

Chapter 8 Electrical Power

8.1 Introduction

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

8.1.2.1 Utility Power Grid Description

Add the following to the end of the first paragraph.

EF3 SUP 8.1-1

The output of Fermi 3 is delivered to a 345 kV switchyard through the unit main step-up transformers, as described in [Section 8.2](#) and [Section 8.3](#). Fermi 3 is connected to the switchyard by a 345 kV normal preferred transmission line that supplies power to the two unit auxiliary transformers (UAT) and a 345 kV alternate preferred transmission line that supplies power to the two reserve auxiliary transformers (RAT). The switchyard for Fermi 3 serves three 345 kV transmission lines, Fermi-Milan #1, Fermi-Milan #2, and Fermi-Milan #3 which connect this switchyard to the Milan substation. These three transmission lines exit the switchyard and traverse westward from the site as shown in [Figure 2.1-204](#) and [Figure 8.2-203](#). The International Transmission Company's (ITC *Transmission*) transmission system and connections to Fermi 3 are further described in [Section 8.2](#).

8.2 Offsite Power Systems

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

8.2.1.1 Transmission System

Replace this section with the following.

EF3 COL 8.2.4-1-A

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.

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. [Figure 8.2-201](#) provides a one-line diagram that shows the 345 kV

switchyard electrical connections to the onsite power system for Fermi 3. From the Fermi 3 345 kV switchyard the three transmission lines leave the site heading west in a common corridor with the Fermi 2 transmission lines. The corridor is described in more detail below. [Figure 8.2-203](#) maps the offsite transmission lines.

The transmission lines connecting the 345 kV switchyard for Fermi 3 to the transmission system are as follows:

- A 345 kV Fermi-Milan #1 overhead line to the Milan substation (approximately 47.3 km [29.4 mi])
- A 345 kV Fermi-Milan #2 overhead line to the Milan substation (approximately 47.3 km [29.4 mi])
- A 345 kV Fermi-Milan #3 overhead line to the Milan substation (approximately 47.3 km [29.4 mi])

The three 345 kV lines for Fermi 3 run in a common corridor, with transmission lines for Fermi 2, to a point just east of I-75. From the intersection of this Fermi site corridor and I-75, the three Fermi-Milan lines run west and north for approximately 19.3 km (12 mi) in a corridor shared with other non-Fermi lines. From this point, all non-Fermi lines turn north and continue on to their respective destinations and the three Fermi-Milan lines continue west for approximately 16 km (10 mi) to the Milan substation.

Transmission tower and steel pole separation, line installation, and clearances are consistent with applicable regulatory standards, typically the National Electrical Safety Code (NESC), 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.

8.2.1.2 Offsite Power System

Replace the first paragraph with the following.

EF3 COL 8.2.4-3-A
EF3 COL 8.2.4-4-A

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 Fermi-Milan transmission lines, and the alternate preferred power source is any other one of the three 345 kV lines.

Delete the last paragraph and add 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.

8.2.1.2.1 Switchyard

Replace the last paragraph with the following.

EF3 COL 8.2.4-2-A
EF3 COL 8.2.4-6-A
EF3 COL 8.2.4-7-A
EF3 COL 8.2.4-8-A

The Fermi 3 switchyard, prior to the point of interconnection with Fermi 3, is a 345 kV, air-insulated, breaker-and-a-half bus arrangement. Fermi 3 is connected to this switchyard by overhead conductors, the normal preferred and alternate preferred power conductors.

The anticipated physical location and electrical interconnection of the 345 kV switchyard for Fermi 3 is shown on [Figure 2.1-204](#) and [Figure 8.2-201](#).

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 preferred switchyard power center and alternate preferred switchyard power center, as shown on [DCD Figure 8.1-1](#). 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.

Periodic monitoring of cable insulation for underground medium voltage cable will be conducted to detect potential cable degradation from moisture intrusion. This program is based upon the recommendations of the EPRI Cable Task Force and establishes preventive maintenance activities for periodic inspection and testing of cables and cable vaults associated with systems within the scope of 10 CFR 50.65.

Fermi 3 switchyard lightning protection system is designed in accordance with IEEE Standard 998-1996 (R2002), "IEEE Guide for Direct Lightning Stroke Shielding of Substations," using the Rolling Sphere Method. Periodic monitoring, maintenance and testing of the switchyard lightning protection system includes the following activities:

- Lightning surge arresters are thermally scanned using infrared technology annually
- Lightning surge arresters are power factor tested during bus inspections and/or relay control scheme testing on a 10 year cycle

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

The anticipated capacity and electrical characteristics for switchyard equipment are as follows:

Breakers	Max Design (kV)	Rated Current (A)	Interrupting Current at Max kV
345 kV	379.5	3250	63 kA
Transmission Lines		Rated Current at 86°F	
345 kV	2940 A		
Bus Work		Rated Current	
345 kV	3660 A		

EF3 COL 8.2.4-5-A

8.2.1.2.2 Protective Relaying

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 located 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. All of these breakers 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.

EF3 SUP 8.2-2

8.2.1.2.3 Testing and Inspection

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 testing and inspection activities include, but are not necessarily limited to, the following:

- Circuit Breaker Inspections – Every 6 years or after 10 automatic operations
- Station infrared (IR) scans – Annually
- Switchyard Inspection – Monthly manual walk through of substation mat to visually inspect all equipment, including but not limited to; locks, fencing, control houses
- Station Batteries and Chargers – Tested annually. Battery load tested every 5 years
- Relays
 - Electromechanical Type – Calibrated on a 5 year cycle
 - Microprocessor Type – Calibrated on a 10 year cycle
 - Control schemes – Tested for operation and insulation integrity on a 10 year cycle
- Current Transformers (CTs), Potential Transformers (PTs), and Coupling Capacitive Voltage Transformer (CCVTs) – Tested concurrently with control schemes on a 10 year cycle

- Communication Equipment (including Line Tuners and Wave Traps) – Tested concurrently with control schemes on a 10 year cycle.
- Bus Inspection/Disconnect Switches – Tested concurrently with control schemes on a 10 year cycle
- Backup AC Generators – Biannual inspections, includes annual load testing
- Ground Mat Integrity – Tested every 15 years
- Lighting Surge Arresters - Infrared thermal scan annually. Power factor tested during bus inspections and/or relay control scheme testing on a 10 year cycle

Monitoring, maintenance and testing of the switchyard protection will be performed under North American Electric Reliability Corporation (NERC) Standard PRC-005-1, “Transmission and Generation Protection System Maintenance and Testing.”

8.2.2.1 Reliability and Stability Analysis

Replace this section with the following.

EF3 COL 8.2.4-9-A
EF3 COL 8.2.4-10-A

A system impact study performed by ITC *Transmission* analyzed loadflow, transient stability and fault analysis for the addition of Fermi 3. ([Reference 8.2-201](#)) The base case for this analysis represented the expected system configuration and loading in 2017 and included planned transmission projects that had budgetary approval at the time the analysis was performed. The sub-transmission system used for the analysis represented the summer for 2007 case and did not include any planned upgrades beyond that time. 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 via power flow analysis using Power Technology International Software PSS/E and MUST power flow and contingency analysis simulation tools. 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.

EF3 COL 8.2.4-10-A

The equipment considered is from the point of interconnection of Fermi 3 to the switchyard out to the 345 kV transmission system. Maximum and minimum switchyard voltage limits established by *ITCTransmission* will be applied to the 345 kV switchyard. 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, and direct notifications to outside agencies until the normal voltage schedule can be maintained. Detroit Edison will establish a Generator Interconnection and Operation Agreement with *ITCTransmission* and protocols for maintenance, communications, switchyard control, and system analysis sufficient to safely operate and maintain the power station interconnection to the transmission system.

ITCTransmission in conjunction with the Midwest ISO provides analysis capabilities for both Long Term Planning and Real Time Operations. System conditions are evaluated to ensure a bounding analysis and model parameters are selected that are influential in determining the system's ability to provide offsite power adequacy. Elements included in the analysis are system load forecasts (including sufficient margin to ensure a bounding analysis over the life of the study), system generator dispatch (including outages of generators known to be particularly influential in offsite power adequacy of affected nuclear units), outage schedules for transmission elements that have significant influence on offsite power adequacy, cross-system power transfers and power imports/exports, and system modification plans and schedules. 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. Other facilities do fail occasionally, but these are random occurrences, and experience has shown that equipment specifications are adequate.

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.

EF3 SUP 8.2-3

8.2.2.3 Failure Modes and Effects Analysis

8.2.2.3.1 Introduction

There are no single failures that can prevent the Fermi offsite power system from performing its function to provide power to Fermi 3 [Reference 8.2-201](#).

8.2.2.3.2 Transmission System Evaluation

Fermi 3 is connected to the ITCTransmission system via three 345 kV overhead transmission lines. The normal preferred power is any one of the three 345 kV lines (See [Subsection 8.2.1.1](#) and [Subsection 8.2.1.2](#)).

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.

8.2.2.3.3 Switchyard Evaluation

A breaker-and-a-half scheme is incorporated in the design of the 345 kV switchyard for Fermi 3. The equipment in this switchyard is rated and positioned within the bus configuration according to the following criteria in order to maintain incoming and outgoing load flow for Fermi 3.

- Equipment continuous current ratings are such that no single contingency in the switchyard (e.g., a breaker being out of service for maintenance) 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 into the switchyard can be isolated without affecting any other transmission line.
- Either bus can be isolated without interruption of any transmission line or other bus.
- All relay schemes used for protection of the offsite power circuits and the switchyard equipment 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.

8.2.4 COL Information

8.2.4-1-A Transmission System Description

EF3 COL 8.2.4-1-A This COL item is addressed in [Subsection 8.2.1.1](#).

8.2.4-2-A Switchyard Description

EF3 COL 8.2.4-2-A This COL item is addressed in [Subsection 8.2.1.2.1](#).

8.2.4-3-A Normal Preferred Power

EF3 COL 8.2.4-3-A This COL item is addressed in [Subsection 8.2.1.2](#).

8.2.4-4-A Alternate Preferred Power

EF3 COL 8.2.4-4-A This COL item is addressed in [Subsection 8.2.1.2](#).

8.2.4-5-A Protective Relaying

EF3 COL 8.2.4-5-A This COL item is addressed in [Subsection 8.2.1.2.2](#).

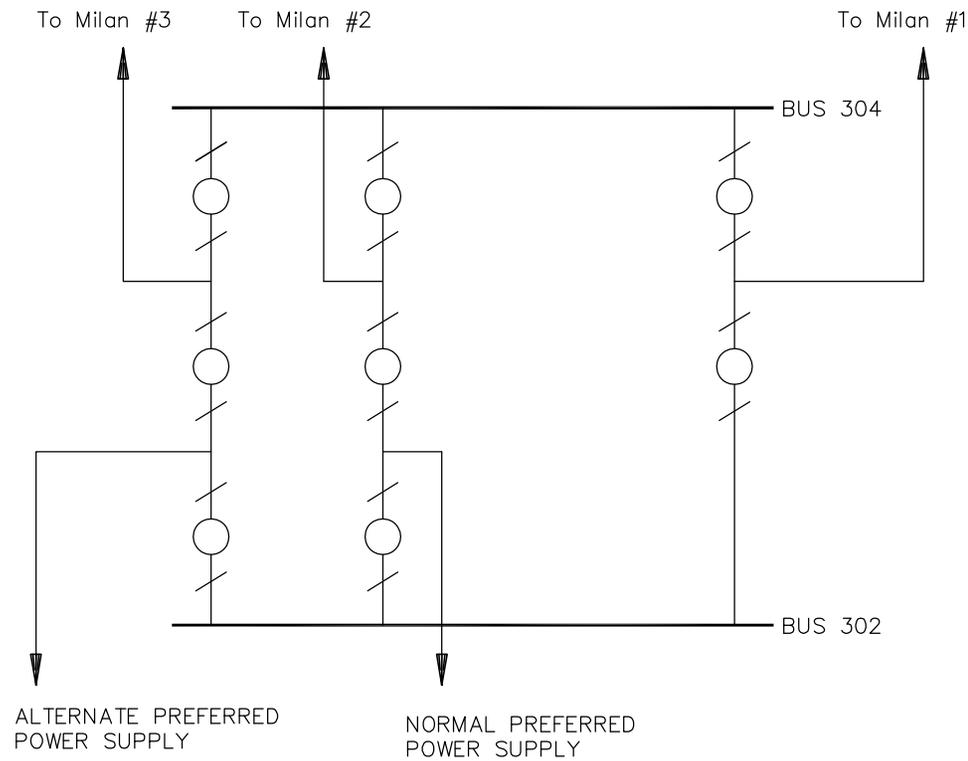
EF3 COL 8.2.4-6-A	8.2.4-6-A Switchyard DC Power This COL item is addressed in Subsection 8.2.1.2.1 .
EF3 COL 8.2.4-7-A	8.2.4-7-A Switchyard AC Power This COL item is addressed in Subsection 8.2.1.2.1 .
EF3 COL 8.2.4-8-A	8.2.4-8-A Switchyard Transformer Protection This COL item is addressed in Subsection 8.2.1.2.1 .
EF3 COL 8.2.4-9-A	8.2.4-9-A Stability and Reliability of the Offsite Transmission Power Systems This COL item is addressed in Subsection 8.2.2.1 .
EF3 COL 8.2.4-10-A	8.2.4-10-A Interface Requirements This COL item is addressed in Subsection 8.2.2.1 .

8.2.1 **References**

- 8.2-201 **ITC***Transmission, System Impact Study Report (MISO G867), "Generation Interconnection in Monroe County, MI", July 21, 2008.*

Figure 8.2-201 345 kV Switchyard Single-Line Diagram

[EF3 COL 8.2.4-1-A]

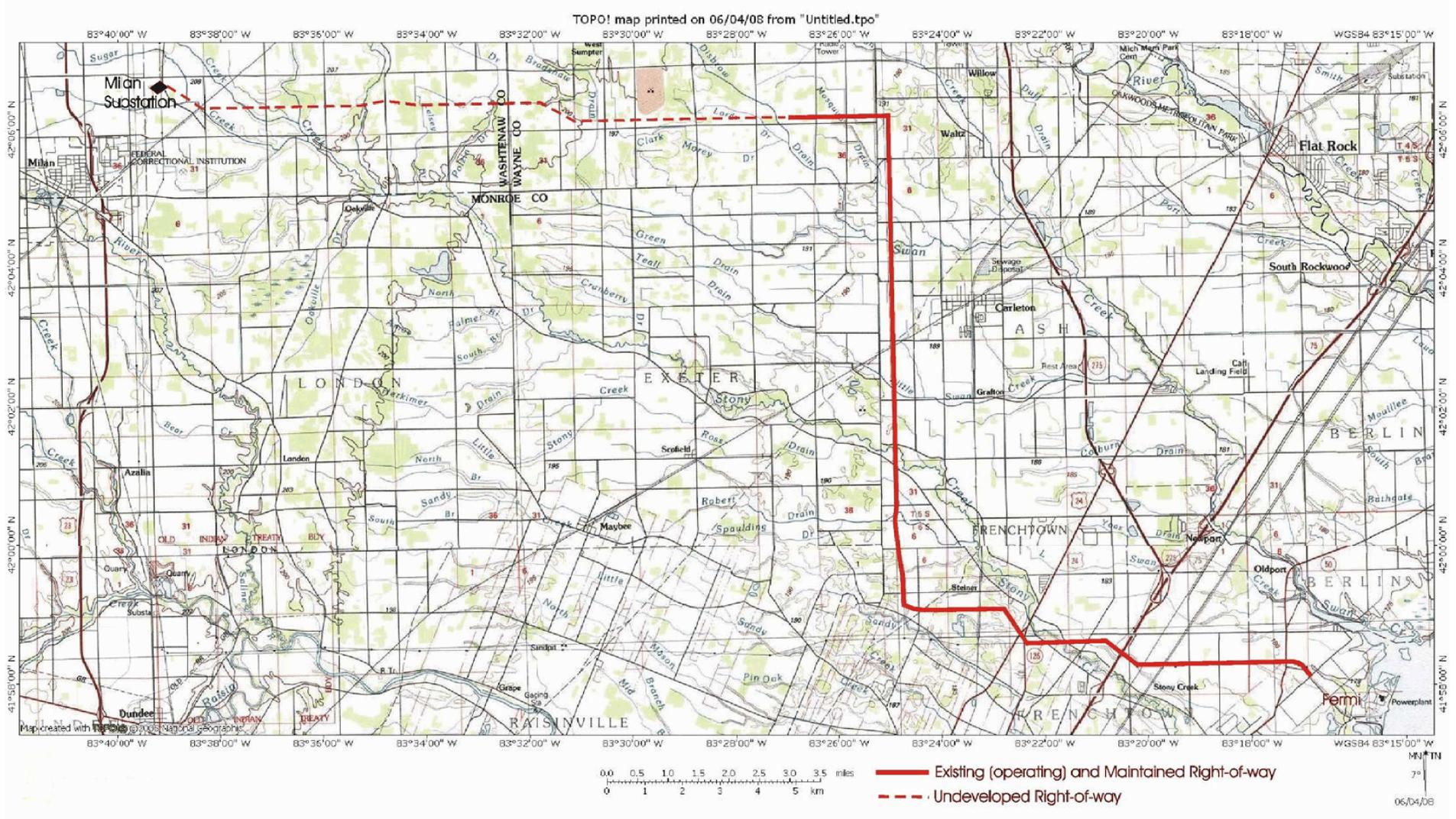


LEGEND:

-  HIGH VOLTAGE CIRCUIT BREAKER
-  DISCONNECT SWITCH

Figure 8.2-203 Transmission Line Map

[EF3 SUP 8.1-1]



8.3 Onsite Power Systems

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

8.3.2.1.1 Safety-Related Station Batteries and Battery Chargers

Replace the fourth paragraph of this section with the following.

EF3 COL8.3.4-1-A

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 station blackout 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](#).

Add the following paragraph at the end of this section.

EF3 SUP 8.3-2

Training and procedures to mitigate an SBO event are implemented in accordance with [Section 13.2](#) and [13.5](#), . As recommended by NUMARC 87-00 (Reference 8.3-201), SBO event mitigation procedures address SBO response (e.g., restoration of onsite standby power sources), AC power restoration (e.g., coordination with transmission system load dispatcher), and severe weather guidance (e.g., identification of sitespecific actions to prepare for the onset of severe weather such as an impending tornado), as applicable. 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](#), Station Blackout. 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
 - Either of the station diesel generators
-

- Restoration of any one of the three 345 kV transmission lines described in [Section 8.2](#).

8.3.4 **COL Information**

8.3.4-1-A **Safety Related Battery float and Equalizing Voltage Values**

EF3 COL 8.3.4-1-A This COL item is addressed in [Subsection 8.3.2.1.1](#).

Table 8.3-4R Safety-Related DC and UPS Nominal Component Data [EF3 COL 8.3.4-1-A]

<p>a. Batteries Two 250 VDC batteries per division, (two parallel strings of 120 lead acid cells per string and 240 cells per battery) 6000 Ah. per battery, 12,000 Ah per division (8 hour rate to 1.75 V/cell @77°F) and qualified to a 72 hour duty cycle.</p>
<p>b. Charger AC input -480 V AC, 3-phase, 60 Hz DC output -250 VDC, 500 A continuous -float voltage @77°F-267.6 VDC at the battery terminals -maximum equalizing charge voltage @77°F -288 VDC at the battery terminals</p>
<p>c. Uninterruptible Power Supply (UPS) i) Inverter -40 kVA with 250 VDC input and 120 V AC, 60 Hz output -AC output voltage regulation of ±1 % steady state -output frequency variation within ±0.1 % of nominal 60 Hz -total harmonic distortion <5%</p>

Notes:

(1) See [DCD Figures 8.1-3](#) and [8.1-4](#) for the configurations of the safety-related DC and UPS systems.

8.35 **References**

- 8.3-201 Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, NUMARC87-00, Revision 1, August 1991

Appendix 8A Miscellaneous Electrical Systems

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

8A.2.1 Description

Replace [DCD Section 8A.2.1](#) with the following.

EF3 COL 8A.2.3-1-A

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](#)).

8A.2.3 COL Information

8A.2.3-1-A Cathodic Protection System

EF3 COL 8A.2.3-1-A

This COL item is addressed in [Subsection 8A.2.1](#).
