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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-11404

Subject: Amended MHI's Response to US-APWR DCD RAI No. 394-3048 Revision 0 (SRP 08.03.01)

References:
1) "Request for Additional Information No. 394-3048 Revision 0, SRP Section: 08.03.01 AC Power Systems (Onsite), Application Section: 8.3.1," dated (June, 18, 2009).
2) "MHI's Response to US-APWR DCD RAI No. 394-3048 Revision 0", dated July 23, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Amended Response to Request for Additional Information No. 394-3048 Revision 0." This amended response is submitted to address SER Open Item 08.03.01-1.

Enclosed is the response to Question 08.03.01-38 that is contained within Enclosure 1.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Atsushi Kumaki for

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. Amended Response to Request for Additional Information No. 394-3048 Revision 0

D081
NRO

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Enclosure 1

UAP-HF-11404
Docket No. 52-021

Amended Response to Request for Additional Information
No. 394-3048 Revision 0

November, 2011

SUPPLEMENTAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

11/22/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 394-3048 REVISION 0**
SRP SECTION:	**08.03.01 - AC POWER SYSTEMS (ONSITE)**
APPLICATION SECTION:	**8.3.1**
DATE OF RAI ISSUE:	**6/18/2009**

QUESTION NO. : 08.03.01-38

In RAI 5-272, Question 08.03.01-6, the staff requested additional information on diversity between the Class-1E GTGs and the AAC GTGs in view of the guidance given in SECY papers and SRP review guidance. By the subject RAI the staff asked MHI to address SECY-90-16, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationships to Current Regulatory requirements." In SECY-90-16, the NRC Commissioners approved the staff's position that all evolutionary ALWR's have an AAC power source of diverse design capable of powering at least one set of normal shutdown loads. Also, RG1.206 provides guidance on meeting 10 CFR 50.63 (Station Blackout Rule) for evolutionary designs. Similar to SECY-90-16, it requires the installation of an AAC power source of diverse design with sufficient capacity, capability, and reliability that will be available on a timely basis for powering at least one complete set of normal safe shutdown loads to bring the plant to safe shutdown. In SECY-91-078, item 5.2.3, "Power Rating of the Combustion Turbine Generators," the staff concluded that, as a minimum, the GTG should be capable of powering one safety division and one division of permanent non-safety loads during worst-case shutdown (to cold shutdown) and that it should have capability to power these loads with some margin for load growth when operating within its continuous rating. In the USAPWR design, The GTG proposed for meeting 10 CFR 50.63 is rated at 4000 kW and are of the same design and manufacture as the class 1E onsite GTG power sources. The applicant has claimed that AAC GTGs and Class1E GTGs are diverse because AAC GTGs use battery for starting whereas the Class1E GTGs use air starting. In view of the guidance given in the SECY-90-16, SECY-91-078, and Chapter 8.4 of the SRP, the staff concluded that Class-1E GTGs and AAC GTGs proposed for the US-APWR design are not diverse.

The staff discussed with MHI its initial response to this RAI during the April 13, 2009, teleconference. During the March 12, 2009, public meeting, MHI agreed to provide to the staff its final resolution of this issue after internal meetings and discussions within MHI. The applicant is requested to discuss and elaborate on limiting common mode failure potential in the safety and non-safety GTGs since they are of the same manufacture and design. Also, the applicants asked to discuss whether the 4000 kW GTG is sized to power one safety division and one division of permanent non-safety loads during worst-case shutdown (to cold shutdown) and that it has the capability to power these loads with some margin for load growth when operating within its continuous rating. The staff requests that MHI docket its response on the issue of diversity between Class1E GTGs and the AAC GTGs to resolve this RAI question.

ANSWER:

MHI understands that adopting different manufacturers for the AAC GTG and Class 1E GTG ensures diversity. Therefore, MHI commits to using different manufacturers for the AAC GTGs and the Class 1E GTGs.

Each AAC GTG has the capacity to achieve and maintain the plant in a hot shutdown condition during an SBO. The US-APWR design incorporates two AAC GTGs. In order to achieve and maintain the plant in safe shutdown (cold shutdown) condition, both of the two AAC GTGs are used. During an SBO, each AAC GTG is aligned to supply power to one train safety bus respectively, with the permanent buses isolated from the AAC GTGs. The loads of the permanent buses are not required for an SBO. However, if one or more Class 1E GTGs are available in addition to two AAC GTGs, one AAC GTG would be aligned to a safety bus with the other aligned to a non safety permanent bus. AAC GTGs are designed with sufficient margin to allow for future load growth. Please refer to DCD Section 8.4 and Table 8.3.1-6 for the analysis.

The supply to the Class 1E bus from AAC GTG was changed so that the AAC GTG can be connected to the Class 1E bus, and isolated from the non-safety permanent bus, during SBO conditions. This was described in the response to RAI No. 386 Question No. 08.03.01-26.

Impact on DCD

See attached DCD markups of Tier 2, Subsection 1.2.1.5.6 (Attachment 1).

See attached DCD markups of Tier 2, Subsection 8.3.1.1.1, Subsection 8.3.1.2.2, Subsection 8.4.1.3, Subsection 8.4.2.1.2 and Subsection 8.4.2.2 (Attachment 2).

See attached DCD markup of Tier 2, Table 14.3-1d (Attachment 3).

See attached DCD markups of Tier 2, Subsection 19.1.3.1 and Table 19.1-119 (Attachment 4).

See attached DCD markups of Tier 1, Subsection 2.6.5.1 and Table 2.6.5-1 (Attachment 5)

Impact on R-COLA

FSAR Chapter 19, Table 19.1-119R should be revised in accordance with the change in the DCD Table 19.1-119.

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Technical/Topical Report

There is no impact on a Technical/Topical Report.

(480 volt ac, 208/120 V ac, 125 V dc.) power distribution systems. The safety-related medium voltage buses A, B, C and D feed the corresponding safety-related low voltage buses, and the non safety-related medium voltage buses feed the non safety-related low voltage buses.

- Both Class 1E and non-Class 1E dc systems are normally powered by the battery chargers connected to the onsite ac power system. When power supply from the battery charger is not available, the onsite dc power system is supplied power from station batteries.

- The onsite power distribution system also includes both safety and non-safety I&C power supply systems. The I&C power supply systems are 120 V ac uninterruptible power supply (UPS) systems used for the reference plant's instrumentation and control systems. The UPS systems are normally powered from the 480 V MCCs through inverters with battery backup.

The term "Station Blackout" (SBO) means the complete loss of ac electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., the loss of offsite electric power system concurrent with a turbine trip and the unavailability of the onsite emergency ac power system). An SBO does not include the loss of available ac power to buses fed by the station batteries through inverters or by alternate ac (AAC) sources, nor does it assume a concurrent LOCA, a single failure or a DBA. The plant is able to withstand on SBO of specified duration and recover from it.

- During an SBO, all ac sources and the onsite Class 1E GTGs are assumed to be inoperable. Two non-Class 1E GTGs are provided as AAC sources. To minimize the potential for common mode failures, a different manufacturer is adopted for the AAC GTGs from the Class 1E GTGs, and the AAC GTGs are provided with diverse starting mechanisms as compared to the Class 1E GTGs.~~with the Class 1E GTGs, different rating GTGs with diverse starting system are provided as AAC sources.~~The auxiliary and support systems for the AAC GTGs are independent and separate from the Class 1E GTGs to minimize the potential for common mode failures. DCD_08.03.01-38

- In the US-APWR design, power to the shutdown buses can be restored from the AAC sources within 60 minutes and, hence, a coping analysis for a duration of 60 minutes is performed.

- Until AAC GTG restores the Class 1E power system within one hour after an SBO occurs, all pumps and fans can not be operated. However, during this time period, the plant is in a condition similar to hot shut down. The turbine driven emergency feedwater pump (EFW) pump and the main steam relief valve remove decay heat so that the core and the reactor coolant system (RCS) are kept in a safe mode. RCP seal can keep its integrity for at least one hour without water cooling. The Class 1E electrical cabinets and I&C cabinets can keep their integrity for at least one hour without HVAC.

8.3.1.1.1 Non-Class 1E Onsite AC Power System

The 13.8kV ac system includes non-Class 1E buses N1 and N2. Bus N1 is connected to either UAT1 or RAT1 and bus N2 is connected to either UAT2 or RAT2 by non-segregated busduct/cable buses. The ratings of UAT1, UAT2, RAT1 and RAT2 are shown in Table 8.3.1-1.

The non-Class 1E 6.9kV ac system includes buses N3, N4, N5, N6, P1 and P2. Buses N3, N4 and P1 are connected to either UAT3 or RAT3 and buses N5, N6 and P2 are connected to either UAT4 or RAT4 by non-segregated busduct/cable buses. The ratings of UAT3, UAT4, RAT3 and RAT4 are shown in Table 8.3.1-1.

The UAT and RAT ratings are adequate to meet the maximum load requirements during normal plant operation, start-up, shutdown and design-basis events, as shown in Table 8.3.1-3.

Non-Class 1E 6.9kV permanent buses P1 and P2 are also connected to the non-Class 1E A-AAC GTG and B-AAC GTG, respectively. The loads which are not safety-related but require operation during LOOP are connected to these buses. ~~The AAC GTGs are of different rating and are provided with diverse starting mechanisms as compared to the Class 1E GTGs. The AAC GTGs are selected as non-Class 1E to minimize common cause failures with the Class 1E GTGs~~A different manufacturer is adopted for the AAC GTGs to minimize common cause failures with the Class 1E GTGs. The AAC GTGs are provided with diverse starting mechanisms as compared to the Class 1E GTGs. The AAC GTGs are started by dc supplied from batteries and the Class 1E GTGs are started by a compressed air system. Rating of AAC GTG is shown in Table 8.3.1-1. Any one AAC GTG is adequate to meet the load requirements shown in Table 8.3.1-5 and Table 8.3.1-6 during LOOP and SBO conditions. DCD_08.03.01-38

Normal offsite power to the non-Class 1E 13.8kV buses N1, N2 and non-Class 1E 6.9kV buses N3, N4, N5, N6, P1 and P2 is provided from the UATs and alternate offsite power is provided from the RATs. Automatic bus transfer schemes are provided on all these buses to automatically transfer the loads from the normal offsite power source to the alternate offsite power source in case of loss of normal power to the buses.

Logic schemes for the automatic fast and slow bus transfer of offsite power from UAT to RAT for non-Class 1E MV buses N1, N2, N3, N4, N5, N6, P1 and P2 are shown in Figure 8.3.1-2. Restoration of power from the alternate offsite source back to normal offsite source is by manual operation.

LOOP condition occurs if power from both the UAT and RAT is lost to the onsite ac power system buses. Motor loads fed from these buses are tripped by the bus undervoltage relays. However, power to the non-Class 1E 6.9kV ac permanent buses P1 and P2 is automatically restored from the A-AAC GTG and B-AAC GTG respectively. The A-AAC GTG is started automatically by the undervoltage relays on bus P1 and B-AAC GTG is started automatically by the bus undervoltage relays on bus P2 during the LOOP condition. As soon as the AAC GTGs reach their preset voltage and frequency limits, the circuit breakers connecting the A-AAC GTG and B-AAC GTG to their respective selector circuits A and B are closed, as shown in Figure 8.3.1-2. The circuit breakers in the 6.9kV switchgears P1 and P2 and the disconnect switches in the selector switches A and B, normally closed. Therefore, power to the 6.9kV buses P1 and P2 is restored as soon as the circuit breaker connecting A-AAC GTG to selector circuit A and B-AAC GTG to selector circuit B are closed. The automatic load sequencer starts the loads on the permanent buses P1 and P2 as required under LOOP condition as shown in Figure 8.3.1-2.

The A-AAC GTG and B-AAC GTG can also be connected manually to their respective 6.9kV permanent buses P1 and P2 during periodic online testing of the AAC GTGs. This can be done locally from the panels located in the power source buildings (PS/Bs) housing the AAC GTGs, or remotely from the main control room (MCR).

13.8kV-480V, two winding SSTs connected to the 13.8kV buses N1 and N2 provide power to the non-Class 1E 480V load center buses N1 and N2 respectively.

6.9kV-480V, two winding SSTs connected to the 6.9kV buses N3, N4, N5, N6, P1 and P2 provide power to non-Class 1E 480V load center buses N3, N4, N5, N6, P1 and P2 respectively. The non-Class 1E 480V load center buses feed the non-Class 1E MCC buses.

A tie connection is provided between all these non-Class 1E 480V load center buses so that in case of loss of power from any one of the non-Class 1E SSTs, the loads on the affected load center bus can be transferred manually to any of the remaining operable load center buses.

The reactor coolant pump (RCP) motors are connected to the non-Class 1E 6.9kV switchgear buses N3, N4, N5 and N6 through two circuit breakers in series. One circuit breaker is located in the reactor building (R/B) and it is qualified for Class 1E application. The other circuit breaker has the same quality and is located in non-Class 1E 6.9kV switchgear in the T/B, as shown in Figure 8.3.1-1.

The non-Class 1E 13.8kV switchgear N1, N2, 6.9kV switchgear N3, N4, N5, N6, P1 and P2 and 480V load centers N1, N2, N3, N4, N5, N6, P1 and P2 are located in the T/B electrical room as shown in Table 8.3.1-9. Status of these circuit breaker is displayed in the MCR.

The A-AAC GTG and B-AAC GTG are located in separate rooms in the PS/B. The rooms for the A-AAC GTG and B-AAC GTG are physically separated from each other and also from the Class 1E GTG rooms as shown in the Figure 8.3.1-4. The non-Class 1E AAC GTGs are of different ~~rating with diverse starting mechanism~~ manufacturer compared to the Class 1E GTGs and do not share any common auxiliaries or support systems with the Class 1E GTGs. This minimizes common-cause failure between the AAC GTGs and the Class 1E GTGs. Each AAC GTG is provided with a 1.5 hour fuel oil day tank and a fuel oil storage tank. The fuel capacity is adequate for 7 days operation. During SBO, the power to the Class 1E buses A or B is restored manually from A-AAC GTG by closing the disconnect switch in the selector circuit A and the circuit breaker in the Class 1E 6.9kV switchgear A or B, to cope with the SBO condition. Similarly, during SBO, the power to the Class 1E buses C or D can also be restored manually from the B-AAC GTG by closing the disconnect switch in the selector circuit B and the circuit breaker in the Class 1E 6.9kV switchgear C or D, to cope with the SBO condition. Only one safety train is required for coping with the SBO event. Table 8.3.1-6 shows the loading on AAC GTG

DCD_08.03.01-38

This regulatory guide endorses IEEE Std 603 (Reference 8.3.1-4) with some clarifications regarding applicability and use of industry standards referenced in Section 3 of IEEE Std 603 (Reference 8.3.1-4). IEEE Std 603 (Reference 8.3.1-4) provides minimum functional and design requirements for the power, instrumentation, and control portions of safety systems for nuclear power generating stations. The IEEE Std 603 (Reference 8.3.1-4) was reissued in 1998 and this later version of the standard is used to establish the minimum functional and design requirements for the safety dc power system. The regulatory positions cited in RG 1.153 (Reference 8.3.1-5) are of clarifying nature and the intent of these regulatory positions is considered in establishing the minimum functional and design requirements for the safety-related ac power system.

- RG 1.155, "Station Blackout"

  This regulatory guide provides guidance for complying with 10 CFR 50.63 (Reference 8.2-5). The plant has two AAC power sources of which only one is required to be operational to cope with an SBO event. The AAC power source design, operation, testing, maintenance and associated quality assurance requirements conform to the guidance provided in RG 1.155. Power to all electrical loads that are required to be operational, is restored within one hour from the onset of an SBO event. AAC source power to only one Class 1E 6.9kV bus is required to cope with an SBO event. Non-Class 1E equipment and circuits that are associated with the AAC power sources are completely independent from the onsite Class 1E standby power sources and the offsite power sources. The Class 1E GTGs are not operated in parallel with the AAC GTGs except briefly during recovery from SBO. The AAC GTGs are not operated in parallel with offsite power sources except during testing of AAC GTGs and recovery from SBO. The AAC GTGs are of different ~~size and have different starting system~~ manufacturer from the Class 1E GTGs. DCD_08.03.01-38

- RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"

  This regulatory guide endorses revision 2 of NUMARC 93-01 (Reference 8.2-6) with some provisions and clarifications for complying with 10 CFR 50.65 (Reference 8.2-7). Conformance to this regulatory guide is generically addressed in Section 1.9.

- RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants"

  This regulatory guide endorses Section 11 of NUMARC 93-01 (Reference 8.2-6) dated February 11, 2000 with some provisions and clarifications for complying with 10 CFR 50.65(a)(4) (Reference 8.2-7). Conformance to this regulatory guide is generically addressed in Section 1.9.

- RG 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants"

8.4.1.3 Alternate AC Power Sources

AAC power sources and their connections to the onsite and offsite ac power systems meet the requirements of RG 1.155 (Reference 8.3.1-21).

Two full capacity 4000 kW, 6.9 kV non-Class 1E GTGs (A and B) are provided as AAC sources and any one of these two GTGs can meet the SBO load requirements shown in Table 8.3.1-6 for the time required to bring and maintain the plant in a safe shutdown condition. Two AAC GTGs are provided for operational flexibility and enhanced reliability, even though the provision of one AAC GTG is adequate to meet the requirements of RG 1.155 (Reference 8.3.1-21). RG 1.155 Appendix B (Reference 8.3.1-21) does not require a single failure criterion to be applicable to the AAC power source. Hence, the provision of two 100% capacity AAC sources will provide greater US-APWR reliability for coping with an SBO event than what is intended by RG 1.155 (Reference 8.3.1-21). The AAC power sources reach set voltage and frequency within 100 seconds from receiving the starting signal. Controls exist in the MCR to start, stop and synchronize the AAC power sources.

To minimize the potential for common mode failures with the Class 1E GTGs, ~~different rating GTGs with diverse starting system~~GTGs of different manufacturer from Class 1E GTGs are provided as AAC sources. The auxiliary and support systems for the AAC GTGs are independent and separate from the Class 1E GTGs to minimize the potential for common mode failures. Completely separate and independent fuel supply systems and onsite fuel storage tanks are provided for the Class 1E GTGs and for the non-Class 1E AAC GTGs. DCD_08.03.01-38

The A-AAC GTG and B-AAC GTG are located in separate rooms in the PS/B. A-AAC GTG is connected to the non-Class 1E 6.9 kV permanent bus P1 through a selector circuit A. Similarly, B-AAC GTG is connected to the non-Class 1E 6.9 kV permanent bus P2 through a selector circuit B. The selector circuit consists of one circuit breaker connected to the AAC source and three disconnect switches. The disconnect switches in the selector circuit A are connected to the 6.9 kV buses P1, A and B (or P2, C and D for selector circuit B) through tie lines, as shown in Figure 8.3.1-1.

The A-AAC GTG and B-AAC GTG are connected to the circuit breakers in selector circuits A and B, respectively. The selector circuits A and B are located in the PS/B. The non-Class 1E 6.9 kV and 480 V permanent power supply systems P1 and P2 are located in the T/B electrical room. These AAC GTG circuit breakers in the selector circuits A and B are normally open and the AAC power sources are not normally connected directly to the plant offsite or onsite power system. The Class 1E circuit breakers in the Class 1E MV switchgears are connected to the disconnect switches (non-Class 1E) in the selector circuits A and B as shown in Figure 8.3.1-1. The non-Class 1E disconnect switches in the selector circuits A and B, and the Class 1E incoming circuit breakers in the Class 1E MV switchgear from the AAC GTG are normally open and do not have any automatic closing function. They perform the isolation between the Class 1E and the non-Class 1E system. This meets RG 1.155, Appendix B (Reference 8.3.1-21) requirements for isolation between AAC sources and the onsite and offsite power systems.

~~The different rating and diverse starting mechanism of the AAC sources from the emergency ac power sources,~~The adoption of different manufacturers and diverse DCD_08.03.01-38 starting mechanisms between the AAC power sources and the emergency ac power sources, the location of AAC sources in separate rooms, the independent auxiliaries, and the interconnections to the offsite and onsite emergency ac power systems ensure that no single point of vulnerability exists. Therefore, a weather-related event or a single failure could not disable all the onsite emergency ac sources and offsite ac power supplies simultaneously along with all the AAC sources.

The AAC sources can be started and connected manually to the onsite Class 1E MV buses within 60 minutes during SBO conditions.

The restoration of power from any one of the AAC sources to any one of the onsite Class 1E MV buses (A-AAC GTG to the Class 1E 6.9kV buses A or B, or B-AAC GTG to the 6.9kV Class 1E buses C or D) is adequate to cope with the SBO condition. The sequence of switching operations for restoring power to the Class 1E 6.9kV buses A or B from the A-AAC GTG during an SBO is described in the following procedure. The sequence of switching operations for restoring power from the B-AAC GTG to the Class 1E 6.9kV buses C or D during an SBO is similar:

1. The A-AAC GTG is started automatically by the undervoltage signal on the 6.9 kV permanent bus P1 due to LOOP.

2. The incoming breakers from the offsite power supply sources to the 6.9 kV permanent bus P1 are tripped and locked out by the undervoltage signal on bus P1.

3. The disconnect switch in the selector circuit connecting to 6.9 kV permanent bus P1 and the circuit breaker on the non-Class 1E 6.9 kV permanent bus P1 are normally closed.

4. The circuit breaker A in the selector circuit A for the A-AAC GTG is closed automatically after the A-AAC GTG reaches the set voltage and frequency and the power supply from the A-AAC GTG is restored to the 6.9 kV permanent bus P1 automatically. The loads on the non-Class 1E 6.9 kV and the 480 V permanent buses P1 are started automatically by the LOOP sequencer.

5. The disconnect switches in the selector circuit A and the incoming circuit breakers from AAC in the Class 1E 6.9 kV switchgear are normally open. Hence, power from AAC source is not restored automatically to the onsite Class 1E 6.9 kV buses A or B.

6. Most of the ac loads on the Class 1E 6.9kV buses A and B are tripped by undervoltage signal except the feeders to the 480 V load centers, battery chargers, emergency lighting etc. Before restoring the power supply to the Class 1E buses from the A-AAC GTG, the loads supplied from the non-Class 1E permanent bus P1, are tripped manually.

7. Power is restored to one of the Class 1E 6.9 kV buses A or B from A-AAC GTG by manually closing the associated disconnect switch in selector circuit A and the

8.4.2.1.2 Station Blackout Coping Analysis

The SBO rule in accordance with 10 CFR 50.63 (Reference 8.2-5) states that no coping analysis is required if the AAC sources can be demonstrated by test to be available to power the shutdown buses within 10 minutes of the onset of an SBO.

Two GTGs of a different ~~rating with diverse starting mechanism~~ manufacturer from the Class 1E GTGs are provided as AAC sources. These AAC GTGs are independent from the Class 1E GTGs and do not share any common auxiliaries or support systems. The AAC GTGs are not normally connected to the plant offsite or onsite power systems. The AAC GTGs are electrically isolated from the emergency Class 1E power supply systems by a non-Class 1E disconnect switch and a Class 1E circuit breaker. The disconnect switch and the Class 1E circuit breaker connecting the AAC GTG to the Class 1E buses are normally open, and would be manually closed during an SBO to restore the power supply to one of the Class 1E 6.9 kV buses A or B, or C or D. The AAC GTGs are automatically started by the undervoltage signal on the 6.9kV permanent buses P1 or P2 and connected to the respective 6.9kV permanent bus P1 or P2 during LOOP. The AAC GTGs can also be manually started and connected to the Class 1E emergency buses. The AAC GTGs start and reach the rated frequency and voltage and are ready to be loaded within 100 seconds. Each AAC source is capable of providing adequate power to the emergency shutdown buses. The power supply from the AAC GTG to one of the Class 1E buses can be restored within 60 minutes. Availability of power from the AAC GTG to one Class 1E 6.9kV bus within 60 minutes is verified by actual field testing. Since the power supply from the AAC GTG to the Class 1E buses cannot be restored within 10 minutes, the following coping analysis is performed for the US-APWR in accordance with the requirements of Section C.3.2 of RG 1.155 (Reference 8.3.1-21): DCD_08.03.01-38

1. After SBO occurs, all ac power sources including all Class 1E GTGs, are lost, except for ac power from the UPS. Power from the AAC GTG will be restored to the required Class 1E power system within 60 minutes. During the 60 minutes, no pumps and fans connected to the Class 1E 6.9kV and 480V ac buses can be operated.

2. With the plant be in above condition, the systems can be kept in safe condition as described below:

   (1) ~~Core and reactor coolant system (RCS) condition~~ DCD_08.04-12

   ~~Until AAC GTG restores the Class 1E power system within one hour after SBO occurs, all pumps and fans cannot be operated. However, during this time, the plant is in a condition similar to hot shut down. Turbine driven (T/D) emergency feedwater (EFW) pump and, main steam relief valve remove the decay heat of the core through natural circulation of the reactor coolant and the core and the RCS are kept in a safe mode. After SBO occurs, the isolation valves on No. 1 seal leak off line of each RCP are closed by the undervoltage signal. The leakage through the No.2 seal is limited and minimal. Thus, the reactor core will remain covered.~~

   (2) RCP seal

NUMARC-87-00 (Reference 8.4-1) also provides guidance acceptable to the staff for meeting these requirements. RG 1.155 (Reference 8.3.1-21) takes precedence when noted in Table 1 of RG 1.155 (Reference 8.3.1-21).

The non-Class 1E AAC power supplies and the connections to the onsite emergency Class 1E power supply system meet all the requirements of RG 1.155 (Reference 8.3.1-21). The AAC power sources meet the recommendations listed under Section C.3.3.5 of RG 1.155 as discussed in the following paragraphs.

Two AAC GTGs, which are independent and of different manufacturer~~have different rating with diverse starting mechanism~~ from the Class 1E ac power sources, are provided as AAC sources to minimize common mode failures. This meets the criterion of having power sources that are independent and diverse from the normal Class 1E ac power sources in accordance with Section C.3.2.5 of RG 1.155 (Reference 8.3.1-21). DCD_08.03.01-38

The AAC GTGs are not normally connected to the offsite or onsite emergency ac power supply systems. The AAC GTGs are connected to the non-Class 1E 6.9 kV permanent buses, P1 and P2 only during LOOP or online test of AAC GTG conditions. The AAC GTGs and their associated non-Class 1E selector circuits A and B are located in separate rooms. The AAC GTGs and the onsite Class 1E ac power system are electrically isolated by a disconnect switch (non-Class 1E) and a circuit breaker (Class 1E) in series. The auxiliaries and support systems for the AAC GTGs are separate and are not shared with the onsite Class 1E ac systems. Therefore, no single point vulnerability exists whereby a weather-related event or single active failure could disable any portion of the blacked-out unit's onsite Class 1E power sources or the offsite power sources and simultaneously fail the AAC GTGs. This meets the criteria 1 and 2 of Section C.3.3.5 of RG 1.155 (Reference 8.3.1-21).

The AAC GTGs are automatically started by the undervoltage signal on the 6.9 kV permanent buses, P1 or P2, and are automatically connected to their respective permanent buses within 100 seconds. The AAC GTGs can be connected manually to the onsite Class 1E buses by closing the non-Class 1E disconnect switch in the selector circuit and the Class 1E incoming circuit breaker in the Class 1E 6.9 kV switchgear as described in Subsection 8.4.1.3. Power supply to at least one of the onsite Class 1E ac train can be restored from the AAC sources within 60 minutes. The availability of power supply to one of the four Class 1E trains is adequate for coping with an SBO event. This meets the requirements of Criterion 3 of Section C.3.3.5 of RG 1.155 (Reference 8.3.1-21).

Each AAC GTG has sufficient capacity to operate the systems necessary for coping with an SBO event for the time required to bring and maintain the plant in safe shutdown condition. Two AAC GTGs are provided even though the provision of only one is adequate to meet the regulatory requirements. This meets the contingency of one AAC GTG not available. Single failure for the AAC GTGs need not be considered in accordance with Appendix B, RG 1.155 (Reference 8.3.1-21). Each AAC GTG has adequate fuel to operate the systems required for coping with an SBO for 8 hours. Therefore, the AAC GTGs meet Criterion 4 of Section C.3.3.5, RG 1.155 (Reference 8.3.1-21).

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 3 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.5.1 Table 2.5.1-3 Table 2.5.1-6 ITAAC #4 2.5.4 Table 2.5.4-2 ITAAC #2	Containment isolation and heat removal can be manually actuated in the event of failure of the containment isolation signal.	Table 19.1-119
2.5.1 Table 2.5.1-3 Table 2.5.1-6 ITAAC #4 2.5.4 Table 2.5.4-2 ITAAC #2	ESF actuation can be performed manually in the event of failure of automatic ESF actuation.	Table 19.1-119
2.6.1 Table 2.6.1-3 ITAAC #1 2.6.5 Table 2.6.5-1 ITAAC #1	Non-Class 1E 6.9kV permanent buses P1 and P2 are also connected to the non-Class 1E A-AAC GTG and B-AAC GTG, respectively. The loads which are not safety-related but require operation during LOOP are connected to these buses.	8.3.1.1.1 Table 19.1-119
2.6.1 Table 2.6.1-3 ITAAC #24	Non-segregated busducts/cable buses to safety buses in the T/B electrical room are segregated into two groups by qualified fire barriers.	8.3.1.1.8 9.5.1 19.1.5.2 Table 19.1-1 Table 19.1-119
2.6.4 Table 2.6.4-1 ITAAC #3, #11, #32	The GTG does not need a cooling water system. Cooling of GTG is achieved by air ventilation system GTG combustion air intake and exhaust system for each of the four GTGs supply combustion air of reliable quality to the gas turbine and exhausts combustion products from the gas turbine to the atmosphere. The air intake also provides ventilation/cooling air to the GTG assembly.	9.5.5 9.5.8 Table 19.1-119
2.6.5.1 Table 2.6.5-1 ITAAC ~~#13,~~ #14, #15	Common cause failure between class 1E GTG and non-class 1E GTG ~~supply~~ is minimized by design characteristics. The AAC power sources ~~are of different size,~~ have different starting systems from the EPS, and the AAC power source engine and generator are designed by a different manufacturer than the class 1E EPS engine and generator.	8.4.1.3 Table 19.1-119
2.6.5.1 Table 2.6.5-1 ITAAC #6	In the event of SBO, power to one Class 1E 6.9kV bus can be restored manually from the AAC GTG. Power to the shutdown buses can be restored from the AAC sources within 60 minutes.	8.3.1.1.2.4 8.4.1.2 8.4.1.3 Table 19.1-119

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NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 4 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.6.5.1 Table 2.6.5-1 ITAAC #1	Alternate ac power supported by two non-Class 1E GTGs is incorporated as a countermeasure against SBO. Alternate ac power sources can supply power to two of the four safety buses in case class 1E GTGs fail during loss of offsite power. AAC power sources are non-Class 1E and non-seismic. AAC power sources supply power to loads required to bring and maintain the plant in a safe shutdown condition for a station blackout (SBO) condition.	8.4.1.3 19.1.3.1 19.1.3.4 19.1.4.1 Table 19.1-1 19.2.2
2.6.5.1 Table 2.6.5-1 ITAAC #1, #5, ~~#13,~~ #14, #15	~~AAC power sources use different rating GTGs than the Class 1E EPSs, with diverse starting system, independent and separate auxiliary and support systems to minimize common cause failure.~~ AAC power sources use diverse starting systems, independent and separate auxiliary and support systems to minimize common cause failure, and AAC power source engine and generator are designed by a different manufacturer than the class 1E EPS engine and generator.	8.4.1.3 Table 19.1-119
2.7.1.2 Table 2.7.1.2-5 ITAAC #8.a 2.7.1.11 Table 2.7.1.11-5 ITAAC #8.a, #18	Main steam depressurization valves (MSDVs) on intact SG(s) can be opened and EFW flow established to promote heat removal and RCS depressurization.	Table 19.1-119
2.7.1.11.1 Table 2.7.1.11-5 ITAAC #1.a	Each EFW pump discharge line connects with a cross-tie line using normally closed motor-operated isolation valves to provide separation of four trains. Operation to open the EFW cross-tie valve when an EFW pump is not available is an important feature to reduce core damage frequency.	10.4.9.2 19.1.4.1 19.2.2
2.7.3.1 Table 2.7.3.1-5 ITAAC #10.a	In the case of failure of running ESWS, with ESW flow rate – low, the standby ESW pump can be started in order to maintain ESWS operation.	Table 19.1-119
2.7.3.1 Table 2.7.3.1-5 ITAAC #1.a	In the case of ESW pump discharge blockage, flow can be switched from the blocked strainer to the standby strainer.	Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #8.a	CCW header tie line isolation valves may be manually closed to achieve header separation in the event of failure of automatic valve closure.	Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #10.a	In the case of failure of running CCWS, with CCW flow rate – low, the standby CCW pump can be started in order to maintain CCWS operation.	Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

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function is addressed in the ET of Level 1 model discussed in Subsection 19.1.4.1.1 and Subsection 19.1.6.1.

- I&C system (Chapter 7, Section 7.1)

  The I&C system consists of the safety-related protection and safety monitoring system (PSMS), the non safety-related plant control and monitoring system (PCMS), and the non safety-related DAS. The DAS monitors and controls safety and non-safety systems, required to cope with anticipated operational occurrences and postulated accidents concurrent with a common cause failure the disables all functions of the PSMS and PCMS. These functions are addressed in the ET and FTs of Level 1 PRA model discussed in Subsection 19.1.4.1.1 and Subsection 19.1.6.1.

- Refueling water storage pit (Chapter 6, Section 6.3).

  Refueling water storage pit (RWSP) is the water source for SI pumps and CS/RHR pumps and has sufficient inventory of boric acid water for refueling and long-term core cooling during a LOCA event. Four independent ECC/CS strainers are installed inside the RWSP. This function is addressed in the FTs of at power Level 1 model discussed in Subsection 19.1.4.1.1.

  During plant shutdown, water in the RWSP is transferred to RWSAT which is water source for charging pump or to spent fuel pit for gravity injection via refueling water recirculation (RWR) pumps. This function is addressed in the FTs of LPSD PRA model discussed in Subsection 19.1.6.1.

The following non-safety systems are also considered key preventive features:

- Alternate containment cooling (Chapter 9, Subsection 9.4.6)

  In the case of the loss of containment cooling at accident conditions, alternate containment cooling utilizing containment fan cooler system is performed by connecting the component cooling water (CCW) system to the containment fan cooler system. Alternate containment cooling provides long term containment cooling by natural convection in containment. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Alternate ac power source (Chapter 8, Subsection 8.4.1.3)

  In addition to the class 1E GTGs, two non-class 1E GTGs are provided to supply power to permanent buses. These two GTGs also functions as an alternate ac power source (AAC), which can supply power to any two of the four Class 1E ac buses in case class 1E GTGs fail during loss of offsite power. To minimize the potential for common cause failures with the class 1E GTGs, the AAC power source engine and generator are designed by a different manufacturer than the class 1E EPS engine and generator, and have~~different rating GTGs with~~ diverse starting systems~~ are provided~~. ~~Furthermore~~Additionally, the auxiliary and support systems for the AAC GTGs are independent and separate from the class 1E GTGs to minimize the potential for common cause failures. This function is

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Table 19.1-119 Key Insights and Assumptions (Sheet 15 of 48)

Key Insights and Assumptions	Dispositions
14. Onsite Electric Power System	
- The onsite Class 1E electric power systems comprise four independent and redundant trains, each with its own power supply, buses, transformers, and associated controls.	8.3.1.1 8.3.1.1.2.1 8.3.1.1.3
- One independent Class 1E GTG is provided for each Class 1E train.	8.3.1.1.2.1
- Non-Class 1E 6.9kV permanent buses P1 and P2 are also connected to the non-Class 1E A-AAC GTG and B-AAC GTG, respectively. The loads which are not safety-related but require operation during LOOP are connected to these buses.	8.3.1.1.1
- In the event of SBO, power to one Class 1E 6.9kV bus can be restored manually from the AAC GTG.	8.3.1.1.1 8.3.1.1.2.2 8.3.1.1.2.3 19.2.5 COL 13.5(6) COL 13.5(7) COL 19.3(6)
- Common cause failure between class 1E GTG and non-class 1E GTG ~~supply~~ is minimized by design characteristics. ~~Different rating GTGs with diverse starting system, independent and separate auxiliary and support systems are provided to minimize common cause failure.~~The AAC power source engine and generator are designed by a different manufacturer than the class 1E EPS engine and generator, and have diverse starting systems, independent and separate auxiliary and support systems.	8.3.1.1.1 8.4.1.3
- The non-safety GTG can be started manually when connecting to the class 1E bus in the event of SBO.	8.4.1.3
- Power to the shutdown buses can be restored from the AAC sources within 60 minutes	8.4.1.3
- Power to the shutdown buses can be restored from the AAC sources within 60 minutes	8.4.1.3
- The GTG does not need cooling water system. Cooling of GTG is achieved by air ventilation system	8.3.1.1.3 8.3.1.1.3.10 9.5.5 9.5.8
- GTG combustion air intake and exhaust system for each of the four GTGs supply combustion air of reliable quality to the gas turbine and exhausts combustion products from the gas turbine to the atmosphere. The air intake also provides ventilation/ cooling air to the GTG assembly.	

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2.6.5 Alternate AC (AAC) Power Source

2.6.5.1 AAC Design Description

Two AAC power sources are provided to supply ac power in case there is a complete loss of offsite power (LOOP) and loss of Class 1E EPSs. AAC power sources supply power to loads required to bring and maintain the plant in a safe shutdown condition for a station blackout (SBO) condition. AAC power sources also provide power to the 6.9kV permanent buses during a LOOP condition. The AAC sources and their connections to Class 1E 6.9kV buses and to non-Class 1E 6.9kV permanent buses are shown on Figure 2.6.1-1. These AAC power sources are non-Class 1E and non-seismic. The two AAC power sources are redundant in that only one AAC power source is required to meet SBO requirements.

1. The functional arrangement of the AAC power sources is as described in the Design Description of Subsection 2.6.5.1.

2. The AAC power sources are located in separate dedicated rooms.

3. Each AAC power source is isolated from the Class 1E power supply systems by a non-Class 1E disconnect switch and a Class 1E circuit breaker connected in series.

4. The Class 1E circuit breakers for the AAC power sources in Class 1E medium voltage switchgear are connected to disconnect switches (non-Class 1E) in selector circuits.

5. Separate and independent fuel supply systems and onsite fuel storage tanks are provided for Class 1E EPSs and AAC power sources.

6. The AAC power sources can be started and connected manually to onsite Class 1E medium voltage buses within 60 minutes during SBO conditions.

7. The AAC power sources fuel oil storage tanks have enough fuel capacity to supply power to the required SBO loads for 8 hours.

8. Controls exist in the MCR to start, stop and synchronize the AAC power sources.

9. Each AAC power source is capable of providing power at the set voltage and frequency to the non-Class 1E 6.9kV buses after receiving a start signal.

10. Each AAC power source status and the breaker status of each Class 1E 6.9kV breaker for the AAC power sources are displayed in the MCR.

11. The functional arrangement of the AAC fuel oil storage and transfer system is as described in the Design Description of Subsection 2.6.5.2.

12. Deleted

13. The two AAC power sources are each sized to meet load requirements for SBO and LOOP conditions. ~~The size of the AAC power source is different than the Class 1E EPSs.~~ DCD_08.03.01-38

14. The two AAC power sources have a diverse starting system from the Class 1E EPSs.

15. The AAC power source design is different than the Class 1E EPS design. DCD_08.03.01-38

2.6.5.2 AAC Fuel Oil Storage and Transfer Systems (FOS) Design Description

Each AAC power source is provided with dedicated fuel oil supply system, fuel oil day tank and storage tank:

- The AAC FOSs are non safety-related.
- Each AAC fuel oil day tank is located inside the associated AAC power source room in the PS/B.

2.6.5.3 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.6.5.1-1 describes the ITAAC for the AAC power source.

Table 2.6.5-1 AAC Systems Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 3 of 3)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria	
13. The two AAC power sources are each sized to meet the load requirements for SBO and LOOP conditions. ~~The size of the AAC power source is different than the Class 1E EPSs.~~	13.i Analyses will be performed to verify the AAC power sources are each sized to meet load requirements for SBO and LOOP conditions.	13.i A report exists and concludes that the two AAC power sources are each sized to meet load requirements for SBO and LOOP conditions.	DCD_08.03.01-38
	13.ii Inspection will be performed to verify that the ratings of the as-built AAC power sources bound the analyses.	13.ii The ratings of the two as-built AAC power sources bound the analyses.	
	~~13.iii Inspection will be performed to verify that the size of the as-built AAC power sources is different than the as-built Class 1E EPSs.~~	~~13.iii The size of the as-built AAC power sources is different than the as-built Class 1E EPSs.~~	DCD_08.03.01-38
14. The two AAC power sources have a diverse starting mechanism from the Class 1E EPSs.	14. Inspection of the as-built starting mechanisms for the Class 1E EPSs and the AAC power sources will be performed.	14. Diverse starting mechanisms are provided for the as-built Class 1E EPSs and the as-built AAC power sources.	
15. The AAC power source design is different than the Class 1E EPS design.	15. Inspection will be performed to verify that the as-built AAC power source engine and generator are designed by a different manufacturer than the as-built Class 1E EPS engine and generator.	15. The as-built AAC power source engine and generator are designed by a different manufacturer than the as-built Class 1E EPS engine and generator.	DCD_08.03.01-38