUP 8.2-3. Furthermore, the staff found that no offsite power contingencies, including a breaker not operating during a fault on an offsite line, fault on a switchyard bus, a spurious relay trip, or a loss of control power, would result in a loss of normal and alternate preferred sources. Also, the staff found that the supplemental information item is in conformance with the guidelines of RG 1.206.

8.2.5 Post Combined License Activities

There are no post COL activities related to this section.

8.2.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–XXXX. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the application has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix [x], Section VI.B.1, all nuclear safety issues relating to the offsite power system that were incorporated by reference have been resolved.

In addition, the staff compared the additional information relating to the COL and supplemental information items in the application to the relevant NRC regulations, the guidance in Section 8.2 of NUREG–0800, and other NRC RGs. The staff's review found that the applicant has adequately addressed the COL items, and the applicant's site-specific supplemental information adequately addresses the NRC regulations: GDCs 17 and 18; and the guidance in RGs 1.32, 1.118, 1.182, 1.160, 1.204, 1.206, NUREG/CR 7000; and recommendations of GL 2007-01.

8.3 Onsite Power Systems

8.3.1 AC Power System

8.3.1.1 *Introduction*

This section of the COL FSAR provides descriptive information, analyses, and referenced documents that include the applicant's information on electrical single-line diagrams, electrical

schematics, logic diagrams, tables, and physical arrangement drawings for the onsite ac power system. The onsite ac power system includes those standby power sources, distribution systems, and auxiliary support systems provided to supply power to safety-related equipment or equipment important to safety, for all normal operating and accident conditions.

In the ESBWR passive reactor design used at Fermi 3, the onsite ac power system is a non-Class 1E system that provides reliable ac power to the various electrical loads in the system. The system does not perform any safety-related functions. These loads enhance an orderly shutdown under emergency (not accident) conditions. Additional loads for investment protection can be manually loaded on the standby power supplies. Diesel generator sets are used as the standby power source for the onsite ac power systems. Those portions of the onsite ac power systems that are not related to safety are described only in sufficient detail to permit an understanding of their interactions with the safety-related portions.

The plant's uninterruptible power supply (UPS) system (120 V of ac vital power) comprises independent Class 1E and non-Class 1E UPS systems. Each system consists of rectifiers, inverters, ungrounded batteries, and distribution panels. The Class 1E UPS system provides reliable power for the safety-related equipment required for the plant instrumentation, control, monitoring, and other vital functions needed to shut down the plant. In addition, the Class 1E UPS system provides power to the emergency lighting in the main control room and the remote shutdown area.

8.3.1.2 *Summary of Application*

Section 8.3.1 of the Fermi 3 COL FSAR, Revision 3, incorporates by reference Section 8.3.1 and Appendix 8A of the certified ESBWR DCD, Revision 9.

In addition, in FSAR Appendix 8A and Subsection 8.3.3.2, the applicant provides the following:

COL Items

- EF3 COL 8A.2.3-1-A Cathodic Protection System

The applicant provides additional information regarding a cathodic protection system in FSAR Appendix 8A.

- EF3 COL 8.3.4-2-A Identification and Monitoring of Underground or Inaccessible Power and Control Cables to the PSWS and DG Fuel Oil Transfer System Equipment That Have Accident Mitigation Functions

The applicant provides additional information regarding cable monitoring program in Subsection 8.3.3.2.

8.3.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–XXXX, the FSER related to the ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the ac power system, and the associated acceptance criteria, are in Section 8.3.1 of NUREG–0800. The review of COL Item 8A.2.3-1-A is subject to the guidance of the National Association of Corrosion Engineers (NACE) standards. COL Item 8.3.4-2-A is

subject to recommendations of GL 2007-01 and guidance of NUREG/CR 7000 (2010) and SRP Section 8.2, Review Procedure 1.L.

8.3.1.4 *Technical Evaluation*

As documented in NUREG–XXXX, NRC staff reviewed and approved Section 8.3.1 and Appendix 8A of the certified ESBWR DCD. The staff reviewed the conformance of Section 8.3.1 and Appendix 8A of the Fermi 3 COL FSAR, Revision 3, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to onsite ac power systems.

The staff reviewed the following information in the COL FSAR:

COL Item

- EF3 COL 8A.2.3-1-A Cathodic Protection System

The applicant provides additional information in Section 8A.2.1 to address COL Item 8A.2.3-1-A. In this section, the applicant replaces DCD Section 8A.2.1, "Description," with the following:

> A cathodic protection system is provided to the extent required. The system is designed in accordance with the requirements of the National Association of Corrosion Engineers (NACE) Standards (DCD Reference 8A-5).

The staff reviewed the supplemental information, related to cathodic protection, provided in Section 8A.2.1 of the EF3 FSAR and found it acceptable because it conforms to the industry standard guidance.

- EF3 COL 8.3.4-2-A Identification and Monitoring of Underground or Inaccessible Power and Control Cables to the PSWS and DG Fuel Oil Transfer System Equipment That Have Accident Mitigation Functions

The applicant provides additional information in Subsection 8.3.3.2 to address COL Item 8.3.4-2-A. The applicant replaces last sentence in the last paragraph of DCD, Revision 9, Subsection 8.3.3.2 with the following:

This COL item is evaluated in Section 8.2.4.

- Commitment (COM-8.3-001)-The COL Applicant will verify that owner yard scope site specific underground or inaccessible power and control cable runs to the PSWS and DG Fuel Oil Transfer System that have accident mitigation functions and are susceptible to protracted exposure to wetted environments or submergence as a result of tidal, seasonal, or weather event water intrusion are adequately identified

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

and monitored for appropriate corrective actions under MR program described in Section 17.6.4.

The milestones for implementation of the above commitment are provided in FSAR Table 13.4-201.

8.3.1.5 *Post Combined License Activities*

The applicant identifies the following commitment:

- Commitment (COM-8.3-001)-The COL Applicant will verify that owner yard scope site specific underground or inaccessible power and control cable runs to the PSWS and DG Fuel Oil Transfer System that have accident mitigation functions and are susceptible to protracted exposure to wetted environments or submergence as a result of tidal, seasonal, or weather event water intrusion are adequately identified and monitored for appropriate corrective actions under MR program described in Section 17.6.4.

The milestones for implementation of the above commitment are provided in FSAR Table 13.4-201.

8.3.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–XXXX. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix [x], Section VI.B.1, all nuclear safety issues relating to the onsite ac power system that were incorporated by reference have been resolved. The staff compared the information in the application to the relevant NRC regulations, the guidance in Section 8.3.1 of NUREG–0800, and industry standards. The staff's review concluded that the applicant has adequately addressed the COL items regarding the Fermi 3 cathodic protection system and cable monitoring program. Therefore, the applicant has satisfied the guidance of NACE standards and NUREG/CR 7000 and recommendations of GL 2007-01.

8.3.2 DC Power Systems

8.3.2.1 *Introduction*

This section of the COL FSAR provides descriptive information, analyses, and referenced documents that include the applicant's information on electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the onsite DC power systems. The onsite DC power systems include those power sources and their distribution systems that supply motive or control power to safety-related equipment. The non-safety-related portions are described only in sufficient detail to permit an understanding of their interactions with the safety-related portions. This section clearly identifies the safety loads and states the length of time they would be operable in the event of a loss of ac power.

The plant's DC power system is comprised of independent Class 1E and non-Class 1E DC power systems. Each system consists of ungrounded stationary batteries, DC distribution equipment, and the UPS.

The Class 1E DC and UPS system in the ESBWR passive reactor design plant is capable of providing reliable power for the safe shutdown of the plant without the support of battery chargers, during a loss of all ac power sources coincident with a design-basis accident for 72 hours. The system is designed so that no single failure will result in a condition that will prevent the safe shut down of the plant.

The non-Class 1E DC and UPS system in the ESBWR passive reactor design plant provides continuous and reliable electric power to the plant's non-Class 1E control and instrumentation loads and equipment, which are required for plant operation and investment protection and for the hydrogen igniters located inside containment. Operation of the non-Class 1E DC and UPS system is not required for nuclear safety.

8.3.2.2 *Summary of Application*

Section 8.3.2 of the Fermi 3 COL FSAR, Revision 3, incorporates by reference Section 8.3.2 of the certified ESBWR DCD, Revision 9.

In addition, in FSAR Section 8.3.2, the applicant provides the following:

COL Item

- EF3 COL 8.3.4-1-A Safety-Related Battery Float and Equalizing Voltage Values

In FSAR Section 8.3.2.1.1, "Safety-Related Station Batteries and Battery Chargers," the applicant provides information on safety-related battery float and equalizing voltage values. Additionally, the applicant modifies DCD Table 8.3-4 item b.

Supplemental Information

- EF3 SUP 8.3-2 Safety-Related Station Batteries and Battery Chargers Station Blackout

In FSAR Section 8.3.2.1.1, the applicant provides supplemental information on the training and procedures to mitigate an SBO, with references to FSAR Sections 13.2 and 13.5.

8.3.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–XXXX, the FSER related to the ESBWR DCD.

COL Item EF3 COL 8.3.4-1-A is subject to the requirements of GDC 17. In addition, the regulatory bases for acceptance of the supplemental information are established in 10 CFR 50.63, "Loss of All Alternating Current Power"; the guidelines of RG 1.155 (1988), "Station Blackout"; and Nuclear Management and Resource Council (NUMARC) 87–00 (issued in November 1987), "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors."

8.3.2.4 *Technical Evaluation*

As documented in NUREG–XXXX, NRC staff reviewed and approved Section 8.3.2 of the certified ESBWR DCD. The staff reviewed Section 8.3.2 of the Fermi 3 COL FSAR and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to the DC power system.

The staff reviewed the following information in the COL FSAR:

COL Item

- EF3 COL 8.3.4-1-A Safety-Related Battery Float and Equalizing Voltage Values

The applicant provides additional information to address COL Item 8.3.4-1-A. The applicant replaces the fourth paragraph of DCD Subsection 8.3.2.1.1 with the following:

> In Divisions 1, 2, 3, and 4, the two 250 volt safety-related batteries per division are sized together so that their total rated capacity will exceed the required battery capacity per division for 72-hour SBO conditions. The DC system minimum battery terminal voltage at the end of the discharge period is 210 VDC (1.75 volts per cell). The maximum equalizing charge voltage for safety-related batteries is specified by the battery vendor and is as allowed by the voltage rating of the connected loads (UPS inverters). The UPS inverters are designed to supply 120 VAC power with DC input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage. The safety-related battery float voltage and maximum equalizing charge voltage values are included in Table 8.3-4R.

Additionally, the applicant modifies DCD Table 8.3-4 item b to include float and maximum equalizing charge voltage as follows:

- float voltage at 77°F- 267.6 VDC at the battery terminals
- maximum equalizing charge voltage at 77°F-288 VDC at the battery terminals.

The staff found that optimum long-term battery performance is obtained by maintaining a float voltage within established design limits of 2.22 volts per cell to 2.24 volts per cell provided by the battery manufacturer, which corresponds to nominally 2.23 volts per cell or 267.6 VDC at 77°F. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. Therefore, float voltage of 267.6 VDC at 77°F is acce ptable. Additionally, the maximum equalizing charge voltage of 288 VDC at the better terminals is acceptable because the UPS inverters (only connected load on DC bus) are designed to function properly with DC input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage (288 VDC).

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The staff found that the applicant adequately resolved COL Item 8.3.4-1-A and float and maximum equalizing charge voltage values were consistent with battery vendor's recommendation and in conformance with the requirements of GDC 17.

Supplemental Information

- EF3 SUP 8.3-2 Safety-Related Station Batteries and Battery Chargers Station Blackout

The applicant provides the following supplemental information at the end of FSAR Subsection 8.3.2.1.1 addressing the training and procedures to mitigate an SBO event:

> Training and procedures to mitigate an SBO event are implemented in accordance with Section 13.2 and 13.5 respectively. The ESBWR is a passive design and does not rely on offsite or onsite AC sources of power for at least 72 hours after an SBO event, as described in DCD Section 15.5.5, SBO. In addition, there are no nearby large power sources, such as a gas turbine or black start fossil fuel plant, that can directly connect to the station to mitigate the SBO event. Restoration from an SBO event will be contingent upon power being made available from any one of the following sources:
>
> - Any of the standby or ancillary diesel generators
> - Restoration of any one of the three 345 kV transmission lines described in Section 8.2.

According to NUMARC 87–00 Revision 0, endorsed in RG 1.155 and referenced in SRP Section 8.4, the SBO response procedures include (1) Station Blackout Response Guidelines, (2) AC Power Restoration, and (3) Severe Weather Guidelines. In **RAI 08.03.02-01,** the staff asked the applicant to confirm that the training and procedures described in Subsection 8.3.2.1.1 include those three topics. The applicant's response to this RAI, dated March 25, 2009 (ML091060495), states that the training and procedures addressed in Subsection 8.3.2.1.1 will include the three topics listed in the RAI. COL FSAR Sections 13.2 and 13.5 discuss training licensed and non-licensed plant personnel and plant procedures, respectively. However, these discussions do not specifically address SBO events. The applicant adds that, in general, training is described in the FSAR in sufficient detail to assure that plant workers receive adequate training for responding to all plant events, both normal and abnormal, and the training will encompass an SBO event. Additionally, the applicant will revise the FSAR to indicate that the procedures will include (1) Station Blackout Response Guidelines, (2) AC Power Restoration, and (3) Severe Weather Guidelines, as recommended by NUMARC 87–00. Based on the above clarifications, the staff found that the applicant's response adequately addresses the staff's concerns, and **RAI 08.03.02-01** is resolved. The staff confirmed that the applicant's proposed changes are included in Revision 3 of the COL application.

Based on the above review, the staff found that the applicant has adequately addressed Supplemental Information Item EF3 SUP 8.3-2. The staff found that the supplemental information item is in conformance with the requirements of 10 CFR 50.63 and the guidelines of RG 1.155 and NUMARC 87–00.

8.3.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

8.3.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–XXXX. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix [x], Section VI.B.1, all nuclear safety issues relating to the onsite DC power system that were incorporated by reference have been resolved.

In addition, the staff compared the additional information relating to the COL and supplemental information items in the application to the relevant NRC regulations, the guidance in Section 8.3.2 of NUREG–0800, and other NRC RGs. The staff concluded that the applicant has adequately addressed the Fermi 3 the COL item regarding safety-related battery float and equalizing voltage values and supplemental information pertaining to training and procedures to mitigate an SBO event. Therefore, the applicant has satisfied the requirements of GDC 17 and 10 CFR 50.63 for this section.

8.4 Station Blackout

The Fermi 3 COL FSAR does not include Section 8.4. The SBO safety analysis is in ESBWR DCD Section 15.5.5. In COL FSAR Section 15.5.5, "Station Blackout," the applicant incorporates by reference Section 15.5.5 of the certified ESBWR DCD, Revision 9, with no departures or supplements.