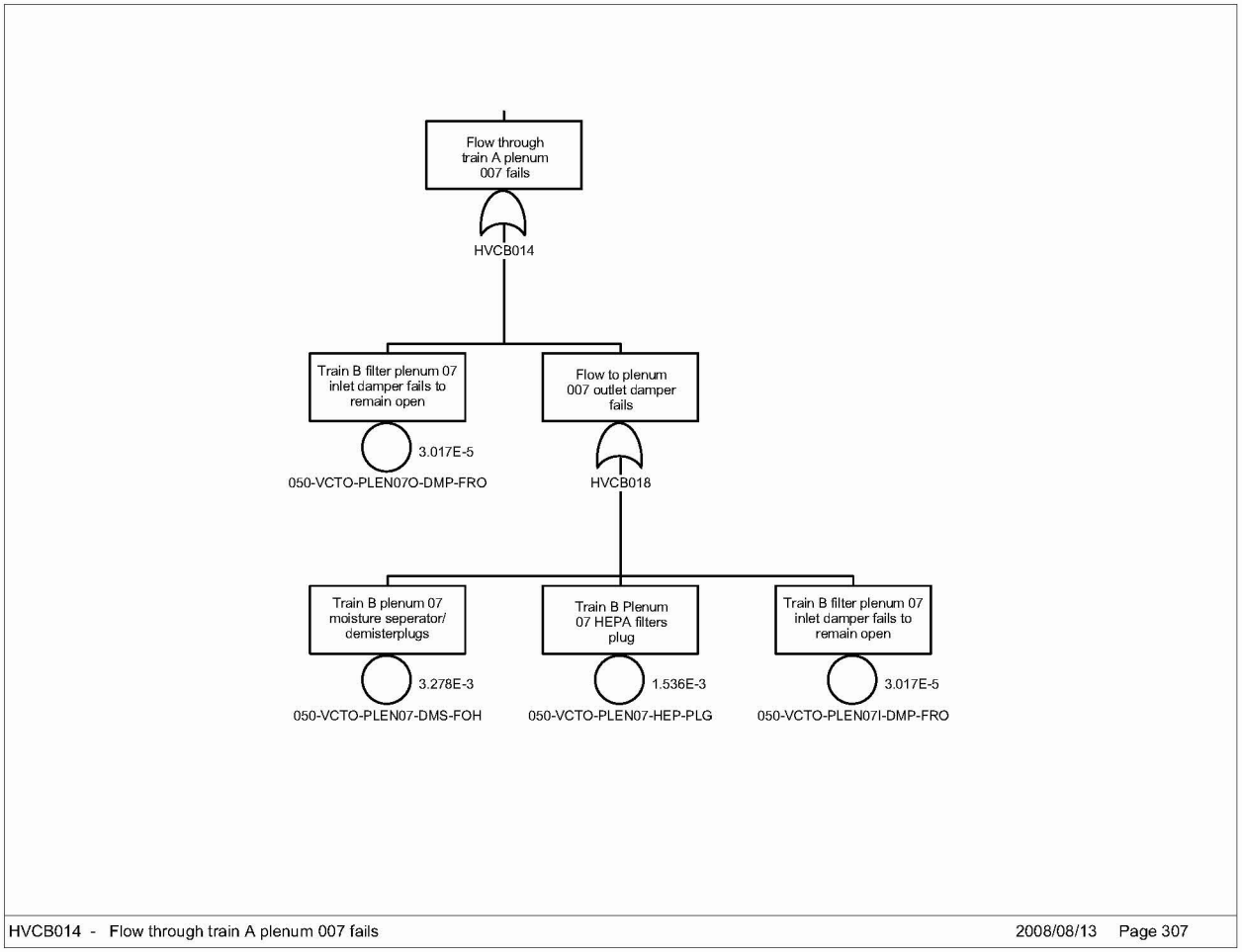
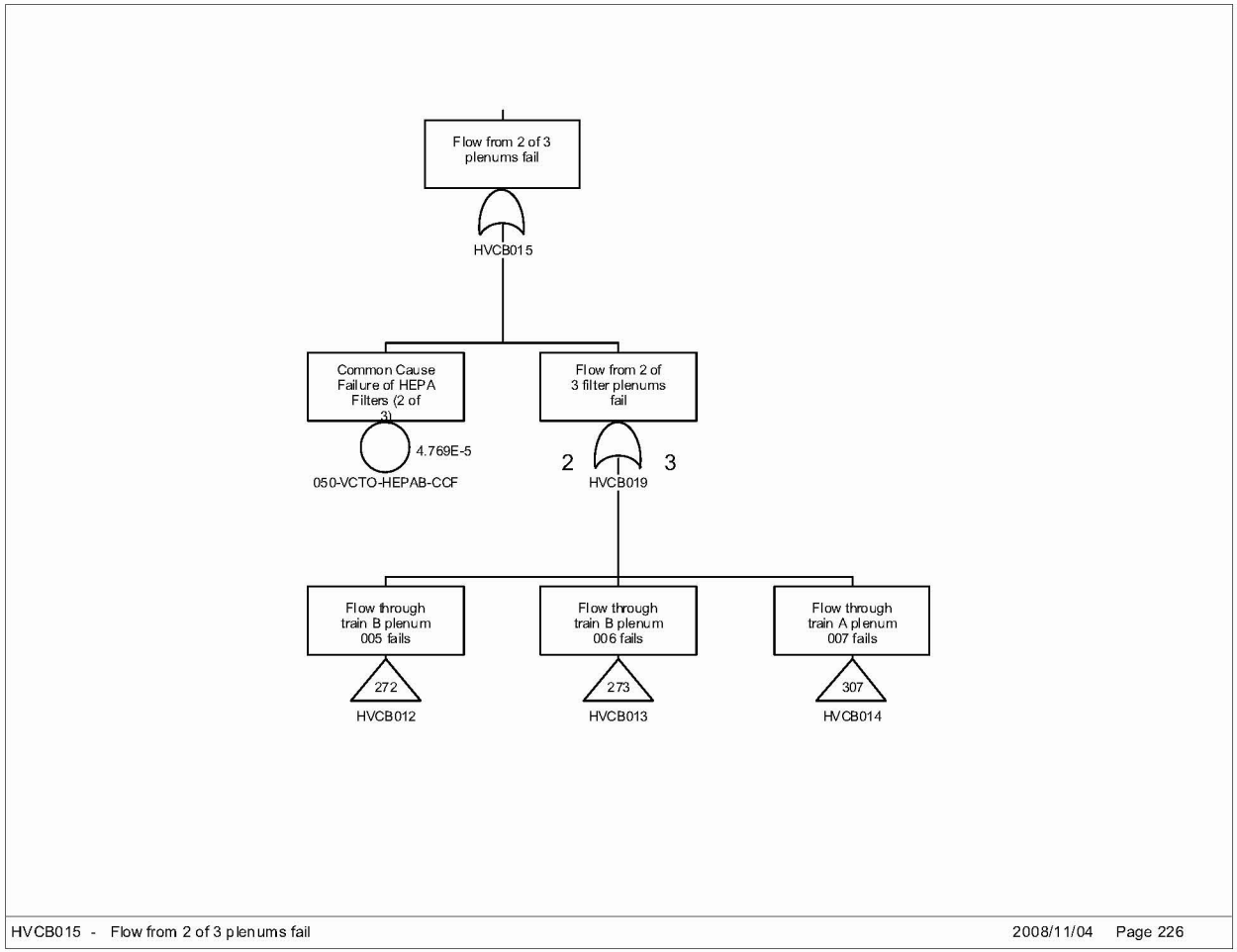
INTENTIONALLY LEFT BLANK



Source: Original

Figure B7.4-22. Flow Through Train B Plenum 007 Fails

INTENTIONALLY LEFT BLANK



Source: Original

Figure B7.4-23. Flow from 2 of 3 Plenums Fail

INTENTIONALLY LEFT BLANK

B8 IMPORTANT TO SAFETY ALTERNATING CURRENT POWER FAULT TREE ANALYSIS

B8.1 REFERENCES

Design Inputs

The PCSA is based on a snapshot of the design. The reference design documents are appropriately documented as design inputs in this section. Since the safety analysis is based on a snapshot of the design, referencing subsequent revisions to the design documents (as described in EG-PRO-3DP-G04B-00037, *Calculations and Analyses* (Ref. 2.1.1, Section 3.2.2.F)) that implement PCSA requirements flowing from the safety analysis would not be appropriate for the purpose of the PCSA.

The inputs in this Section noted with an asterisk (*) indicate that they fall into one of the designated categories described in Section 4.1, relative to suitability for intended use.

B8.1.1 BSC (Bechtel SAIC Company) 2008. *Normal Power System 13.8KV Site Distribution Overall Single Line Diagram*. 000-E10-EEN0-00202-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG. 20080206.0078.

B8.1.2 BSC 2008. *Emergency Diesel Generator Facility-13.8kV ITS Switchgear 26D-EEE0-SWGR-00001 Single Line Diagram (Train A)*. 26D-E10-EEE0-00101-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080204.0001.

B8.1.3 BSC 2008. *Emergency Diesel Generator Facility-13.8kV ITS Switchgear 26D-EEE0-SWGR-00002 Single Line Diagram (Train B)*. 26D-E10-EEE0-00201-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080204.0002.

B8.1.4 BSC 2007. *Emergency Diesel Generator Facility – 480V ITS MCC 26D-EEE0-MCC-00001 Single Line Diagram (Train A)*. 26D-E10-EEE0-00301-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071130.0026.

B8.1.5 BSC 2007. *Emergency Diesel Generator Facility – 480V ITS MCC 26D-EEE0-MCC-00002 Single Line Diagram (Train B)*. 26D-E10-EEE0-00401-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071130.0027.

B8.1.6 BSC 2007. *Emergency Diesel Generator Facility – ITS 125VDC System Single Line Diagram (Train A)*. 26D-E10-EED0-00101-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071026.0015.

B8.1.7 BSC 2007. *Emergency Diesel Generator Facility – ITS 125V DC System Single Line Diagram (Train B)*. 26D-E10-EED0-00201-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071026.0016.

B8.1.8 BSC 2007. *Emergency Diesel Generator Facility – Fuel Oil System Calculation*. 26D-M6C-EG00-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071025.0001.

B8.1.9 BSC 2007. *Emergency Diesel Generator Facility – Generator Room Ventilation System Calculation.* 26D-M5C-VNI0-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071015.0018.

B8.1.10 BSC 2007. *Emergency Diesel Generator Facility – Switchgear and Battery Rooms Ventilation System Calculation.* 26D-M5C-VNI0-00200-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071022.0001.

B8.1.11 BSC 2007. *Wet Handling Facility 480V ITS Load Center 050-EEE0-LC-00001 Train A Single Line Diagram.* 050-E10-EEE0-00301-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071116.0017.

B8.1.12 BSC 2007. *Wet Handling Facility 480V ITS Load Center 050-EEE0-LC-00002 Train B Single Line Diagram.* 050-E10-EEE0-00401-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071116.0018.

B8.1.13 BSC 2007. *Wet Handling Facility 480V ITS MCC 050-EEE0-MCC-00001 Train A Single Line Diagram.* 050-E10-EEE0-00101-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071116.0015.

B8.1.14 BSC 2007. *Wet Handling Facility 480V ITS MCC 050-EEE0-MCC-00002 Train B Single Line Diagram.* 050-E10-EEE0-00201-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071116.0016.

B8.1.15 *BSC 2007. *Wet Handling Facility Confinement ITS Electrical Room HVAC System - Train A Ventilation & Instrumentation Diagram.* 050-M80-VCT0-00301-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071010.0001.

B8.1.16 *BSC 2007. *Wet Handling Facility Confinement ITS Electrical Room HVAC System - Train B Ventilation & Instrumentation Diagram.* 050-M80-VCT0-00303-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071010.0003.

B8.1.17 BSC 2008. *Wet Handling Facility Confinement ITS Battery Room Exhaust System - Train A Ventilation & Instrumentation Diagram.* 050-M80-VCT0-00302-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080109.0018.

B8.1.18 BSC 2008. *Wet Handling Facility Confinement ITS Battery Room Exhaust System - Train B Ventilation & Instrumentation Diagram.* 050-M80-VCT0-00304-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080109.0019.

B8.1.19 *Eide, S.A.; Gentillon, C.D.; Wierman, T.E.; and Rasmuson, D.M. 2005. *Analysis of Loss of Offsite Power Events: 1986-2004.* Volume 1 of *Reevaluation of Station Blackout Risk at Nuclear Power Plants.* NUREG/CR-6890. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20071114.0164.

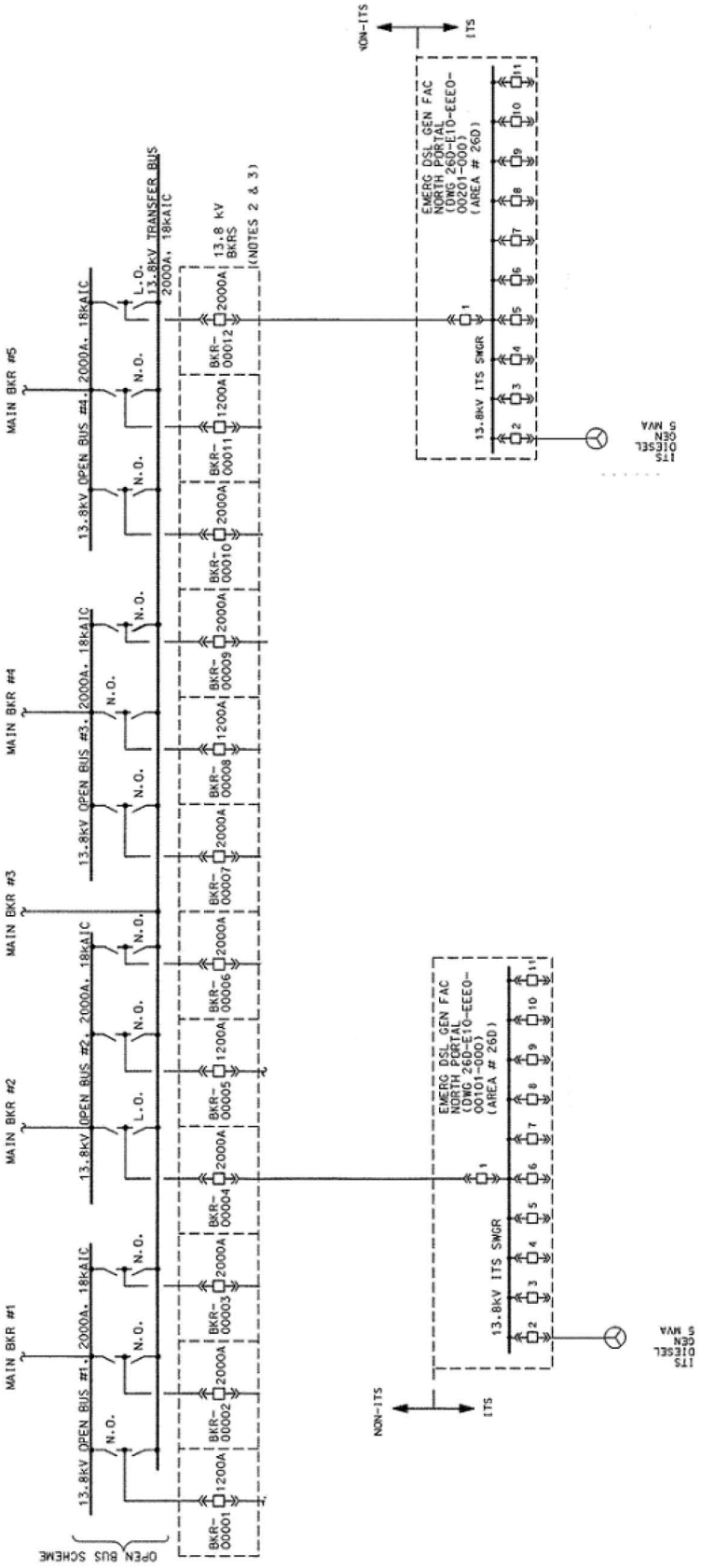
B8.2 IMPORTANT TO SAFETY ALTERNATING CURRENT POWER DESCRIPTION

The ITS AC power system supplies power to the ITS HVAC systems in the three CRCFs, the WHF, and RF. The ITS power system makes use of two elements: (1) the onsite ITS power supply and (2) the ITS equipment needed to supply power from the onsite ITS power supply to the ITS loads in each of the site facilities. During normal operations AC power is supplied from two offsite 138 kV power lines through the 138 kV to 13.8 kV switchyard and then through the plant AC power distribution system to the various facilities throughout the site. Off-normal conditions for the distribution of AC power occur during a loss of offsite power (LOSP). A LOSP may be the result of problems on the power grid, or the result of failures within the plant AC power systems (most likely within the 138 kV to 13.8 kV switchyard). Under these conditions, the AC power source for the WHF ITS equipment is two onsite ITS diesel generators. (There are several diesel generators located onsite. However there are only two generators designated as ITS; the two that support each division of ITS equipment (A or B) in the three CRCFs, the WHF and the RF.) Power is supplied to ITS loads via the same onsite AC power distribution system that is used during normal operation. Each ITS diesel generator supplies power to one division (A or B) of ITS systems. Each ITS diesel generator, its associate support systems and the power distribution system is independent, and electrically isolated, of the other diesel generator, its support systems and power distribution system.

B8.2.1 Normal AC Power Distribution

Normal AC power to the WHF ITS equipment is provided via two 13.8 kV ITS switchgears (A and B), one supplying WHF Train A ITS loads and the second supplying power to WHF Train B ITS loads. These two 13.8 kV ITS switchgears (Figures B8.2-1 through B8.2-3) are normally aligned to receive power from the site 138 kV to 13.8 kV switchyard though Open Buses 2 and 4.

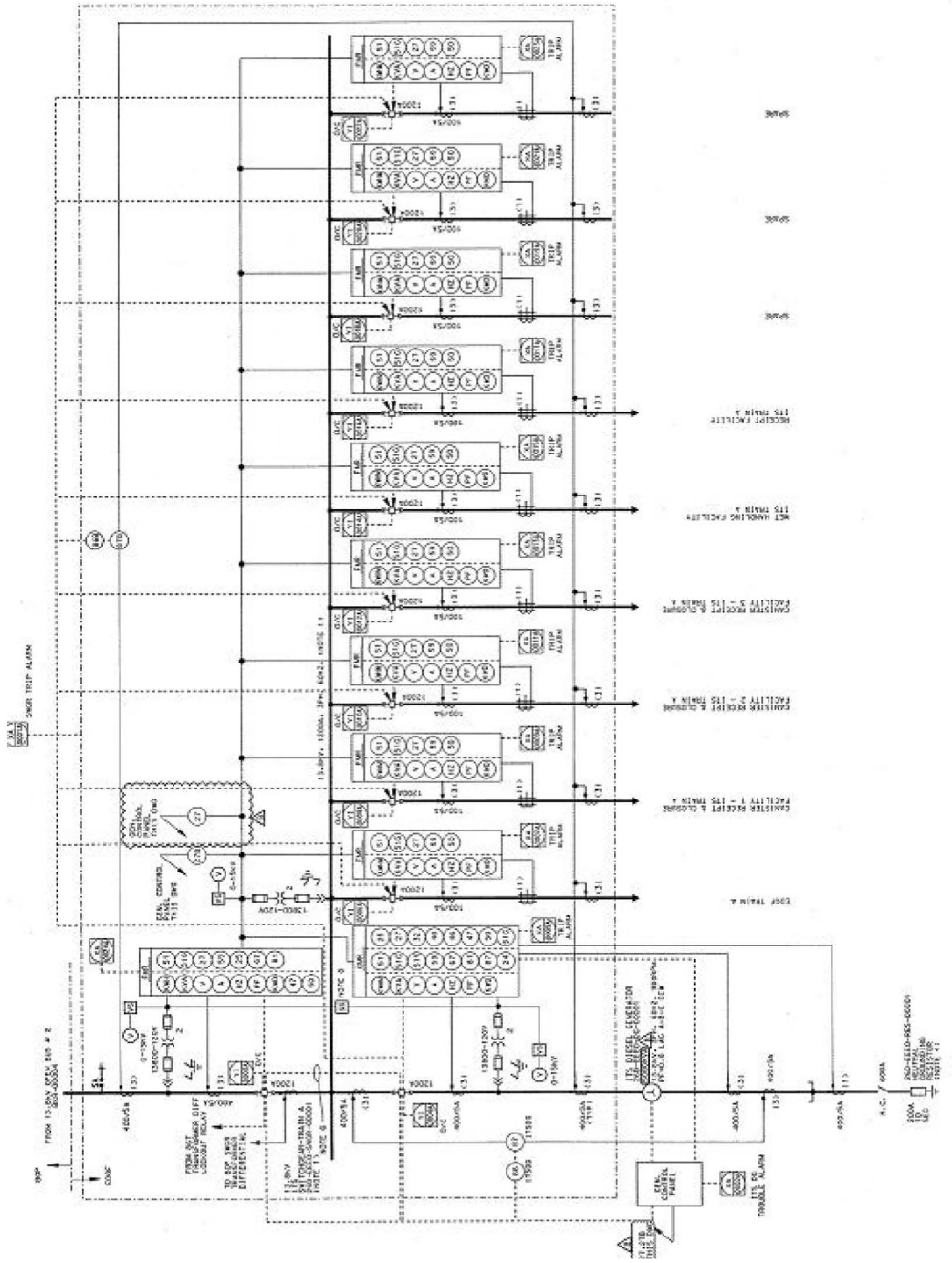
In addition to supplying power to the ITS loads in the WHF, the 13.8 kV ITS switchgear supplies power to equipment in the EDGF (Emergency Diesel Generator Facility) required to support ITS diesel generator operation. These loads include the diesel generator room fans, 13.8 kV ITS switchgear room and battery room AHU, the ITS diesel generator fuel oil pumps, and DC power (via a battery charger) to operate the ITS switchgear circuit breakers. (Figures B8.2-4 and B8.2-5 for ITS diesel generator Train A and Figures B8.2-6 and B8.2-7 for ITS diesel generator Train B).



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

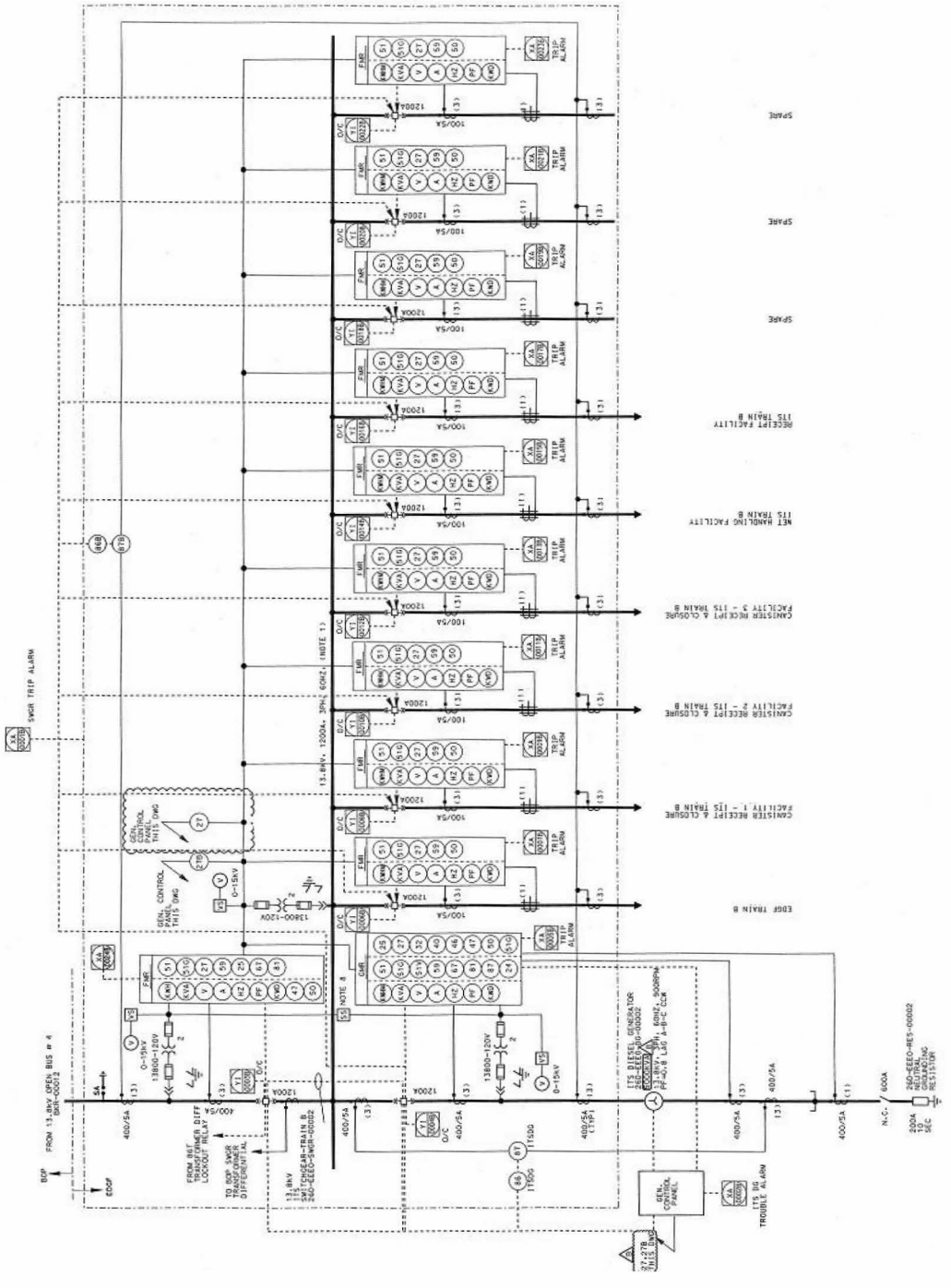
Source: Modified from Ref. B8.1.1

Figure B8.2-1. AC Power – Main Electrical Distribution



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.
Source: Ref. B8.1.2

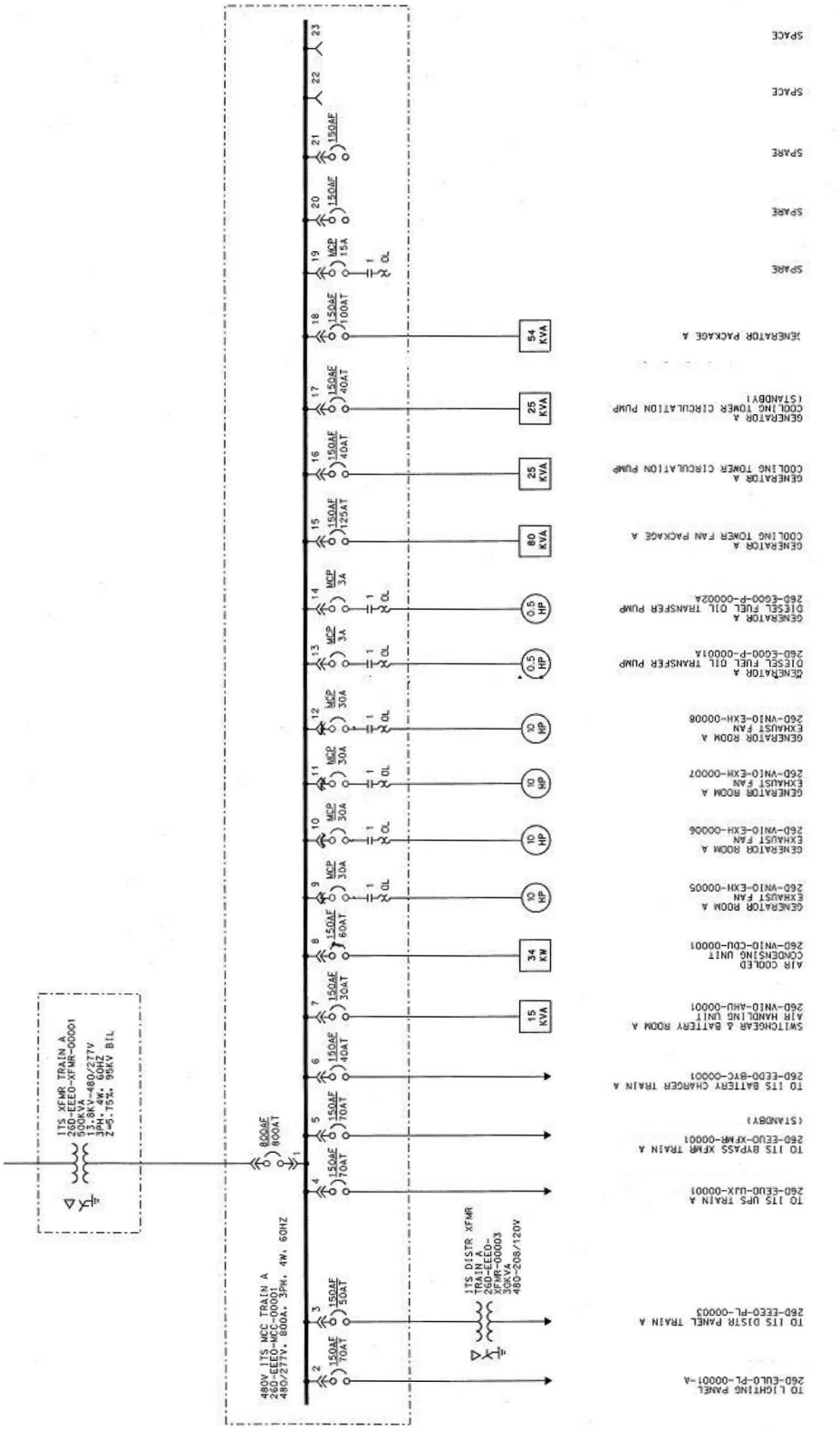
Figure B8.2-2. AC Power – 13.8 kV ITS Switchgear Train A



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.3

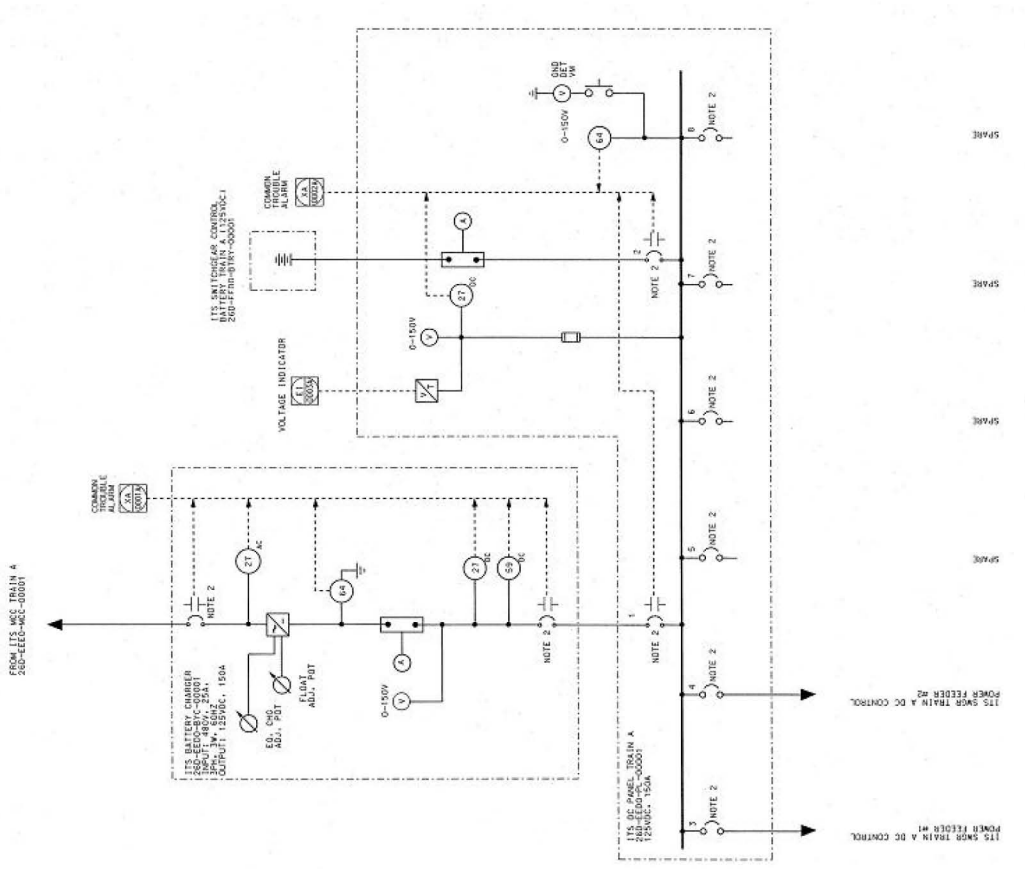
Figure B8.2-3. AC Power – 13.8 kV ITS Switchgear Train B



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.4

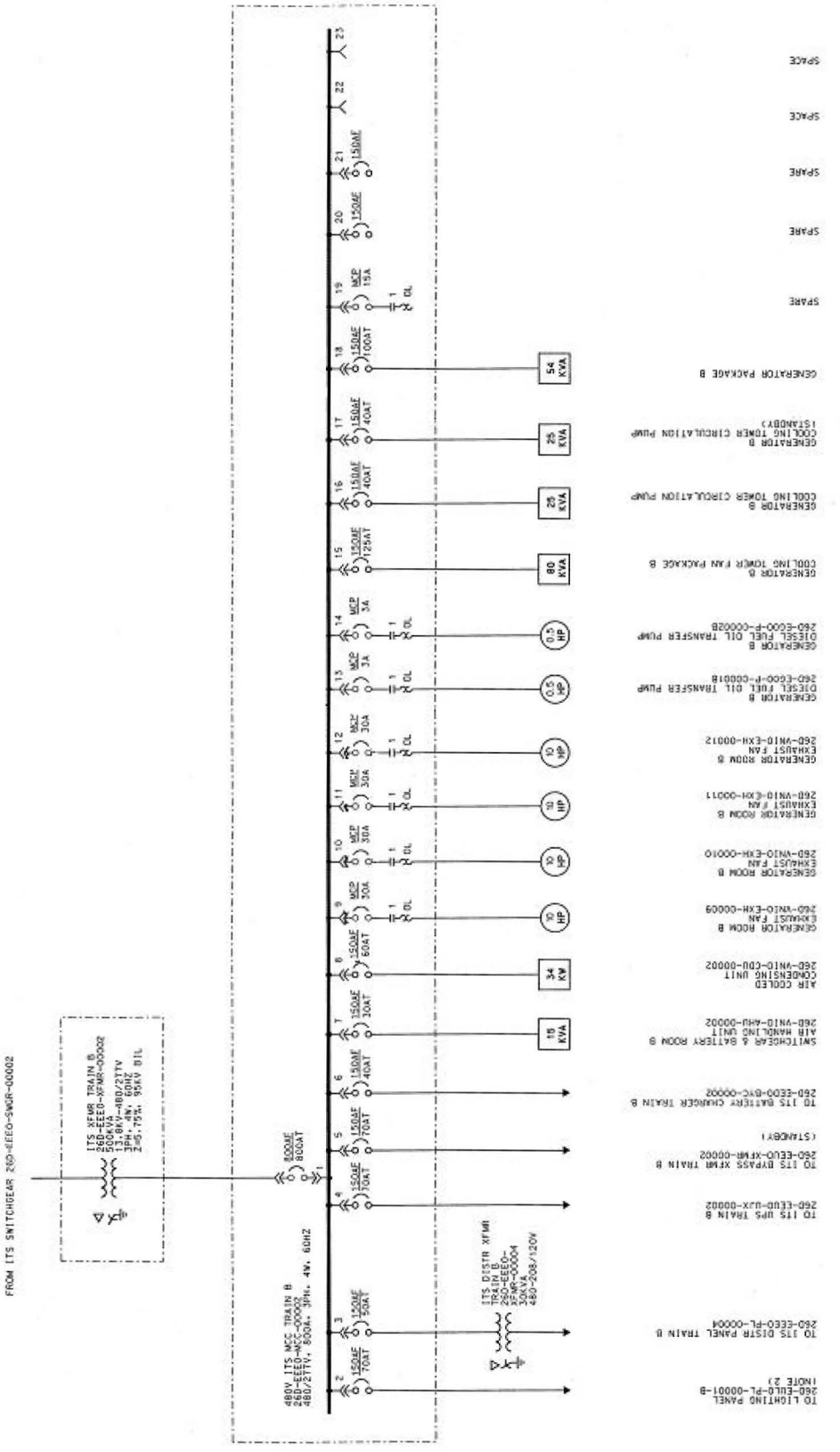
Figure B8.2-4. Emergency Diesel Generator Facility – 480 V ITS MCC Train A



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.6

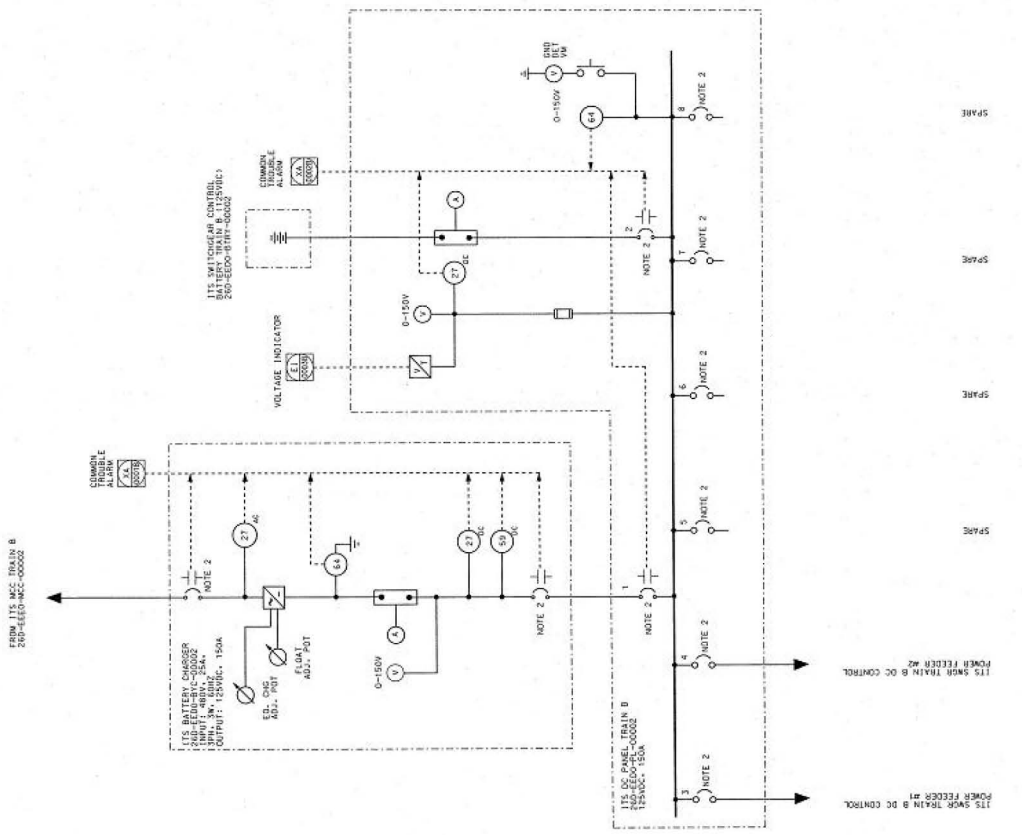
Figure B8.2-5. ITS 125 V DC System Train A



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.5

Figure B8.2-6. Emergency Diesel Generator Facility – 480 V ITS MCC Train B



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B.8.1.7

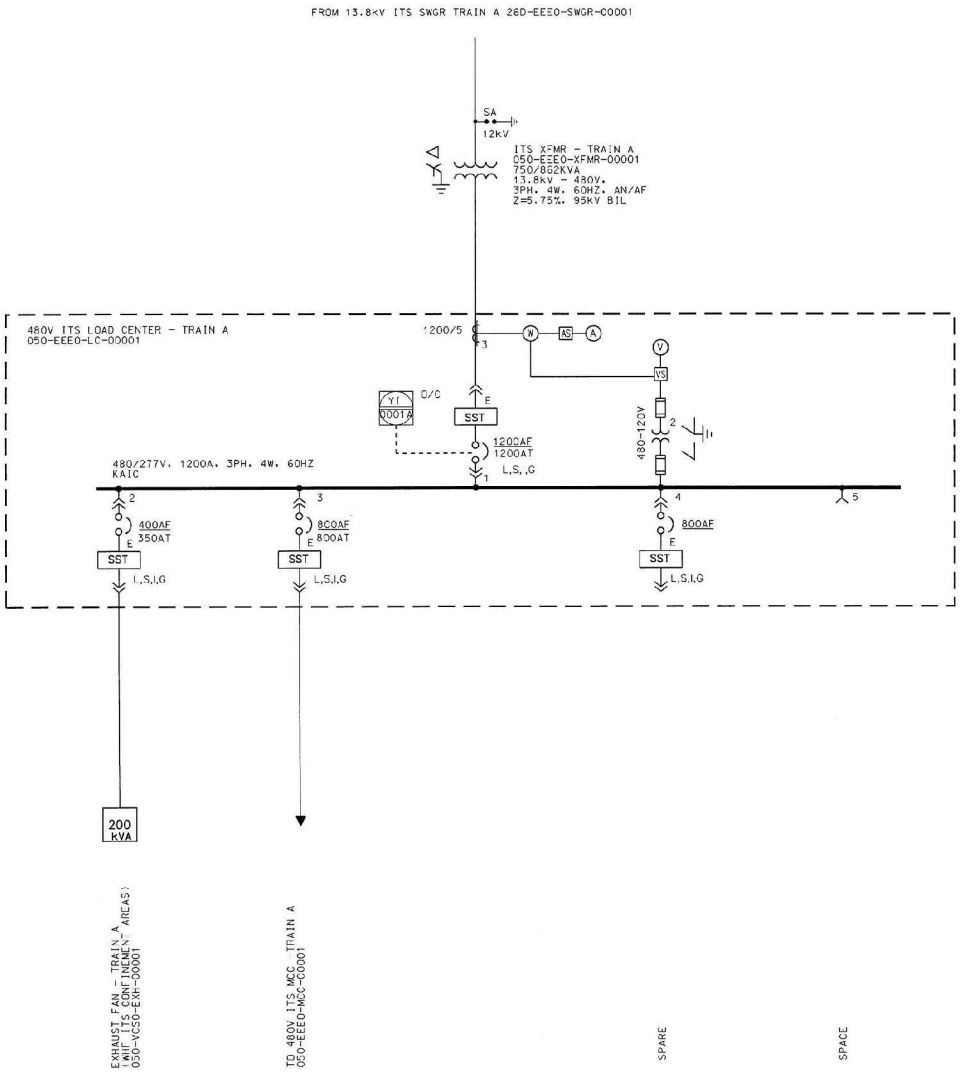
Figure B8.2-7. ITS 125 V DC System Train B

The ITS loads within the WHF are powered via two ITS 480/277 V load centers and ITS 480/277 V motor control centers (MCC) located within separate areas in the WHF. ITS 480/277 V Load Center Train A (Figure B8.2-8) and ITS 480/277 V MCC Train A (Figure B8.2-10) support Train A of the WHF ITS HVAC.

For the remainder of this attachment these will be referred to as ITS Load Center Train A and ITS MCC Train A.

The ITS 480/277 V Load Center Train B (Figure B8.2-9) and ITS 480/277V MCC Train B (Figure B8.2-11) support Train B of the WHF ITS HVAC.

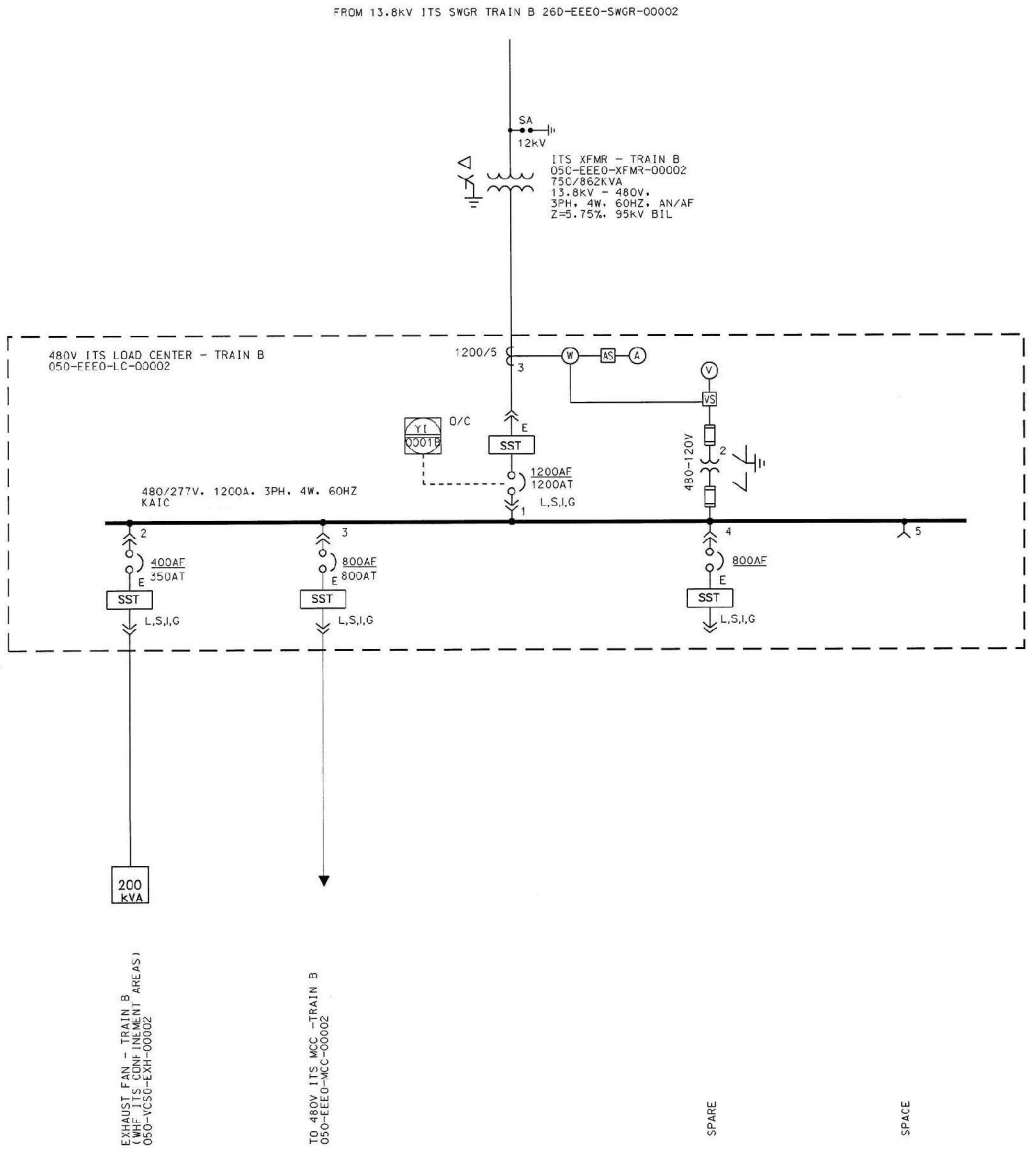
For the remainder of this attachment these will be referred to as ITS Load Center Train B and ITS MCC Train B. Each division of the AC power supply from the 13.8 kV ITS switchgears to the WHF ITS equipment passes through a 13.8 kV to 480 V transformer (Figures B8.2-8 through B8.2-11).



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.11

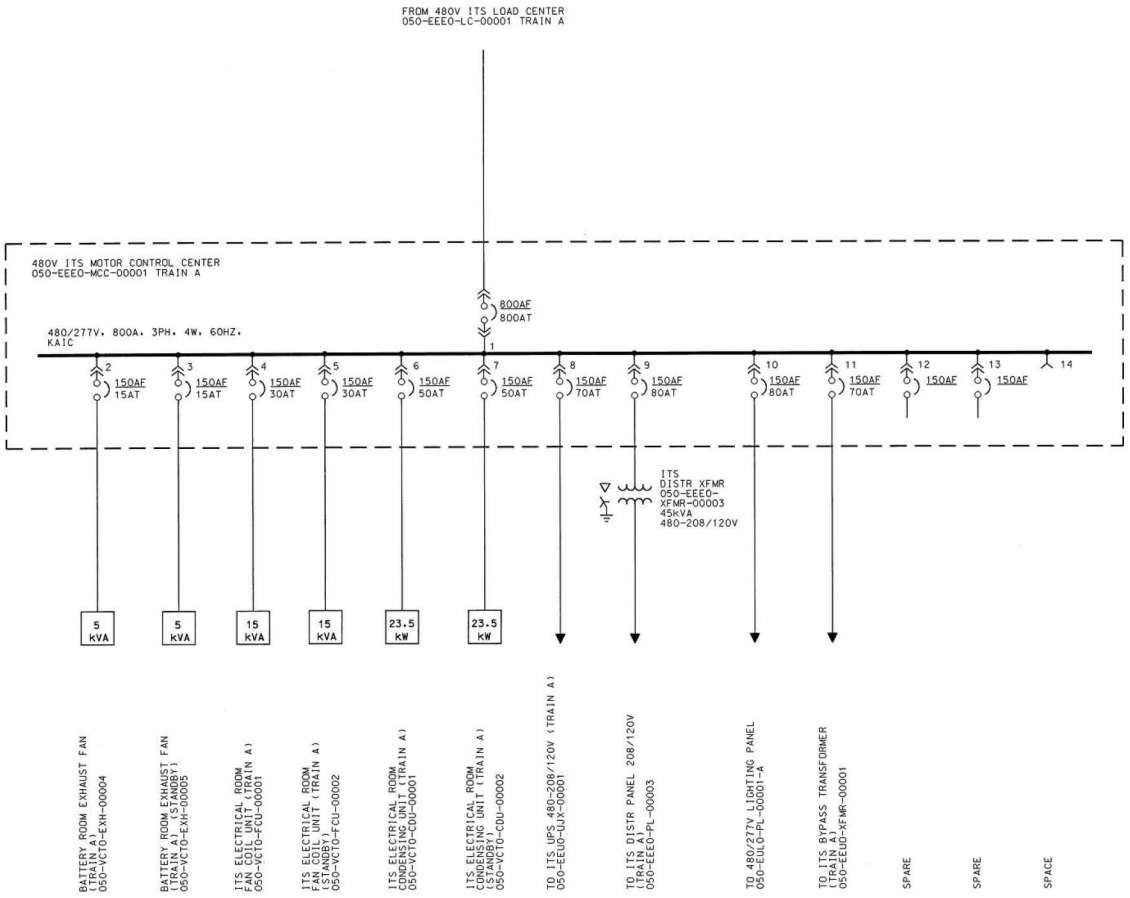
Figure B8.2-8. WHF 480 V ITS Load Center Train A



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.12

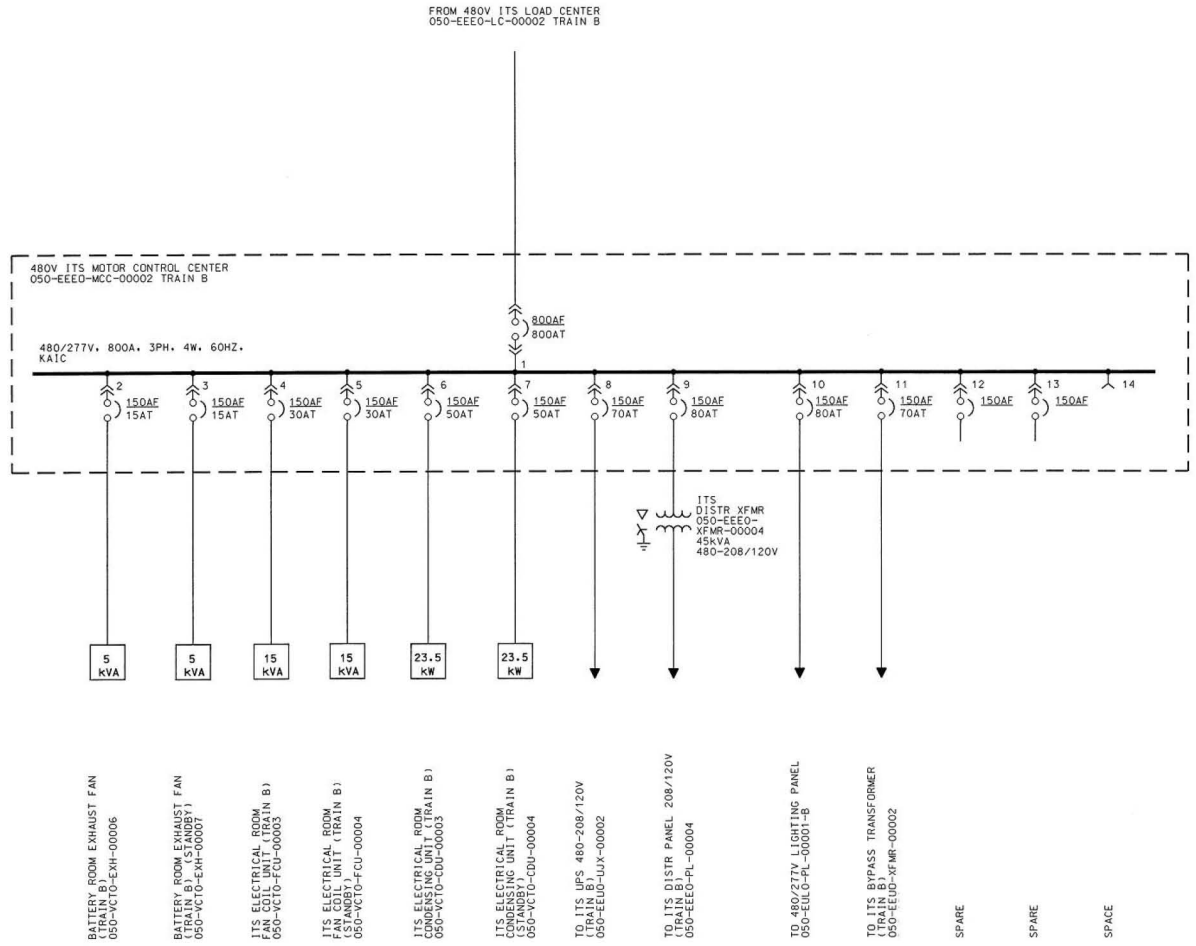
Figure B8.2-9. WHF 480 V ITS Load Center Train B



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.

Source: Ref. B8.1.13

Figure B8.2-10. WHF 480 V ITS MCC Train A



NOTE: Legibility of figure does not affect technical content of the document. See source for detail.

Source: Ref. B8.1.14

Figure B8.2-11. WHF 480 V ITS MCC Train B

B8.2.2 ITS Onsite AC Power

The ITS power supply system is intended to provide back-up power to selected buildings and operations in the event of LOSP. A LOSP could result from a loss of power on the offsite power grid or a failure within the site 138 kV to 13.8 kV switchyard. This portion of the ITS power supply system consists of two identical divisions of ITS diesel generator supplied AC power. The primary components in each division include: a diesel generator, support systems for the diesel generator, and a load sequencer.

Both ITS diesel generators are located in the EDGF. Each is sized to provide sufficient 13.8 kV power to support all of the ITS loads in one ITS switchgear (A or B) in six facilities (three CRCFs, the WHF, the RF, and the EDGF). The ITS diesel generator starts upon detection of an under-voltage condition via an under voltage relay of the 13.8 kV ITS switchgear. The

switchyard to switchgear feeder breaker also trips open upon detection of this undervoltage condition. Each ITS diesel generator is equipped with a complete set of support systems including HVAC systems, uninterruptible power supply (UPS) and DC power systems, a fuel oil system, diesel generator start subsystem, diesel generator cooling subsystem, and lube oil subsystem that are separate and independent from the support system for the other ITS diesel generator.

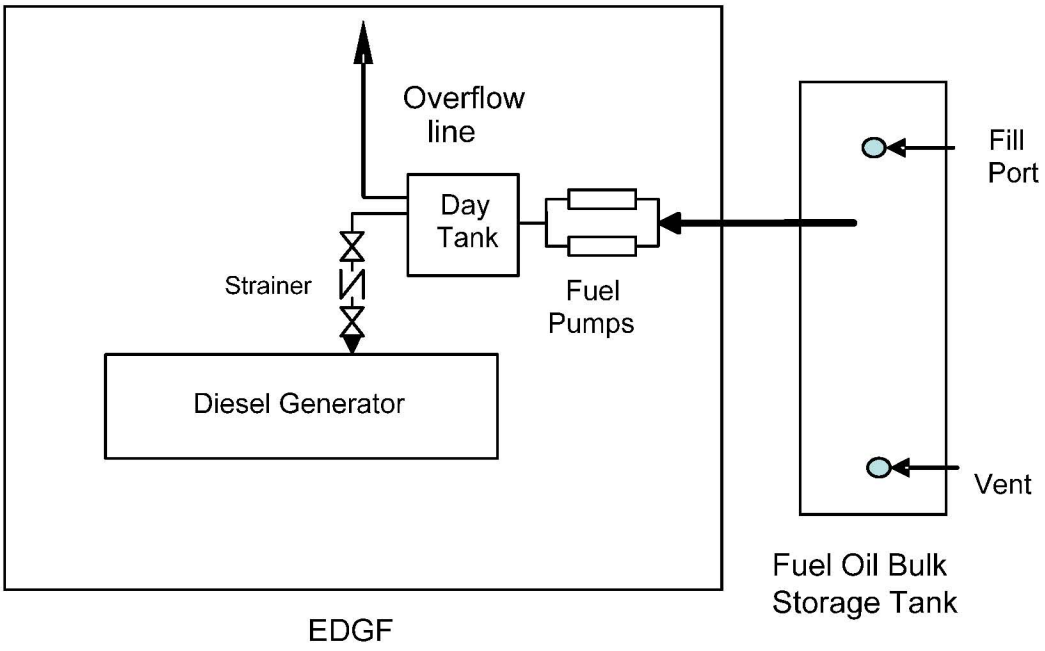
The EDGF is divided into several areas/rooms supporting the two trains of ITS AC power. Separate HVAC systems are provided for each room. The HVAC for the 13.8 kV ITS Switchgear Room and Battery Room for each train of the ITS power system includes an AHU and two exhaust fans for each battery room for both air flow and temperature control (Ref. B8.1.10). The system for each of the ITS Diesel Generator Rooms consists of four exhaust fans, as maintaining air flow is sufficient to maintain room temperature within the ITS diesel generator operational limits. All four fans must operate to maintain an acceptable temperature within the ITS Diesel Generator Room (Ref. B8.1.9).

The 125 V DC power system (one for each ITS division) provides the essential power needed to operate (open/close) the medium voltage circuit breakers on the ITS switchgears. The UPS supports the ITS diesel generator control system. The UPS is not included in the ITS AC power model. A UPS is generally very reliable and the inclusion of this support system would not noticeably impact the ITS AC power system failure rate. The DC power for each division of the ITS power supply in the EDGF is supplied by a single battery. The battery is continuously charged through a single battery charger powered (through a transformer and the 480 V ITS MCC, 26D-EEE0-MCC-00001) from the 13.8 kV ITS switchgear (Figures B8.2-5 and B8.2-7).

Each ITS diesel generator fuel oil system consists primarily of a bulk storage tank, two fuel pumps, and a day tank (Figure B8.2-12). The bulk storage tank, located outside of the EDGF, has a capacity sufficient to operate the ITS diesel generator for two weeks. Each fuel pump is sized to be capable of providing sufficient makeup flow to the day tank once the level in the day tank has dropped to a one hour supply for the ITS diesel generator, and to refill the tank while the ITS diesel generator is running. The day tank, located within the EDGF, has a capacity to support four hours of ITS diesel generator operation (Ref. B8.1.8).

The lube oil subsystem, the diesel generator cooling subsystem, and the starting subsystem are considered to be part of the diesel generator and their failures are not modeled as separate events in the fault trees.

The load sequencer controls the sequence of events that occur after a LOSP and the diesel generator starts. Upon a LOSP, and after the diesel generator starts and reaches its rated capacity, the load sequencer connects the diesel generator to the 13.8 kV ITS switchgear and then reconnects all division ITS loads, including the WHF ITS loads.

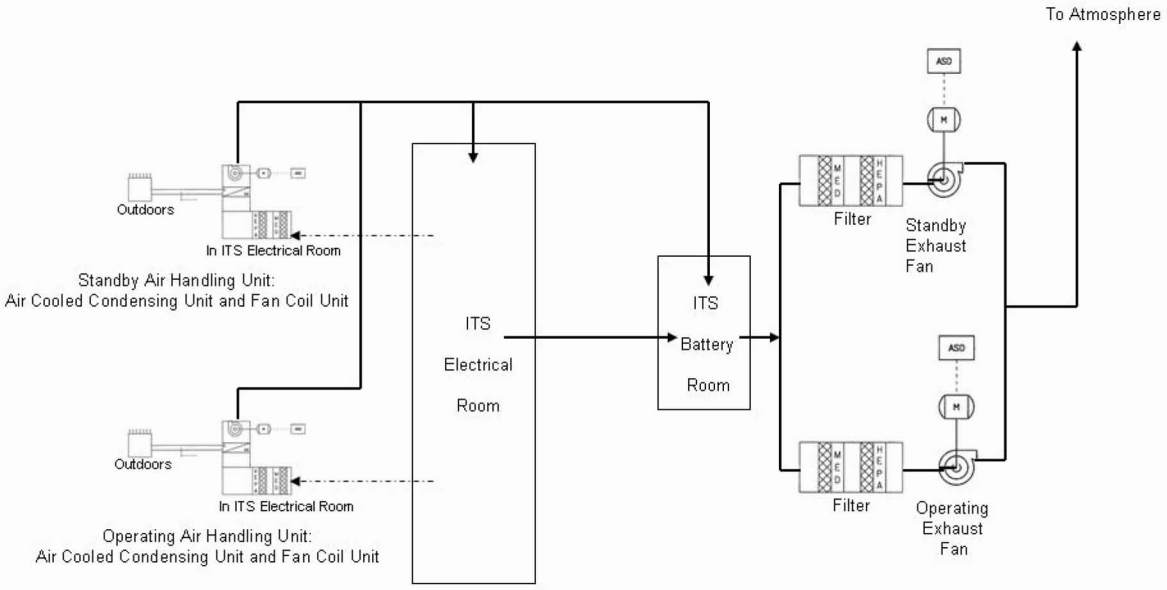


NOTE: EDGF = Emergency Diesel Generator Facility.

Source: Modified from Ref. B8.1.8

Figure B8.2-12. ITS Diesel Generator Fuel Oil System

Within the WHF, ventilation and cooling for the ITS Electrical Rooms and ITS Battery Rooms is provided by a dedicated ventilation system. A separate ventilation train is provided for each train of ITS Electrical/Battery Rooms. Each train consists of two AHUs (each consisting of an air cooled condensing unit and a fan coil unit), two exhaust fans and associated ducting and instrumentation (Fig B8.2-13). Each AHU and exhaust fan is rated at 100% capacity. Two AHUs, one in each train (air cooled condensing units 50-VCT0-CDU-00001 and 50-VCT0-CDU-00003 and fan coil units 50-VCT0-FCU-00001 and 50-VCT0-FCU-00003) are normally operating while the second one in each train (air cooled condensing units 50-VCT0-CDU-00002 and 50-VCT0-CDU-00004 and fan coil units 50-VCT0-FCU-00002 and 50-VCT0-FCU-00004) is normally in standby. Similarly, two exhaust fans, one in each train, (exhaust fan 50-VCT0-EXH-00004 and 50-VCT0-EXH-00006) are normally operating while the second one in each train (exhaust fan 50-VCT0-EXH-00005 and 50-VCT0-EXH-00007) is normally in standby ((Ref. B8.1.15), (Ref. B8.1.16), (Ref. B8.1.17), and (Ref. B8.1.18)).



NOTE: Legibility of figure does not affect technical content of the document. Details are found in the source document.
ITS = important to safety.

Source: Ref. B8.1.15, Ref. B8.1.16, Ref. B8.1.17, and Ref. B8.1.18

Figure B8.2-13. Simplified Diagram of Representative Train of WHF ITS Electrical and ITS Battery Rooms Ventilation System

B8.2.3 ITS AC Power Normal Operations

Under normal operating conditions, AC power is supplied from two 138 kV offsite power lines. Power is passed through the 138 kV to 13.8 kV switchyard with the two independent 13.8 kV ITS switchgears. From here, power is transmitted to two 13.8 kV to 480 V transformers, one supporting division A and one supporting division B of the WHF. Power to individual ITS equipment within each facility is provided via the ITS load centers and ITS MCCs (one of each for division A and division B).

The AC power system is normally operating, but one division at a time may be taken out of service for maintenance. With one division out of service, only one division of the supported ITS systems can be considered to be operable.

B8.2.4 ITS AC Power Off-Normal Operations

The off-normal condition of interest for the ITS AC power system is a LOSP. During a LOSP, both ITS diesel generators are required to start and accept loads in a timely manner. Upon a LOSP, the onsite power distribution system supporting ITS loads is disconnected from the switchyard; a circuit breaker between the 13.8 kV ITS switchgear and the switchyard in each division automatically opens. Both diesel generators start automatically and are connected to the 13.8 kV ITS switchgear when the connecting breaker is closed by the load sequencer. The load sequencer then reconnects the WHF loads to the 13.8 kV ITS switchgear. Both diesel generators continue to supply AC power until normal power is restored.

B8.2.5 ITS AC Power Testing and Maintenance

The normal AC power system is operated continuously. Maintenance would be performed on an as needed basis. The diesel generators and supporting subsystems are normally in a standby mode. Routine tests are performed to ensure that the ITS diesel generator can start and load, in the event of a loss of normal power, including during a LOSP event.

Requirements

The ITS diesel generators and their associated support components (start systems, lube oil, HVAC) are tested monthly on a staggered basis.

Features

Normal maintenance is performed in accordance with manufacturer's recommendations.

Maintenance outages that remove a division of ITS AC power from operation are limited to one week.

B8.2.5.1 Fault Trees

Requirements:

The fault tree model for the ITS AC power system includes: (1) those components that have been declared as ITS and (2) those AC power distribution system components whose failure would require the ITS AC power system to perform. The ITS power system includes components that are normally in standby (e.g., the diesel generator) and components that are normally in operation. The portions of the normal AC power distribution system modeled include the AC power distribution system from the 13.8 kV ITS switchgear to the facility ITS load centers.

The mission time for the ITS AC power system is set to 720 hours. This is based on the mission time requirement for the WHF HVAC system following the potential breach of a waste canister.

B8.2.5.1.2 Design Feature

Common-cause failures have been included for sixteen events. Six are associated with ITS diesel generator operation: two for the ITS diesel generators (e.g., failure to start or run) themselves and four for the pair of fuel pumps (e.g., failure to start and run for each pair) that support each ITS diesel generator. Three more are associated with the failure to open/close of the circuit breakers that disconnect the 13.8 kV ITS switchgear from the normal offsite power supply, the ITS load center feed breakers, and the breakers that connect the ITS diesel generators to the 13.8 kV ITS switchgear. Six are associated with the WHF Confinement ITS Electrical and Battery Rooms ventilation system: one each for the failure to start and run the system standby exhaust fans, one for the failure to run the operating exhaust fans, one each for the failure to start and run the standby AHUs, and one for the failure to run the operating AHUs. The final CCF event modeled is associated with the WHF 13.8 kV to 480 V ITS transformers. Additional detail about the treatment of CCF failures can be found in Attachment C.

Four human error conditions are incorporated into the model (details are provided in Section B.8.4 of this attachment). All four address the failure to properly restore portions of the system to operable status following maintenance.

The ITS diesel generator lube oil, cooling systems, and start subsystems are considered to be part of the diesel generator and are not modeled as separate systems.

B8.3 DEPENDENCIES AND INTERACTIONS

Dependencies are broken down into five categories with respect to their interactions with structures, systems, and components. The five areas considered are addressed in Table B8.3-1 with the following dependencies:

1. Functional dependence
2. Environmental dependence
3. Spatial dependence
4. Human dependence
5. Failures based on external events.

Table B8.3-1. Dependencies and Interactions Analysis

Structures, Systems, and Components	Dependencies & Interactions				
	Functional	Environ-mental	Spatial	Human	External Events
ITS Diesel Generators	Start systems, load sequencer	EDGF diesel Generator Room HVAC	—	Test and maintenance	—
13.8 kV ITS Switchgear	ITS diesel generator, WHF 13.8 kV to 480 V ITS transformers	EDGF Switchgear Room HVAC	—	Test and maintenance	Offsite power
ITS Load Centers and MCCs	ITS diesel generator, 13.8 kV ITS switchgear	WHF ITS AC Power Room Ventilation	—	Test and maintenance	Offsite power
AC Load Breakers	EDGF DC power system	—	—	Test and maintenance	
WHF 13.8 V to 480 V ITS Transformers	ITS diesel generator, 13.8 kV ITS switchgear	—	—	Test and maintenance	Offsite power
WHF ITS AC Power Room Ventilation	WHF ITS MCCs	—	—	Test and maintenance	—

NOTE: EDGF = Emergency Diesel Generator Facility; HVAC = heating, ventilation, and air conditioning; ITS = important to safety; MCC = motor control centers; WHF = Wet Handling Facility.

Source: Original

B8.4 IMPORTANT TO SAFETY ALTERNATING CURRENT POWER FAILURE SCENARIOS

For the WHF the ITS AC power system has two credible failure scenarios:

1. Loss of AC Power to WHF ITS Load Center Train A. Failure to provide power to the WHF ITS HVAC system Train A powered by ITS Load Center Train A.

2. Loss of AC Power to WHF ITS Load Center Train B. Failure to provide power to the WHF ITS HVAC system Train B powered by ITS Load Center Train B.

B8.4.1 Loss of AC Power to WHF ITS Load Center Train A

B8.4.1.1 Description

WHF confinement following the potential breach of a waste canister is provided, in part, by the WHF ITS HVAC system. The ITS AC power system provides the power needed to operate the ITS HVAC system equipment. This fault tree models the components that are required to provide AC power from either the normal offsite power supplies or from ITS Diesel Generator A to ITS Load Center Train A.

B8.4.1.2 Success Criteria

Success criteria for this train of the ITS AC power system is providing AC power from either the normal power system, or from the ITS diesel generator (Diesel Generator A) to the ITS HVAC division powered through WHF ITS Load Center Train A. The AC power system must operate in support of the ITS HVAC system for as long as necessary to successfully provide confinement after the potential release of material from a breached canister. Therefore, the mission time (i.e., the period for which ITS AC power must be supplied to the ITS HVAC system) is the same for the ITS AC power system as it is for the ITS HVAC system, 720 hours.

B8.4.1.3 Design Features and Requirements

Requirements

Each ITS diesel generator has support systems that are independent from the support system for the other diesel generator. Independent support systems include:

- Fuel oil systems
- HVAC systems to include the ITS diesel generator room and 13.8 kV ITS switchgear room systems
- Lube oil system
- ITS diesel generator cooling systems
- Diesel generator start system.

Features

The 13.8 kV ITS switchgear is isolated from the main switchyard upon a loss of power in the switchyard, either due to a LOSP or from failures within the switchyard.

The WHF load is shed from the 13.8 kV ITS switchgear upon a loss of power indication.

A load sequencer controls the loading of the diesel generator onto the 13.8 kV ITS switchgear upon the ITS diesel generator reaching rated output. The same load sequencer controls reloading the WHF loads onto the ITS AC power system.

Environmental systems are provided to maintain the temperature in the various EDGF rooms within acceptable levels. This includes a fan system for the diesel generator room and an AHU for the 13.8 kV ITS Switchgear and Battery Room.

B8.4.1.4 Fault Tree Model

The top event in this fault tree is "Loss of AC Power to WHF ITS Load Center Train A." This is defined as a failure of normal and ITS on-site power to ITS Load Center Train A. Faults considered in the evaluation of this top event include: failure of components in the normal AC

power system, failure of the ITS diesel generator, human events that can contribute to onsite system failures resulting in a power loss at the WHF and a LOSP.

In industrial applications such as this, electrical energy is transmitted using various conductor configurations that include bus ducts which are conductor bars assembled with insulators in grounded enclosures and insulated wires that may be run in one of several forms between electrical devices. These forms include in metal or plastic pipe, called a conduit or they can be laid in cable trays or rectangular raceways having lids. These passive structural components isolate and support the electrical conductor and are not considered contributors to failure of the electrical distribution system just as failure of the floor an electrical motor sets on would not be considered a contributor to failure mechanisms associated with the motor. Failures of these structural components could be contributors to failures during a seismic event, however, the data is not parsed to that level and for this analysis it is given that the electrical distribution system fails during any significant seismic event with the failure mechanisms contributing to the electrical distribution system failure not specifically delineated. For non-seismic events, random failures of these passive structural components have not been included in the system analysis.

In this fault tree offsite power is not modeled as an initiating event, but as a system failure. The value used for this event represents the probability that offsite power is lost in the 720 hours following a possible radioactive release from a damaged canister.

B8.4.1.5 Basic Event Data

Table B8.4-1 contains a list of basic events used in the "Loss of AC Power to WHF ITS Load Center Train A" fault tree. Included are component failures, maintenance errors and the human and CCF events identified in the previous two sections. The data, for both random and CCFs used to develop the failure probabilities associated with these basic events, comes from the component reliability data analysis (Attachment C). Human reliability analyses (Attachment E) provide the probabilities for the human events.

Mission times for the various components are based on the following:

- Fault exposure time (168 hours) for events limited to one week maintenance outages (train out of service (OOS) for maintenance).
- Mission time (360 hours) for operation of standby equipment that would operate after a LOSP (i.e., distribution of the occurrence of an LOSP is evenly distributed over the 720 hrs after a potential radiological release, average mission time is therefore 360 hours), and average fault-exposure time for standby components tested monthly.
- Mission time (720 hours) for operating components.

While some of the components are normally in operation, it is possible for any of the components to be OOS for maintenance. With Train A of AC power OOS (resulting in Train A of the facility ITS HVAC being OOS), Train B provides support to an operable ITS HVAC Train B. The intent of the maintenance events modeled is for the events to address maintenance on any component in that AC power division. This is true for the components normally in operation and

the standby components. The maintenance unavailability represented by the ITS load center maintenance events model the unavailability of any component from the 13.8 kV ITS switchgear through the ITS load center. The maintenance unavailability represented by the ITS diesel generator maintenance events represent the unavailability of any of the components or systems that would prevent the ITS diesel generator from starting and loading onto the 13.8 kV ITS switchgear. As noted earlier, all of the human events are associated with the failure to restore a component to operable or standby status after maintenance. The operator-related events shown in the following table are combinations events: they include the probability that the component has been taken OOS for maintenance and that site personnel have not restored the component to operable or standby status. A screening value of 0.1 has been used for the HEP in all cases.

Table B8.4-1. Basic Event Probability for the Loss of AC Power to WHF ITS Load Center Train A Fault Tree

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
050-#EEE-LDCNTRA-BUA-FOH	WHF Load Center A Fails	3	4.391E-04	—	6.100E-07	7.200E+02
050-#EEE-LDCNTRA-BUA-MTN	ITS Load Center Train A OOS for Maintenance	3	1.025E-04	—	6.100E-07	1.680E+02
050-#EEE-LDCNTRA-BUA-ROE	Failure to Restore ITS Load Center Train A post maint	1	1.025E-05	1.025E-05	—	—
050-#EEE-LDCNTRA-C52-FOD	Load Center A feed breaker Fails to Reclose	1	2.240E-03	2.240E-03	—	—
050-#EEE-LDCNTRA-C52-SPO	Load Center A Feed Circuit Breaker Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
050-#EEE-LDCNTRB-BUA-MTN	ITS Load Center Train B OOS for Maintenance	3	1.025E-04	—	6.100E-07	1.680E+02
050-#EEE-LDCNTRB-BUA-ROE	Failure to Restore ITS Load Center Train B post maint	1	1.025E-05	1.025E-05	—	—
050-#EEE-LDCNTRS-C52-CCF	Common cause failure of the ITS Load Center feed breakers to reclose	C	1.053E-04	—	—	—
050-#EEE-WHFITSA-XMR-CCF	WHF ITS Transformers CCF	C	4.923E-06	—	—	—
050-#EEE-WHFITSA-XMR-FOH	WHF ITS Transformer Train B Failure	3	2.095E-04	—	2.910E-07	7.200E+02
050-#EEE-MCC0001-C52-SPO	WHF ITS MCC 0001 Feed Breaker Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
050-#EEE-MCC0001-MCC-FOH	WHF ITS MCC 00001 Fails	3	5.378E-03	—	7.490E-06	7.200E+02
050-VCT0-AHU0001-AHU-FTR	WHF ITS Elec AHU 00001 Fails to run	3	2.732E-03	—	3.800E-06	7.200E+02
050-VCT0-AHU0001-CTL-FOD	WHF ITS Elec AHU 00001 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-AHU0002-AHU-FTR	WHF ITS ELec AHU 00002 Fails to Run	3	2.732E-03	—	3.800E-06	7.200E+02
050-VCT0-AHU0002-CTL-FOD	WHF ITS Elec AHU 00002 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-AHU0002-FAN-FTS	WHF ITS Elec AHU 00002 Fails to Start	1	2.020E-03	2.020E-03	—	—
050-VCT0-AHU0103-AHU-CCR	CCF of the running WHF ITS Elec AHUs to continue to run	C	6.421E-05	—	—	—
050-VCT0-AHU0202-AHU-CCR	CCF of standby WHF ITS Elec AHUs to run	C	6.421E-05	—	—	—
050-VCT0-AHU0202-AHU-CCS	CCF of standby WHF ITS Elec AHUs to start	C	9.494E-05	—	—	—
050-VCT0-EXH-004-CTL-FOD	WHF ITS Elec Exh Fan 00004 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-EXH-004-FAN-FTR	WHF ITS Elec Exhaust Fan 00004 Fails to Run	3	5.059E-02	—	7.210E-05	7.200E+02
050-VCT0-EXH-005-CTL-FOD	WHF ITS Elec Exh fan 00005 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-EXH-005-FAN-FTR	WHF ITS Elec Exhaust Fan 00005 Fails to Run	3	5.059E-02	—	7.210E-05	7.200E+02

Table B8.4-1. Basic Event Probability for the Loss of AC Power to WHF ITS Load Center Train A Fault Tree (Continued)

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
050-VCT0-EXH-005-FAN-FTS	WHF ITS Elec Exh Fan 00005 Fails to Start	1	2.020E-03	2.020E-03	—	—
050-VCT0-EXH-007-FAN-FTS	WHF ITS Elec Exh fan 00007 Fails to Start	1	2.020E-03	2.020E-03	—	—
050-VCT0-EXH0406-FAN-CCR	CCF of running Exh fans for WHF ITS Elec.	C	1.189E-03	—	—	—
050-VCT0-EXH0507-FAN-CCF	CCF to run: standby Exh fans for the WHF ITS Elec	C	1.189E-03	—	—	—
050-VCT0-EXH0507-FAN-CCR	CCF to start; standby Exh fans for the WHF ITS Elec	C	9.494E-05	—	—	—
26D-##EG-DAYTNKA-TKF-FOH	ITS DG A Day Tank (00002A) Fails	3	1.584E-04	—	4.400E-07	3.600E+02
26D-##EG-FLITLKA-IEL-FOD	ITS DG A fuel transfer pumps Interlock Failure	1	2.750E-05	2.750E-05	—	—
26D-##EG-FTP1DGA-PMD-FTR	ITS DG A Fuel Transfer Pump Fails to Run	3	1.234E-02	—	3.450E-05	3.600E+02
26D-##EG-FTP1DGA-PMD-FTS	ITS DG A Fuel Pump 1A Fails to Start	1	2.500E-03	2.500E-03	—	—
26D-##EG-FTP2DGA-PMD-FTR	ITS DG A Fuel Transfer Pump 2A Fails to Run	3	1.234E-02	—	3.450E-05	3.600E+02
26D-##EG-FTP2DGA-PMD-FTS	ITS DG A Fuel Transfer Pump 2A Fails to Start	1	2.500E-03	2.500E-03	—	—
26D-##EG-FULPMPA-PMD-CCR	Common cause failure of ITS DG A fuel pumps to run	C	2.901E-04	—	—	—
26D-##EG-FULPMPA-PMD-CCS	Common cause failure of ITS DG A fuel pumps to start	C	1.175E-04	—	—	—
26D-##EG-STRTDGA-C72-SPO	ITS switchgear A Battery Circuit Breaker (DC) Spur Op	3	3.851E-04	—	1.070E-06	3.600E+02[d]
26D-##EG-WKTNK_A-TKF-FOH	ITS DG A Bulk Fuel Tank (00001A) Fails	3	1.584E-04	—	4.400E-07	3.600E+02
26D-##EGBATCHRGA-BYC-FOH	ITS Switchgear A Battery: Battery Charger failue	3	1.276E-03	—	7.600E-06	1.680E+02[c]
26D-#EEE-SWGRDGA-BUA-FOH	13.8kV ITS Switchgear A Failure	3	4.391E-04	—	6.100E-07	7.200E+02
26D-#EEESWGRDGA-AHU-FTR	13.8kV ITS Switchgear room Air Handling Unit Fails	3	2.732E-03	—	3.800E-06	7.200E+02
26D-#EEG-HVACFA1-FAN-FTR	ITS DG A room Fan 1 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-#EEG-HVACFA1-FAN-FTS	ITS DG A room Fan 1 (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-#EEG-HVACFA2-FAN-FTR	ITS DG A room Fan 2 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-#EEG-HVACFA2-FAN-FTS	ITS DG A room Fan 2 (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-#EEG-HVACFA3-FAN-FTR	ITS DG A room Fan 3 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02

Table B8.4-1. Basic Event Probability for the Loss of AC Power to WHF ITS Load Center Train A Fault Tree (Continued)

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
26D-#EEG-HVACFA3-FAN-FTS	ITS DG A room Fan 3 (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-#EEG-HVACFA4-FAN-FTR	ITS DG A room Fan 4 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-#EEG-HVACFA4-FAN-FTS	ITS DG A room Fan 4 (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-#EEU-208_DGA-BUD-FOH	ITS DC Panel A DC Bus Failure	3	8.640E-05	—	2.400E-07	3.600E+02[d]
26D-#EEY-DGALOAD-C52-FOD	ITS DG A Load Breaker (AC) Fails to Close	1	2.240E-03	2.240E-03	—	—
26D-#EEY-DGLOADS-C52-CCF	Common cause failure of ITS DG Load Breakers to close	C	1.053E-04	—	—	—
26D-#EEY-ITSDG-A-#DG-FTR	ITS Diesel Generator A Fails to Run	3	7.698E-01	—	4.080E-03	3.600E+02
26D-#EEY-ITSDG-A-#DG-FTS	Diesel Generator Fails to Start	1	8.380E-03	8.380E-03	—	—
26D-#EEY-ITSDG-A-#DG-MTN	ITS DG A OOS Maintenance	1	1.950E-03	1.950E-03	—	—
26D-#EEY-ITSDG-A-#DG-RSS	Failure to properly return ITS DG A to service	1	1.950E-04	1.950E-04	—	—
26D-#EEY-ITSDG-B-#DG-MTN	ITS DG B OOS Maintenance	1	1.950E-03	1.950E-03	—	—
26D-#EEY-ITSDG-B-#DG-RSS	Failure to properly restore ITS DG-B to service	1	1.950E-04	1.950E-04	—	—
26D-#EEY-ITSDGAB-#DG-CCR	CCF ITS DG A & B Fail to Run	C	1.809E-02	—	—	—
26D-#EEY-ITSDGAB-#DG-CCS	CCF DG A and B to Start	C	3.939E-04	—	—	—
26D-#EEY-OB-SWGA-C52-FOD	13.8kV ITS SWGR feed breaker (AC) Fails to open	1	2.240E-03	2.240E-03	—	—
26D-#EEY-OB-SWGA-C52-SPO	13.8kV ITS SWGR A feed Breaker Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
26D-#EEY-OB-SWGS-C52-CCF	Common cause failure of 13.8kV ITS SWGR feed breakers to open	C	1.053E-04	—	—	—
26D-#EG-LCKOUTRL-RLY-FTP	13.8kV ITS Switchgear Feed breaker lockaout relay fails to Open CB	3	3.152E-03	—	8.770E-06	3.600E+02
26D-#EGLDSQNCRA-SEQ-FOD	DG A Load Sequencer Fails	1	3.330E-03	3.330E-03	—	—
26D-EG-BATTERYA-BTR-FOD	ITS Switchgear A Battery No Output Given Challenge	1	8.200E-03	8.200E-03	—	—
27A-#EEE-BUS2DGA-C52-SPO	13.8kV Open Bus 2 ITS Load Breaker Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
27A-#EEN-OPENBS2-BUA-FOH	13.8kV Open Bus 2 Bus Failure	3	4.391E-04	—	6.100E-07	7.200E+02

Table B8.4-1. Basic Event Probability for the Loss of AC Power to WHF ITS Load Center Train A Fault Tree (Continued)

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
27A-#EEN-OPNBS1A-SWP-SPO	13.8kV Open Bus 2 to ITS Div A Electric Power Switch Spur. Xfer	3	1.116E-04	—	1.550E-07	7.200E+02
LOSP*	Loss of offsite power	1	2.990E-03	2.990E-03	—	—

NOTE: [a]For Calc. Type 3 with a mission time of 0, SAPHIRE performs the quantification using the system mission time. See Table 6.3-1 for definitions of calculation types.
[b]The designation of a circuit breaker as AC or DC refers to the system designation for the circuit breaker, it is not representative of the motive power for the circuit breaker.
[c]The failure of the battery charger would result in eventual depletion of the battery and a low power indication on both the battery and the DC bus. The 168 hr mission time was selected as a conservative estimation for the detection time of this failure.
[d]The mission times for the DC bus related failure rates do not take credit for any monitoring of bus status, which would provide nearly instantaneous indication of a bus failure or loss of power to the bus. The standby component mission time was used conservatively.
LOSP* represents the probability of losing offsite power during the 720 hours HVAC is required after any breach of a container releases radioactive material. It is based on a loss of offsite power frequency of 3.59E-02/year from NUREG/CR6890 (Ref. B8.1.19, Table ES-1).

AHU = air handling unit; Calc. = calculation; CCF = common-cause failure; DG = diesel generator; Div = division; elec = electrical; exh = exhaust; ITS = important to safety; MCC = motor control center; OOS = out of service; Spur = spurious; WHF = Wet Handling Facility; Xfer = transfer.

Source: Original

B8.4.1.5.1 Human Failure Events

Six basic HFEs (Table B8.4-2) are associated with human error. All of the HFEs are associated with the failure to properly restore components to operable status following maintenance. The first two shown in Table B8.4-2 are associated with the failure to restore the normal power supply to the WHF ITS load centers after maintenance. The last two are representative of the failure to restore the ITS diesel generators (and any other components that would prevent the ITS diesel generator from starting or loading) to service after maintenance. These events are combination events consisting of the probability that a component was removed for maintenance and the failure of plant operators (assigned a screening value of 0.1) to restore the component after maintenance.

Table B8.4-2. Human Failure Events

Name	Description
050-#EEE-LDCNTRA-BUA-ROE	Failure to Restore ITS Load Center Train A post maint
050-#EEE-LDCNTRB-BUA-ROE	Failure to Restore ITS Load Center Train B post maint
26D-#EEY-ITSDG-A-#DG-RSS	Failure to properly return ITS DG A to service
26D-#EEY-ITSDG-B-#DG-RSS	Failure to properly return ITS DG-B to service
26D-#EEY-ITSDG-A-#DG-MTN	ITS DG A OOS Maintenance
26D-#EEY-ITSDG-B-#DG-MTN	ITS DG B OOS Maintenance

NOTE: DG = diesel generator; ITS = important to safety; maint = maintenance; OOS =out of service.

Source: Original

B8.4.1.5.2 Common-Cause Failures

Fourteen of the sixteen CCFs identified earlier (Section B8.2.5.1.2) have been included in the analysis of the loss of ITS AC power to the ITS Load Center Train A. Twelve of the CCF events affect both trains of ITS AC power. Two affect only this train of the system. The remaining two affect only the other train of the system. Two are associated with the ITS diesel generators: CCF of the ITS diesel generators to start and CCF of the ITS diesel generators to run. The CCF of the ITS diesel generator fuel oil system incorporates two CCFs: CCF of the two fuel oil pumps to start and the CCF of the pumps to run. Three circuit breaker CCF events were considered. These are the CCF of: (1) 13.8 kV ITS switchgear feed breakers (from 13.8 kV open buses) to open on LOSP, (2) ITS diesel generator load breakers to close when commanded by the load sequencer, and (3) ITS load center feed breakers to close when commanded by the load sequencer. Six CCFs are associated with the WHF ITS Electrical and Battery Rooms' ventilation system, two for the CCF of standby exhaust fans (one to start and one to run), one for the CCF of the running exhaust fan to continue to run, two for the CCF of the standby AHUs (one to start and one to run), and one for the CCF of the running AHU to continue to run. The last CCF event considered is the CCF of the 13.8 kV to 480 V ITS transformers.

Table B8.4-3. Common-Cause Basic Events

Name	Description	Alpha-factor
050-#EEE-LDCNTRS-C52-CCF	Common cause failure of the ITS Load Center feed breakers to reclose	0.0235
050-#EEE-WHFITSA-XMR-CCF	WHF ITS Transformers CCF	0.047
26D-##EG-FULPMPA-PMD-CCR	Common cause failure of ITS DG A fuel pumps to run	0.0235
26D-##EG-FULPMPA-PMD-CCS	Common cause failure of ITS DG A fuel pumps to start	0.047
26D-#EEY-DGLOADS-C52-CCF	Common cause failure of ITS DG Load Breakers to close	0.047
26D-#EEY-ITSDGAB-#DG-CCR	CCF ITS DG A & B Fail to Run	0.0235
26D-#EEY-ITSDGAB-#DG-CCS	CCF DG A and B to Start	0.047
26D-#EEY-OB-SWGS-C52-CCF	Common cause failure of 13.8kV ITS SWGR feed breakers to open	0.047
050-VCT0-AHU0103-AHU-CCR	CCF of the running WHF ITS elec AHUs to continue to run	0.0235
050-VCT0-AHU0202-AHU-CCR	CCF of standby WHF ITS Elec AHUs to continue to run	0.0235
050-VCT0-AHU0202-AHU-CCS	CCF of standby WHF ITS Elec AHUs to start	0.047
050-VCT0-EXH0406-FAN-CCR	CCF of running Exh fans for WHF ITS Elec.	0.0235
050-VCT0-EXH0507-FAN-CCF	CCF to run: standby Exh fans for the WHF ITS Elec	0.0235
050-VCT0-EXH0507-FAN-CCR	CCF to start: standby Exh fans for the WHF ITS Elec	0.047

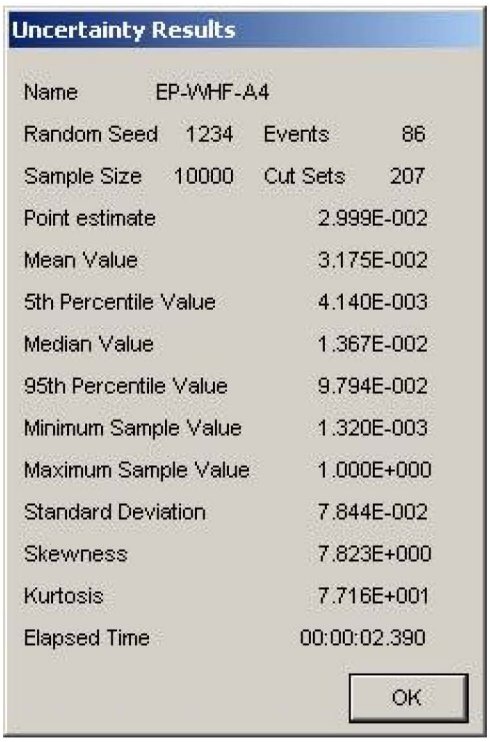
NOTE: AHU = air handling unit; CCF = common-cause failure; DG = diesel generator; Elec = electrical; Exh = exhaust; ITS = important to safety; SWGR = switchgear; WHF = Wet Handling Facility.

Source: Original

All of the common-cause successes modeled are used on pairs of components with one of two success criteria (i.e., two of two failure criteria). Alpha-factors used to determine the CCF probability are 0.047 for demand failures and 0.0235 for time dependent failures (see Attachment C, Table C3-1, CCCG=2, and the associated text).

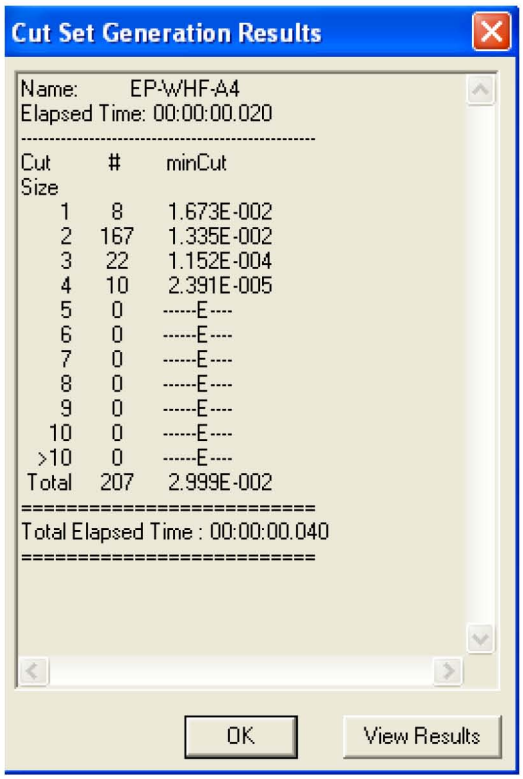
B8.4.1.6 Uncertainty and Cut Set Generation

Figure B8.4-1 contains the uncertainty results obtained from running the fault trees for the "Loss of AC Power to WHF ITS Load Center Train A". Figure B8.4-2 provides the cut set generation results for the "Loss of AC Power to WHF ITS Load Center Train A" fault tree.



Source: Original

Figure B8.4-1. Uncertainty Results of the "Loss of AC Power to WHF ITS Load Center Train A" Fault Tree



Source: Original

Figure B8.4-2. Cut Set Generation Results for the "Loss of AC Power to WHF ITS Load Center Train A" Fault Tree

B8.4.1.7 Cut Sets

Table B8.4-4 contains the top 25 cut sets accounting for 97% of the system failure probability for the "Loss of AC Power to WHF ITS Load Center Train A" fault tree.

Table B8.4-4. Dominant Cut Sets for the Loss of AC Power to WHF ITS Load Center Train A

% Total	% Cut Set	Probability/ Frequency	Basic Event	Description	Event Probability
17.93	17.93	5.378E-03	050-#EEE-MCC0001-MCC-FOH	WHF ITS MCC 00001 Fails	5.378E-03
30.65	12.72	3.816E-03	050-#EEE-LDCNTRA-C52-SPO	Load Center A Feed Circuit Breaker Spurious Operation	3.816E-03
43.37	12.72	3.816E-03	050-#EEE-MCC0001-C52-SPO	WHF ITS MCC 0001 Feed Breaker Spurious Operation	3.816E-03
53.16	9.79	2.938E-03	26D-#EEY-ITSDG-A-#DG-FTR	ITS Diesel Generator A Fails to Run	7.698E-01
			26D-#EEY-OB-SWGA-C52-SPO	13.8kV ITS SWGR A Feed Breaker Spurious Operation	3.816E-03

Table B8.4-4. Dominant Cut Sets for The Loss of AC Power to WHF ITS Load Center Train A (Continued)

% Total	% Cut Set	Probability/ Frequency	Basic Event	Description	Event Probability
62.95	9.79	2.938E-03	26D-#EEY-ITSDG-A-#DG-FTR	ITS Diesel Generator A Fails to Run	7.698E-01
			27A-#EEE-BUS2DGA-C52-SPO	13.8kV Open Bus 2 ITS Load Breaker Spurious Operation	3.816E-03
72.06	9.11	2.732E-03	26D-#EEESWGRDGA-AHU-FTR	13.8kV ITS Switchgear room Air Handling Unit Fails	2.732E-03
80.59	8.53	2.559E-03	050-VCT0-EXH-004-FAN-FTR	WHF ITS Elec Exhaust Fan 00004 Fails to Run	5.059E-02
			050-VCT0-EXH-005-FAN-FTR	WHF ITS Elec Exhaust Fan 00005 Fails to Run	5.059E-02
88.26	7.67	2.302E-03	26D-#EEY-ITSDG-A-#DG-FTR	ITS Diesel Generator A Fails to Run	7.698E-01
			LOSP*	Loss of offsite power	2.990E-03
89.72	1.46	4.391E-04	050-#EEE-LDCNTRA-BUA-FOH	WHF Load Center A Fails	4.391E-04
91.18	1.46	4.391E-04	26D-#EEE-SWGRDGA-BUA-FOH	13.8kV ITS Switchgear A Failure	4.391E-04
92.31	1.13	3.380E-04	26D-#EEY-ITSDG-A-#DG-FTR	ITS Diesel Generator A Fails to Run	7.698E-01
			27A-#EEN-OPENBS2-BUA-FOH	13.8kV Open Bus 2 Bus Failure	4.391E-04
93.01	0.70	2.095E-04	050-#EEE-WHFITSA-XMR-FOH	WHF ITS Transformer Train B Failure	2.095E-04
93.35	0.34	1.027E-04	050-VCT0-EXH-004-FAN-FTR	WHF ITS Elec Exhaust Fan 00004 Fails to Run	5.059E-02
			050-VCT0-EXH-005-CTL-FOD	WHF ITS Elec Exh fan 00005 Controller Fails	2.030E-03
93.69	0.34	1.027E-04	050-VCT0-EXH-004-CTL-FOD	WHF ITS Elec Exh Fan 00004 Controller Fails	2.030E-03
			050-VCT0-EXH-005-FAN-FTR	WHF ITS Elec Exhaust Fan 00005 Fails to Run	5.059E-02
94.03	0.34	1.025E-04	050-#EEE-LDCNTRA-BUA-MTN	ITS Load Center Train A OOS for Maintenance	1.025E-04
			050-#EEE-LDCNTRB-BUA-MTN	ITS Load Center Train B OOS for Maintenance	9.999E-01
			050-#EEE-LDCNTRB-BUA-ROE	Failure to Restore ITS Load Center Train B post maint	1.000E+000
94.37	0.34	1.022E-04	050-VCT0-EXH-004-FAN-FTR	WHF ITS Elec Exhaust Fan 00004 Fails to Run	5.059E-02
			050-VCT0-EXH-005-FAN-FTS	WHF ITS Elec Exh Fan 00005 Fails to Start	2.020E-03
94.70	0.33	9.777E-05	26D-#EEG-HVACFA1-FAN-FTR	ITS DG A room Fan 1 (Motor-Driven) Fails to Run	2.562E-02
			26D-#EEY-OB-SWGA-C52-SPO	13.8kV ITS SWGR A feed Breaker Spurious Operation	3.816E-03

Table B8.4-4. Dominant Cut Sets for The Loss of AC Power to WHF ITS Load Center Train A (Continued)

% Total	% Cut Set	Probability/ Frequency	Basic Event	Description	Event Probability
95.03	0.33	9.777E-05	26D-#EEG-HVACFA2-FAN-FTR	ITS DG A room Fan 2 (Motor-Driven) Fails to Run	2.562E-02
			26D-#EEY-OB-SWGA-C52-SPO	13.8kV ITS SWGR A feed Breaker Spurious Operation	3.816E-03
95.36	0.33	9.777E-05	26D-#EEG-HVACFA3-FAN-FTR	ITS DG A room Fan 3 (Motor-Driven) Fails to Run	2.562E-02
			26D-#EEY-OB-SWGA-C52-SPO	13.8kV ITS SWGR A feed Breaker Spurious Operation	3.816E-03
95.69	0.33	9.777E-05	26D-#EEG-HVACFA4-FAN-FTR	ITS DG A room Fan 4 (Motor-Driven) Fails to Run	2.562E-02
			26D-#EEY-OB-SWGA-C52-SPO	13.8kV ITS SWGR A feed Breaker Spurious Operation	3.816E-03
96.02	0.33	9.777E-05	26D-#EEG-HVACFA1-FAN-FTR	ITS DG A room Fan 1 (Motor-Driven) Fails to Run	2.562E-02
			27A-#EEE-BUS2DGA-C52-SPO	13.8kV Open Bus 2 ITS Load Breaker Spurious Operation	3.816E-03
96.35	0.33	9.777E-05	26D-#EEG-HVACFA2-FAN-FTR	ITS DG A room Fan 2 (Motor-Driven) Fails to Run	2.562E-02
			27A-#EEE-BUS2DGA-C52-SPO	13.8kV Open Bus 2 ITS Load Breaker Spurious Operation	3.816E-03
96.68	0.33	9.777E-05	26D-#EEG-HVACFA3-FAN-FTR	ITS DG A room Fan 3 (Motor-Driven) Fails to Run	2.562E-02
			27A-#EEE-BUS2DGA-C52-SPO	13.8kV Open Bus 2 ITS Load Breaker Spurious Operation	3.816E-03
97.01	0.33	9.777E-05	26D-#EEG-HVACFA4-FAN-FTR	ITS DG A room Fan 4 (Motor-Driven) Fails to Run	2.562E-02
			27A-#EEE-BUS2DGA-C52-SPO	13.8kV Open Bus 2 ITS Load Breaker Spurious Operation	3.816E-03
97.30	0.29	8.591E-05	26D-#EEY-ITSDG-A-#DG-FTR	ITS Diesel Generator A Fails to Run	7.698E-01
			27A-#EEN-OPNBS1A-SWP-SPO	13.8kV Open Bus 2 to ITS Div A Electric Power Switch Spur. Xfer	1.116E-04

NOTE: DG = diesel generator; Elec = electrical; Exh = exhaust; ITS = important to safety; MCC = motor control center; OOS = out of service; Spur = spurious; SWGR = switchgear; WHF = Wet handling Facility; Xfer = transfer.

Source: Original

B8.4.2 Loss of AC Power to WHF ITS Load Center Train B

B8.4.2.1 Description

WHF confinement following the potential breach of a waste canister is provided, in part, by the WHF ITS HVAC system. The ITS AC power system provides the AC power needed to operate the ITS HVAC system equipment. This fault tree models the components that are required to

provide AC power from either the normal offsite power supplies or from ITS Diesel Generator B to ITS Load Center Train B.

B8.4.2.2 Success Criteria

Success criteria for this train of the ITS AC power system is to provide AC power from either the normal power system or from the ITS diesel generator (Diesel Generator Train B) to the ITS HVAC division powered through WHF ITS Load Center Train B. The AC power system must operate in support of the ITS HVAC system for as long as necessary to successfully provide confinement after the potential release of material from a breached canister. Therefore, the mission time (the period for which AC power must be supplied to the ITS HVAC system) is the same for the ITS AC power system as it is for the ITS HVAC system, 720 hours.

B8.4.2.3 Design Requirements and Features

Requirements

Each ITS diesel generator has support systems that are independent from the support system for the other diesel generator. Independent support systems include:

- Fuel oil systems
- HVAC systems to include the ITS diesel generator room and 13.8kV ITS switchgear room systems
- Lube oil system
- ITS diesel generator cooling systems
- Diesel generator start system.

Features

The 13.8 kV ITS switchgear is isolated from the main switchyard upon a loss of power in the switchyard, either due to a LOSP or from failures within the switchyard.

The WHF load is shed from the 13.8 kV switchgear upon a loss of power indication.

A load sequencer controls the loading of the diesel generator onto the 13.8 kV ITS switchgear upon the ITS diesel generator reaching rated output. The same load sequencer controls reloading the WHF loads onto the ITS AC power system.

Environmental systems are provided to maintain the temperature in the various EDGF rooms within acceptable levels. This includes a fan system for the diesel generator room and AHUs for the 13.8 kV ITS switchgear and battery room.

B8.4.2.4 Fault Tree Model

The top event in this fault tree is "Loss of AC Power to WHF ITS Load Center Train B." This is defined as a failure of normal and ITS on-site power to ITS Load Center Train B. Faults considered in the evaluation of this top event include: failure of components in the normal AC power system, failure of the ITS diesel generator, human events that can contribute to onsite system failures resulting in a power loss at the WHF and a LOSP.

In industrial applications such as this, electrical energy is transmitted using various conductor configurations that include bus ducts which are conductor bars assembled with insulators in grounded enclosures and insulated wires that may be run in one of several forms between electrical devices. These forms include in metal or plastic pipe, called a conduit or they can be laid in cable trays or rectangular raceways having lids. These passive structural components isolate and support the electrical conductor and are not considered contributors to failure of the electrical distribution system just as failure of the floor an electrical motor sets on would not be considered a contributor to failure mechanisms associated with the motor. Failures of these structural components could be contributors to failures during a seismic event, however, the data is not parsed to that level and for this analysis it is given that the electrical distribution system fails during any significant seismic event with the failure mechanisms contributing to the electrical distribution system failure not specifically delineated. For non-seismic events, random failures of these passive structural components have not been included in the system analysis.

In this fault tree offsite power is not modeled as an initiating event, but as a system failure. The value used for this event represents the probability that offsite power is lost in the 720 hours following a possible radioactive release from a damaged canister.

B8.4.2.5 Basic Event Data

Table B8.4-5 contains a list of basic events used in the "Loss of AC Power to WHF ITS Load Center Train B" fault tree. Included are component failures, maintenance errors and the human events and the CCF events identified in the previous two sections. The data, for both random and CCFs used to develop the failure probabilities associated with these basic events comes from the component reliability data analysis (Attachment C). Human reliability analyses (Attachment E) provide the probabilities for the human events.

Mission times for the various components are based on the following:

- Fault exposure time (168 hours) for events limited to one week maintenance outages (train OOS for maintenance).
- Mission time (360 hours) for operation of standby equipment that would operate after a LOSP (distribution of the occurrence of an LOSP is evenly distributed over the 720 after a potential radiological release, average mission time is therefore 360 hours), and average fault exposure time for standby components tested monthly.
- Mission time (720 hours) for operating components.

While some of the components are normally in operation, it is possible for any of the components to be OOS for maintenance. With Train A of AC power OOS (resulting in Train B of the facility ITS HVAC being OOS) Train A provides support to an operable ITS HVAC Train A. The intent of the maintenance events modeled is for the events to address maintenance on any component in that AC power division. This is true for the components normally in operation and the standby components. The maintenance unavailability represented by the ITS load center maintenance events model the unavailability of any component from the 13.8 kV ITS switchgear through the ITS load center. The maintenance unavailability represented by the ITS diesel generator maintenance events represent the unavailability of any of the components or systems that would prevent the ITS diesel generator from starting and loading onto the 13.8 kV ITS switchgear. As noted earlier, all of the human events are associated with the failure to restore a component to operable or standby status after maintenance. The operator-related events shown in the following table are combination events: they include the probability that the component has been taken OOS for maintenance and that site personnel have not restored the component to operable or standby status. A screening value of 0.1 has been used for the HEP in all cases.

Table B8.4-5. Basic Event Probability for the Loss of AC Power to WHF ITS Load Center Train B Fault Trees

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
050-#EEE-LDCNTRA-BUA-MTN	ITS Load Center Train A OOS for Maintenance	3	1.025E-04	—	6.100E-07	1.680E+02
050-#EEE-LDCNTRA-BUA-ROE	Failure to Restore ITS Load Center Train A post maint	1	1.025E-05	1.025E-05	—	—
050-#EEE-LDCNTRB-BUA-FOH	WHF ITS Load Center B Fails	3	4.391E-04	—	6.100E-07	7.200E+02
050-#EEE-LDCNTRB-BUA-MTN	ITS Load Center Train B OOS for Maintenance	3	1.025E-04	—	6.100E-07	1.680E+02
050-#EEE-LDCNTRB-BUA-ROE	Failure to Restore ITS Load Center Train B post maint	1	1.025E-05	1.025E-05	—	—
050-#EEE-LDCNTRB-C52-FOD	13.8kV ITS SWGR to WHF ITS LC B Circuit Breaker Fails on Demand	1	2.240E-03	2.240E-03	—	—
050-#EEE-LDCNTRB-C52-SPO	WHF ITS Load Center Circuit Breaker (AC) Spur Op	3	3.816E-03	—	5.310E-06	7.200E+02
050-#EEE-LDCNTRS-C52-CCF	Common cause failure of the ITS Load Center feed breakers to reclose	C	1.053E-04	—	—	—
050-#EEE-MCC0002-C52-SPO	WHF MCC-00002 Feed Breaker Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
050-#EEE-MCC0002-MCC-FOH	WHF ITS MCC00002 Failure	3	5.378E-03	—	7.490E-06	7.200E+02
050-#EEE-WHFITSA-XMR-CCF	WHF ITS Transformers CCF	C	4.923E-06	—	—	—
050-#EEE-WHFITSB-XMR-FOH	WHF ITS Transformer Train B Failure	3	2.095E-04	—	2.910E-07	7.200E+02
050-VCT0-AHU0003-AHU-FTR	WHF ITS Elec AHU 00003 Fails to Run	3	2.732E-03	—	3.800E-06	7.200E+02
050-VCT0-AHU0003-CTL-FOD	WHF ITS Elec AHU 00003 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-AHU0004-AHU-FTR	WHF ITS ELec AHU 00004 Fails to Run	3	2.732E-03	—	3.800E-06	7.200E+02
050-VCT0-AHU0004-CTL-FOD	WHF ITS Elec AHU 00004 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-AHU0004-FAN-FTS	WHF ITS Elec AHU 00004 Fails to Start	1	2.020E-03	2.020E-03	—	—
050-VCT0-AHU0103-AHU-CCR	CCF of the running WHF ITS Elec AHUs to continue to run	C	6.421E-05	—	—	—
050-VCT0-AHU0202-AHU-CCR	CCF of standby WHF ITS Elec AHUs to run	C	6.421E-05	—	—	—
050-VCT0-AHU0202-AHU-CCS	CCF of standby WHF ITS Elec AHUs to start	C	9.495E-05	—	—	—
050-VCT0-EXH-006-CTL-FOD	WHF ITS Elec Exh Fan 0006 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-EXH-006-FAN-FTR	WHF ITS Elec Exh. Fan Fails to Run	3	5.059E-02	—	7.210E-05	7.200E+02
050-VCT0-EXH-007-CTL-FOD	WHF ITS Elec Exh fan 00007 Controller Fails	1	2.030E-03	2.030E-03	—	—
050-VCT0-EXH-007-FAN-FTR	WHF ITS Elec Exhaust Fan 00007 Fails to Run	3	5.059E-02	—	7.210E-05	7.200E+02
050-VCT0-EXH-007-FAN-FTS	WHF ITS Elec Exh fan 00007 Fails to Start	1	2.020E-03	2.020E-003	—	—

Table B8.4-5. Basic Event Probability for The Loss of AC Power to WHF ITS Load Center Train B Fault Trees (Continued)

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
050-VCT0-EXH0406-FAN-CCR	CCF of running Exh fans for WHF ITS Elec.	C	1.189E-03	—	—	—
050-VCT0-EXH0507-FAN-CCF	CCF to Run: Standby Exh fans for the WHF ITS Elec	C	1.189E-03	—	—	—
050-VCT0-EXH0507-FAN-CCR	CCF to Start: standby Exh fans for the WHF ITS Elec	C	9.494E-05	—	—	—
26D-##EGBATCHRGB-BYC-FOH	ITS DG B Battery Charger failue	3	1.276E-03	—	7.600E-06	1.680E+02[c]
26D-##EG-DAYTNKB-TKF-FOH	ITS DG B Day fuel tank fails	3	1.584E-04	—	4.400E-07	3.600E+02
26D-##EG-FLITLKB-IEL-FOD	ITS DG B fuel transfer pumps Interlock Failure	1	2.750E-05	2.750E-05	—	—
26D-##EG-FTP1DGB-PMD-FTR	ITS DG B Fuel Transfer Pump 1 (Motor Driven) Fails to Run	3	1.234E-02	—	3.450E-05	3.600E+02
26D-##EG-FTP1DGB-PMD-FTS	ITS DG B Fuel Transfer Pump 1 (Motor Driven) Fails to Start	1	2.500E-03	2.500E-03	—	—
26D-##EG-FTP2DGB-PMD-FTR	ITS DG B Fuel Transfer Pump 2 (Motor Driven) Fails to Run	3	1.234E-02	—	3.450E-05	3.600E+02
26D-##EG-FTP2DGB-PMD-FTS	ITS DG B Fuel Transfer Pump 2 (Motor Driven) Fails to Start on Demand	1	2.500E-03	2.500E-03	—	—
26D-##EG-FULPMPB-PMD-CCR	Common cause failure of ITS DG B fuel pumps to run	C	2.901E-04	—	—	—
26D-##EG-FULPMPB-PMD-CCS	Common cause failure of ITS DG B fuel pumps to start	C	1.175E-04	—	—	—
26D-##EG-HVACFN1-FAN-FTR	ITS DG B room Fan 1 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-##EG-HVACFN1-FAN-FTS	ITS DG B room Fan (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-##EG-HVACFN2-FAN-FTR	ITs DG B room Fan 2 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-##EG-HVACFN2-FAN-FTS	ITS DG B Room Fan (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-##EG-HVACFN3-FAN-FTR	ITS DG B room Fan 3 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-##EG-HVACFN3-FAN-FTS	ITS DG B Room Fan 3 (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-##EG-HVACFN4-FAN-FTR	ITS DG B Fan 4 (Motor-Driven) Fails to Run	3	2.562E-02	—	7.210E-05	3.600E+02
26D-##EG-HVACFN4-FAN-FTS	ITS DG B Room Fan 4 (Motor-Driven) Fails to Start	1	2.020E-03	2.020E-03	—	—
26D-##EG-STRTDGB-C72-SPO	13.8kV ITS SWGR Battery B Circuit Breaker (DC) Spur Op	3	3.851E-04	—	1.070E-06	3.600E+02[d]
26D-##EG-WKTNK_B-TKF-FOH	ITS DG B Bulk Fuel Tank Fails	3	1.584E-04	—	4.400E-07	3.600E+02
26D-#EEE-SWGRDGB-AHU-FTR	EDGB Switchgear Room Air Handling Unit Failure to Run	3	2.732E-03	—	3.800E-06	7.200E+02

Table B8.4-5. Basic Event Probability for The Loss of AC Power to WHF ITS Load Center Train B Fault Trees (Continued)

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
26D-#EEE-SWGRDGB-BUA-FOH	13.8kV ITS Switchgear B Bus Failure	3	4.391E-04	—	6.100E-07	7.200E+02
26D-#EEU-208_DGB-BUD-FOH	ITS DG B DC Panel Failure	3	8.640E-05	—	2.400E-07	3.600E+02[d]
26D-#EEY-DGBLOAD-C52-FOD	ITS DG B Load Breaker (AC) fails to close	1	2.240E-03	2.240E-03	—	—
26D-#EEY-DGLOADS-C52-CCF	Common cause failure of ITS DG Load Breakers to close	C	1.053E-04	—	—	—
26D-#EEY-ITSDG-A-#DG-MTN	ITS DG A OOS Maintenance	1	1.950E-03	1.950E-03	—	—
26D-#EEY-ITSDG-A-#DG-RSS	Failure to properly return ITS DG A to service	1	1.950E-04	1.950E-04	—	—
26D-#EEY-ITSDGAB-#DG-CCR	CCF ITS DG A & B Fail to Run	C	1.809E-02	—	—	—
26D-#EEY-ITSDGAB-#DG-CCS	CCF DG A and B to Start	C	3.939E-04	—	—	—
26D-#EEY-ITSDGB-#DG-FTR	Diesel Generator Fails to Run	3	7.698E-01	—	4.080E-03	3.600E+02
26D-#EEY-ITS-DGB-#DG-FTS	Diesel Generator Fails to Start	1	8.380E-03	8.380E-03	—	—
26D-#EEY-ITSDG-B-#DG-MTN	ITS DG B OOS Maintenance	1	1.950E-03	1.950E-03	—	—
26D-#EEY-ITSDG-B-#DG-RSS	Failure to properly restore ITS DG-B to service	1	1.950E-04	1.950E-04	—	—
26D-#EEY-OB-SWGB-C52-FOD	Circuit Breaker (AC) Fails on Demand	1	2.240E-03	2.240E-03	—	—
26D-#EEY-OB-SWGB-C52-SPO	Circuit Breaker (AC) Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
26D-#EEY-OB-SWGS-C52-CCF	Common cause failure of 13.8kV ITS SWGR feed breakers to open	C	1.053E-04	—	—	—
26D-#EG-BATTERYB-BTR-FOD	ITS SWGR Control Battery B No Output	1	8.200E-03	8.200E-03	—	—
26D-#EG-LDSQNCRB-SEQ-FOD	ITS DG B load sequencer fails	1	3.330E-03	3.330E-03	—	—
26D-#EG-LOCKOUTB-RLY-FTP	13.8 ITS SWGR Lockout Relay (Power) Fails to Open CB	3	3.152E-03	—	8.770E-06	3.600E+02
27A-#EEE-BUS3DGB-C52-SPO	Circuit Breaker (AC) Spurious Operation	3	3.816E-03	—	5.310E-06	7.200E+02
27A-#EEN-OPENBS4-BUA-FOH	13.8kV Open Bus 4 Bus Failure	3	4.391E-04	—	6.100E-07	7.200E+02
27A-#EEN-OPNBS3B-SWP-SPO	13.8kV Open Bus 4 to ITS B Electric Power Switch Spur Xfer	3	1.116E-04	—	1.550E-07	7.200E+02

Table B8.4-5. Basic Event Probability for The Loss of AC Power to WHF ITS Load Center Train B Fault Trees (Continued)

Name	Description[b]	Calc. Type[a]	Calculation Probability	Failure Probability	Lambda	Mission Time[a]
LOSP*	Loss of offsite power	1	2.990E-03	2.990E-03	—	—

NOTE: [a]For Calc. Type 3 with a mission time of 0, SAPHIRE performs the quantification using the system mission time. See Table 6.3-1 for definitions of calculation types.
[b]The designation of a circuit breaker as AC or DC refers to the system designation for the circuit breaker, it is not representative of the motive power for the circuit breaker.
[c]The failure of the battery charger would result in eventual depletion of the battery and a low power indication on both the battery and the DC bus. The 168 hr mission time was selected as a conservative estimation for the detection time of this failure.
[d]The mission times for the DC bus related failure rates do not take credit for any monitoring of bus status, which would provide nearly instantaneous indication of a bus failure or loss of power to the bus. The standby component mission time was used conservatively.
LOSP* represents the probability of losing offsite power during the 720 hours HVAC is required after any breach of a container releases radioactive material. It is based on a loss of offsite power frequency of 3.59E-02/year from NUREG/CR6890 (Ref. B8.1.19, Table ES-1).

AHU = air handling unit; Calc. = calculation; CCF = common-cause failure; DG = diesel generator; EDGB = Emergency Diesel Generator Building; elec = electrical; Exh = exhaust; ITS = important to safety; LC = load center; MCC = motor control center; OOS = out of service; op = operation; Spur = spurious; SWGR = switchgear; WHF = Wet Handling Facility; Xfer = transfer.

Source: Original

B8.4.2.5.1 Human Failure Events

Four basic HFEs (Table B8.4-6) are associated with human error. All of the HFEs are associated with the failure to properly restore components to operable status following maintenance. The first two shown in Table B8.4-6 are associated with the failure to restore the normal power supply to the WHF ITS load centers after maintenance. The last two are representative of the failure to restore the ITS diesel generators (and any other components that would prevent the ITS diesel generator from starting or loading) to service after maintenance. These events are combination events consisting of the probability that a component was removed for maintenance and the failure of plant operators (assigned a screening value of 0.1) to restore the component after maintenance.

Table B8.4-6. Human Failure Events

Name	Description
050-#EEE-LDCNTRA-BUA-ROE	Failure to Restore ITS Load Center Train A post maint
050-#EEE-LDCNTRB-BUA-ROE	Failure to Restore ITS Load Center Train B post maint
26D-#EEY-ITSDG-A-#DG-RSS	Failure to properly return ITS DG A to service
26D-#EEY-ITSDG-B-#DG-RSS	Failure to properly return ITS DG B to service

NOTE: DG = diesel generator; ITS = important to safety; maint = maintenance.

Source: Original

B8.4.2.5.2 Common-Cause Failures

Fourteen of the sixteen CCF identified earlier (Table B8.4-7) have been included in the analysis of the loss of ITS AC power to the ITS Load Center Train B. Ten of the CCF events affect both trains of ITS AC Power. Two affect only this train of the system. The remaining two affect only the other train of the system. Two are associated with the ITS diesel generators: CCF of the ITS diesel generators to start and CCF of the ITS diesel generators to run.

The CCF of the ITS diesel generator fuel oil system incorporates two CCFs: CCF of the two fuel oil pumps to start and the CCF of the pumps to run. Three circuit breaker CCF events were considered. These are the CCF of the (1) 13.8 kV ITS switchgear feed breakers (from 13.8 kV open buses) to open on LOSP, (2) ITS diesel generator load breakers to close when commanded by the load sequencer, and (3) ITS load center feed breakers to close when commanded by the load sequencer. Six CCF are associated with the WHF ITS Electrical and Battery Rooms' ventilation system, two for the CCF of standby exhaust fans (one to start and one to run), one for the CCF of the running exhaust fan to continue to run, two for the CCF of the standby AHUs (one to start and one to run), and one for the CCF of the running AHU to continue to run. The last CCF event considered is the CCF of the 13.8 kV to 480 V ITS transformers.

All of the CCFs modeled are used on pairs of components with one of two success criteria (i.e., two of two failure criteria). Alpha-factors used to determine the CCF probability are 0.047 for demand failures and 0.0235 for time dependent failures (see Attachment C, Table C3-1, CCCG=2, and the associated text). Two CCFs in Table B8.4-7 are used to represent the CCF associated with the failure to start and failure to run for components. For these two CCFs, the

appropriate alpha-factors were applied to the start and run portions of the random failure probability to develop a single CCF probability for the components.

Table B8.4-7. Common-Cause Basic Events

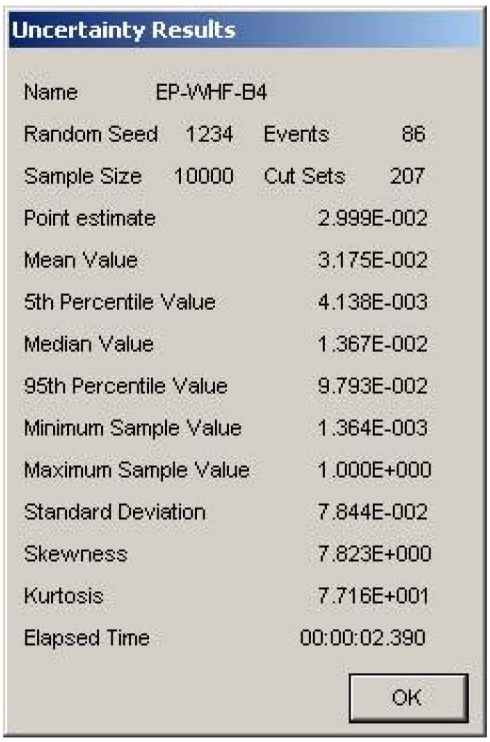
Name	Description	Alpha-factor
050-#EEE-LDCNTRS-C52-CCF	Common cause failure of the ITS Load Center feed breakers to reclose	0.0235
050-#EEE-WHFITSA-XMR-CCF	WHF ITS Transformers CCF	0.047
26D-##EG-FULPMPB-PMD-CCR	Common cause failure of ITS DG B fuel pumps to run	0.0235
26D-##EG-FULPMPB-PMD-CCS	Common cause failure of ITS DG B fuel pumps to start	0.047
26D-#EEY-DGLOADS-C52-CCF	Common cause failure of ITS DG Load Breakers to close	0.047
26D-#EEY-ITSDGAB-#DG-CCR	CCF ITS DG A & B Fail to Run	0.0235
26D-#EEY-ITSDGAB-#DG-CCS	CCF DG A and B to Start	0.047
26D-#EEY-OB-SWGS-C52-CCF	Common cause failure of 13.8kV ITS SWGR feed breakers to open	0.047
050-VCT0-AHU0103-AHU-CCR	CCF of the running WHF ITS elec AHUs to continue to run	0.0235
050-VCT0-AHU0202-AHU-CCR	CCF of standby WHF ITS Elec AHUs to continue to run	0.0235
050-VCT0-AHU0202-AHU-CCS	CCF of standby WHF ITS Elec AHUs to start	0.047
050-VCT0-EXH0406-FAN-CCR	CCF of running Exh fans for WHF ITS Elec.	0.0235
050-VCT0-EXH0507-FAN-CCF	CCF to run: standby Exh fans for the WHF ITS Elec	0.0235
050-VCT0-EXH0507-FAN-CCR	CCF to start: standby Exh fans for the WHF ITS Elec	0.047

NOTE: AHU = air handling unit; CCF = common-cause failure; DG = diesel generator; elec = electrical; exh = exhaust; ITS = important to safety; SWGR = switchgear; WHF = Wet Handling Facility.

Source: Original

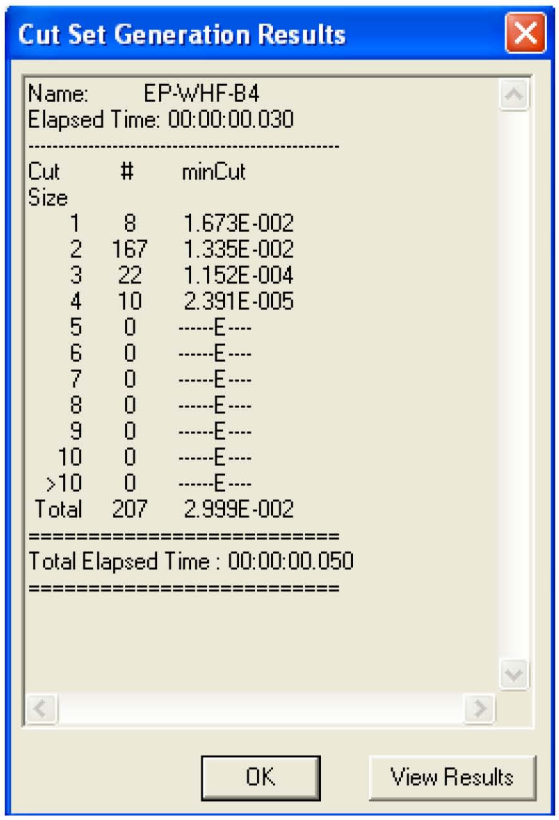
B8.4.2.6 Uncertainty and Cut Set Generation

Figure B8.4-3 contains the uncertainty results obtained from running the fault tree for "Loss of AC Power to WHF ITS Load Center Train B." Figure B8.4-4 provides the cut set generation results for the "Loss of AC Power to WHF ITS Load Center Train B."



Source: Original

Figure B8.4-3. Uncertainty Results of the "Loss of AC Power to WHF ITS Load Center Train B" Fault Tree



Source: Original

Figure B8.4-4. Cut Set Generation Results for the "Loss of AC Power to WHF ITS Load Center Train B" Fault Tree

B8.4.2.7 Cut Sets

Table B8.4-8 contains the top 25 cut sets that contribute 97% of the total system failure probability for the "Loss of AC Power to WHF ITS Load Center Train B" fault tree.