Table 8.3-9—Onsite AC Power System Failure Modes and Effects Analysis
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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
1	Main generator	Provides power to the transmission system and the EATs and NATS through the switchyard.	Fault or failure in the main generator or main turbine	Fault or failure in the main generator, or main turbine that results in main generator or main turbine trip.	None, system does not have a safety-related function.	Alarms in the MCR	a. Main generator is tripped and MSUs are isolated by protective relays. b. Turbine trip is initiated. c. Offsite power sources remain in service.
2	Main step-up transformer 30BTA01, 30BTA02, or 30BTA03	Transforms main generator output voltage to offsite transmission system voltage and transmits main generator output to the switchyard.	Fault or failure in the MSU	Internal or external fault.	None, system does not have a safety-related function.	Alarms in the MCR	a. Main generator is tripped and MSUs are isolated by protective relays. b. Turbine trip is initiated. c. Offsite power sources to NPSS and EPSS switchgear remain in service.
3	Main step-up transformer cooling	Provides MSU cooling.	Loss of cooling	Failure of pumps or cooling fans.	None, system does not have a safety-related function.	Alarms in the MCR	a. Failure of group of pumps or cooling fans will leave remaining pumps and cooling fans unaffected. b. Main generator output reduction to within remaining cooling capability is necessary.
4	Isolated phase bus duct	Transfers power from the main generator to the MSUs.	Bus failure	Bus failure, including failure of bus supports or insulators.	None, system does not have a safety-related function.	Alarms in the MCR	a. IPB, MSU and generator are isolated by protective relays, which cause main generator output breakers located in switchyard to trip. b. Turbine trip is initiated. c. Offsite power sources to NPSS and EPSS switchgear remain in service.
5	Isolated phase bus duct cooling	Provides forced air cooling for the IPB.	Loss of cooling	Failure of the IPB cooling system including loss of cooling heat sink.	None, system does not have a safety-related function.	Alarms in the MCR	a. Standby fan will auto start on fan failure. b. Loss of closed cooling water or loss of forced air circulation will require main generator output reduction to maintain temperature within the IPB ratings.
6	Normal auxiliary transformer 30BBT01, or 30BBT02	Supplies power from switchyard to the NPSS 13.8 kV switchgear.	Transformer failure	Fault, including internal fault resulting in sudden pressure or overcurrent.	None, system does not have a safety-related function.	Alarms in the MCR	a. Faulted transformer is isolated by protective relaying. b. Transformer failure initiates a fast transfer of affected NPSS buses to alternate source NAT.

Table 8.3-9—Onsite AC Power System Failure Modes and Effects Analysis
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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
7	Normal auxiliary transformer cooling	Provides cooling to the NAT.	Loss of transformer cooling	Loss of one or both sets of fans due to loss of operating power, fan failure, or cable failure.	None, system does not have a safety-related function.	Alarms in the MCR	a. Normal alignment has transformer loading within transformer self-cooling ratings, so there are no immediate actions required. b. Should transformer also be carrying the alternate loads, high temperature alarm provides indication to transfer loads if necessary. Excessively high temperature beyond the NAT alarm level will cause that NAT to trip from service, causing possible reactor and turbine trip, or plant power reduction or shutdown as a result of de-energized balance of plant loads. c. Loading on the affected NAT is manually transferred to the remaining NAT.
8	Emergency auxiliary transformer 30BDT01 or 30BDT02	Supplies power from the switchyard to the EPSS 6.9 kV switchgear.	Transformer failure	Fault, including internal fault resulting in sudden pressure or overcurrent.	None, system does not have a safety-related function.	Alarms in the MCR	a. Faulted transformer is isolated by protective relaying. b. Transformer failure initiates a fast transfer of affected EPSS buses to alternate source EAT.
9	Emergency auxiliary transformer cooling	Provides cooling to the EAT.	Loss of transformer cooling	Loss of one or both sets of fans due to loss of operating power, fan failure or cable failure.	None, system does not have a safety-related function.	Alarms in the MCR	a. Normal alignment has transformer loading within transformer self-cooling rating, so there are no immediate actions required. b. Should transformer also be carrying the alternate loads, high temperature alarm provides indication to transfer loads if necessary. Excessively high temperature beyond the EAT alarm level will cause that EAT to trip from service. c. EAT trip while carrying all four EPSS divisions will cause loss of power to each division and subsequent EDG start and loading onto the affected buses.
10	13.8 kV electrical bus that exists between NATs and the 13.8 kV NPSS switchgear 31BBA, 32BBA, 33BBA, or 34BBA	Provides connection between the NATs and the 13.8 kV NPSS switchgear.	Electrical bus fault	Electrical bus fault or failure.	None, system does not have a safety-related function.	Alarms in the MCR	a. A fault on the electrical bus will result in isolation of the affected transformer by protective relaying. b. The source breaker to the affected NPSS switchgear 31BBA, 32BBA, 33BBA, or 34BBA operates and isolates the transformer. c. Transformer failure initiates a fast transfer of the affected buses.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
11	13.8 kV NPSS switchgear primary source breaker from NATs to switchgear 31BBA, 32BBA, 33BBA, or 34BBA	Provides primary point of isolation for 13.8 kV buses 31BBA, 32BBA, 33BBA, or 34BBA from NATs.	Breaker failure or fault	Breaker failure resulting in breaker tripping.	None, system does not have a safety-related function.	Alarms in the MCR	a. The faulted breaker is isolated by protective relaying; the affected 13.8 kV switchgear bus and all downstream buses are de-energized. b. SBODGs will re-energize 31BBH or 32BBH if necessary. c. The affected and unfaulted bus can be manually transferred to its alternately assigned NAT source. d. Possible reactor or turbine trip, or plant power reduction or shutdown as a result of lost balance of plant loads.
12	NPSS 13.8 kV switchgear 31BBA, 32BBA, 33BBA, or 34BBA	Transfer power from the NATs to the NPSS loads in the respective train.	Loss of voltage	Bus fault or failure.	None, system does not have a safety-related function.	Alarm in the MCR	a. The faulted bus is isolated by protective relaying; the affected 13.8 kV switchgear bus source breakers are tripped and locked out. b. Downstream buses are de-energized. c. Possible reactor or turbine trip, or plant power reduction or shutdown as a result of de-energized balance of plant loads. d. SBODGs will re-energize 31BBH or 32BBH if necessary.
13	Feeder breaker from NPSS bus 31BBA, 32BBA, 33BBA, or 34BBA to the source breaker on 31BBC, 32BBC, 33BBC or 34BBC Or the source breaker on NPSS bus 31BBC, 32BBC, 33BBC or 34BBC	Connect BBA bus to the respective BBC bus.	Breaker failure	Breaker failure resulting in breaker tripping.	None, redundant RCP trip function is unaffected.	Alarm in the MCR	a. Faulted breaker is isolated by protective relaying; the affected 13.8 kV switchgear bus 31BBC, 32BBC, 33BBC, or 34BBC and downstream buses are de-energized. b. Respective 31BDE, 32BDE, 33BDE or 34BDE bus and RCP is de-energized, resulting in plant shutdown as required by technical specifications. c. The RCP trip function remains available with the RCP breaker.
14	Feeder breaker from NPSS bus 31BDE, 32BDE, 33BDE, or 34BDE.	Connect BBC bus to the respective BDE bus.	Breaker failure	Breaker failure resulting in breaker tripping.	None, de-energizing RCP accomplishes RCP trip safety function.	Alarm in the MCR	a. Faulted breaker is isolated by protective relaying; the affected 13.8 kV switchgear bus 31BDE, 32BDE, 33BDE, or 34BDE is de-energized. a. Respective RCP is de-energized, resulting in plant shutdown as required by technical specifications.
15	NPSS distribution transformers 31BBT08 or 32BBT08	Transforms 31BBA or 32BBA 13.8 kV power to 6.9 kV power for 31BBH and 32BBH respectively.	Transformer failure	Transformer fault including short circuit.	None, system does not have a safety-related function.	Alarm in the MCR	a. Protective relaying isolates faulted transformer. b. Respective 31BBH or 32BBH is de-energized. c. Respective SBODG starts and re-powers the 31BBH or 32BBH switchgear.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
16	NPSS 6.9 kV 31BBH or 32BBH switchgear	Supply NUPS and 12UPS battery chargers. Provides connection point for SBODGs to the NPSS.	Bus failure	Bus fault including short circuit.	None, system does not have a safety-related function.	Alarm in the MCR	a. Protective relaying isolates faulted switchgear; source breakers are tripped and locked out. b. 31BBH or 32BBH and downstream buses are de-energizing. c. NUPS and 12UPS standby battery chargers can be placed in service for affected trains. d. SBODG unavailable for affected bus.
17	NPSS distribution transformers 31BFT08 or 32BFT08	Transforms 31BBH or 32BBH 6.9 kV power to 480 Vac for 31BFX and 32BFX respectively.	Transformer failure	Transformer fault, including short circuit.	None, system does not have a safety-related function.	Alarm in the MCR	a. Protective relaying isolates faulted transformer. b. 31BFX or 32BFX and downstream buses are de-energized. c. NUPS and 12UPS standby battery chargers can be placed in service for affected trains. d. Affected SBODG auxiliaries are de-energized resulting in the supported SBODG being unavailable.
18	NPSS 480 Vac load centers 31BFX or 32BFX	Supplies NUPS and 12UPS battery chargers; feeds MCCs 31BHZ01, 32BHZ01 which supply SBODG auxiliaries.	Bus failure	Bus fault including short circuit.	None, system does not have a safety-related function.	Alarm in the MCR	a. Protective relaying isolates faulted load center; source breaker is tripped and locked out. b. 31BFX or 32BFX and downstream buses are de-energized. c. NUPS and 12UPS standby battery chargers can be placed in service for affected trains. d. Affected SBODG auxiliaries are de-energized resulting in the supported SBODG being unavailable.
19	6.9 kV power cable between either EAT and the EPSS switchgear 31BDA, 32BDA, 33BDA or 34BDA	Transfer power from the EATs to the EPSS loads in the respective division.	Cable or cable duct fault	Cable or cable duct fault including short circuit or ground fault.	None, power feed from the EAT to the EPSS switchgear does not have a safety-related function.	Alarms in the MCR	a. Protective relaying isolates the affected power cable and transformer. b. Fast transfer of the affected buses is initiated by EAT failure.
20	6.9 kV safety-related switchgear primary source breaker from EATs to switchgear 31BDA, 32BDA, 33BDA, or 34BDA	Provides primary point of isolation of 6.9 kV switchgear from EATs.	Breaker failure or fault	Breaker failure resulting in breaker tripping.	None, safety-related function is maintained by redundant divisions.	Alarms in the MCR	a. The faulted breaker is isolated by protective relaying; the affected 6.9 kV switchgear bus and downstream buses are de-energized. b. The respective division EDG starts and automatically re-energizes the affected buses. c. The EDG can be paralleled with the alternate source EAT to transfer EPSS loads.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
21	EPSS 6.9 kV safety-related switchgear 31BDA, 32BDA, 33BDA, or 34BDA	Powers 6.9 kV EPSS loads and transfers power from the EATs to the rest of the EPSS buses in each division.	Bus failure	Bus fault, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Protective relay operation trips and locks out the bus source breakers and load breakers. b. Affected bus and downstream buses are de-energized. c. Respective division EDG will start but will not energize the faulted bus due to the EDG output breaker lock out.
22	EPSS 6.9 kV safety-related switchgear 31BDB, 31BDC, 31BDD, 32BDB, 32BDD, 33BDB, 33BDD, 34BDB, 34BDC or 34BDD	Powers 6.9 kV EPSS loads and transfers power to EPSS 480 Vac buses in each division.	Bus failure	Bus fault, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Protective relay operation trips and locks out the bus source breaker. b. Affected bus and downstream buses are de-energized.
23	EPSS distribution transformers 31BMT01, 31BMT02, 31BMT03, 31BMT04, 32BMT01, 32BMT02, 32BMT03, 32BMT04, 33BMT01, 33BMT02, 33BMT03, 33BMT04, 34BMT01, 34BMT02, 34BMT03 or 34BMT04	Transforms 6.9 kV from switchgear to 480 Vac for load center and MCC loads.	Transformer failure	Transformer fault, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Supplied bus undervoltage alarm in the MCR	a. Protective relaying isolates the faulted transformer, de-energizing downsteam loads.
24	6.9 kV feeder cable between EPSS 6.9 kV switchgear bus and distribution transformer or load center	Supplies power from 6.9 kV switchgear to EPSS distribution transformers and load centers.	Cable failure	Cable fault, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Protective relaying isolates the faulted cable, de-energizing downstream loads.
25	EPSS load centers: 31BMB, 31BMC, 31BMD, 32BMB, 32BMD, 33BMB, 33BMD, 34BMB. 34BMC or 34BMD	Supplies power to large EPSS 480 Vac loads and MCCs.	Load center failure	Load center failure such as bus failure, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Protective relaying trips and locks out load center source breaker, de-energizing downstream loads.
26	480 Vac feeder cable between EPSS load center and MCC	Supplies power to EPSS MCCs.	Cable failure	Cable fault, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Protective relaying isolates the faulted cable, de-energizing downstream loads.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
27	480 Vac EPSS MCCs: 31BNA01, 31BNB01, 31BNB02, 31BNB03, 31BNC01, 31BND01, 32BNA01, 32BNA02, 32BNB01, 32BNB02, 32BNB03, 32BND01, 33BNA01, 33BNA02, 33BNB01, 33BNB02, 33BNB03, 33BND01, 34BNA01, 34BNA02, 34BNB01, 34BNB03, 34BNC01 or 34BND01	Supplies power to smaller EPSS 480 Vac loads.	MCC failure	MCC bus fault, including short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Protective relaying trips and locks out faulted MCC source breaker, de-energizing downstream loads.
28	Voltage regulating transformer 31BNT01, 32BNT01, 33BNT01 or 34BNT01	Provides regulated voltage to: 31BNB02, 31BNB03, 32BNB02, 32BNB03, 33BNB02, 33BNB03, 34BNB02 or 34BNB03 Inverter static switch bypass source for 31BRU01, 32BRU01, 33BRU01, 34BRU01.	Transformer failure	Transformer failure including failure to regulate voltage, or short circuit.	None. Safety-related function is maintained by redundant divisions.	Bus undervoltage alarm in the MCR	a. Failure to regulate voltage results in voltage levels below that necessary to start and accelerate motors during EDG loading sequence. Safety-related functions are completed with redundant equipment for any motors that do not start. b. Protective relaying isolates affected transformer, de-energizing downstream loads. c. EUPS inverter static switch bypass source is unavailable.
29	Emergency diesel generators: division 1 EDG, division 2 EDG, division 3 EDG or division 4 EDG	Supplies standby power to EPSS switchgear 31BDA, 32BDA, 33BDA or 34BDA in the event of loss of power to the respective bus.	EDG failure while operating in the emergency mode	EDG failure.	None. Safety-related function is maintained by redundant divisions.	Alarm in the MCR	a. EDG output breaker is tripped with the EDG trip. b. EPSS 6.9 kV switchgear and downstream buses are de-energized. c. Bus is available to be re-powered from normal offsite power source.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
30	EPSS division 1 switchgear, load centers and MCCs, while being fed by alternate feed from division 2	Supplies power to safety-related loads during normal conditions and DBEs.	EDG failure while operating in the emergency mode.	EDG failure.	None. Safety-related function is maintained by redundant divisions.	Alarm in the MCR	An EDG trip while operating in the emergency mode when the redundant EDG in the divisional pair is out of service and the alternate feed is implemented is assumed worst case condition during DBA and LOOP, as the most equipment is affected. a. EDG 1 assumed out of service at start of following two different transients. b. EDG 2 trip will cause loss of power to EPSS buses in divisions 1 and 2. EUPS loads in divisions 1 and 2 are powered from the battery for two hours. Redundant EDGs and safety-related loads in divisions 3 and 4 have capacity and capability to perform required safety-related functions. c. EDG 3 or EDG 4 trip will cause loss of power to affected division EPSS buses. EUPS loads in affected division are powered from the battery for two hours. EDG 2 and required redundant safety-related loads in divisions 1 and 2 have capacity and capability to perform required safety-related functions.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
30	EPSS division 2 switchgear, load centers and MCCs, while being fed by alternate feed from division 1	Supplies power to safety-related loads during normal conditions and DBEs.	EDG failure while operating in the emergency mode.	EDG failure.	None. Safety-related function is maintained by redundant divisions.	Alarm in the MCR	An EDG trip while operating in the emergency mode when the redundant EDG in the divisional pair is out of service and the alternate feed is implemented is assumed worst case condition during DBA and LOOP, as the most equipment is affected. a. EDG 2 assumed out of service at start of following two different transients. b. EDG 1 trip will cause loss of power to EPSS buses in divisions 1 and 2. EUPS loads in divisions 1 and 2 are powered from the battery for two hours. Redundant EDGs and safety-related loads in divisions 3 and 4 have capacity and capability to perform required safety-related function. c. EDG 3 or EDG 4 trip will cause loss of power to affected division EPSS buses. EUPS loads in affected division are powered from the battery for two hours. EDG 1 and required redundant safety-related loads in divisions 1 and 2 have capacity and capability to perform required safety-related functions.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
31	EPSS division 3 switchgear, load centers and MCCs, while being fed by alternate feed from division 4	Supplies power to safety-related loads during normal conditions and DBEs.	EDG failure while operating in the emergency mode.	EDG failure.	None. Safety-related function is maintained by redundant divisions.	Alarm in the MCR	An EDG trip while operating in the emergency mode when the redundant EDG in the divisional pair is out of service and the alternate feed is implemented is assumed worst case condition during DBA and LOOP, as the most equipment is affected. a. EDG 3 assumed out of service at start of following two different transients. b. EDG 4 trip will cause loss of power to EPSS buses in divisions 3 and 4. EUPS loads in divisions 3 and 4 are powered from the battery for two hours. Redundant EDGs and safety-related loads in divisions 1 and 2 have capacity and capability to perform required safety-related functions. c. EDG 1 or EDG 2 trip will cause loss of power to affected division EPSS buses. EUPS loads in affected division are powered from the battery for two hours. EDG 4 and required redundant safety-related loads in divisions 3 and 4 have capacity and capability to perform required safety-related functions.

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Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect on System Safety-Related Function	Method of Failure Detection	Remarks
32	EPSS division 4 switchgear, load centers and MCCs, while being fed by alternate feed from division 3	Supplies power to safety-related loads during normal conditions and DBEs.	EDG failure while operating in the emergency mode.	EDG failure.	None. Safety-related function is maintained by redundant divisions.	Alarm in the MCR	An EDG trip while operating in the emergency mode when the redundant EDG in the divisional pair is out of service and the alternate feed is implemented is assumed worst case condition during DBA and LOOP, as the most equipment is affected. a. EDG 4 assumed out of service at start of following two different transients. b. EDG 3 trip will cause loss of power to EPSS buses in divisions 3 and 4. EUPS loads in divisions 3 and 4 are powered from the battery for two hours. Redundant EDGs and safety-related loads in divisions 1 and 2 have capacity and capability to perform required safety-related functions. c. EDG 1 or EDG 2 trip will cause loss of power to affected division EPSS buses. EUPS loads in affected division are powered from the battery for two hours. EDG 3 and required redundant safety-related loads in divisions 3 and 4 have capacity and capability to perform required safety-related functions.

Next File