

# REQUEST FOR ADDITIONAL INFORMATION 318-2227 REVISION 1

4/6/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 09.05.04 - Emergency Diesel Engine Fuel Oil Storage and Transfer System  
Application Section: Tier 2 9.5.4

QUESTIONS for Balance of Plant Branch 2 (ESBWR/ABWR) (SBPB)

09.05.04-6

**RAI 9.5.4-01:** FSAR Tier 2 Table 9.5.4-1 states that the safety related portion of the system piping, fitting and valves will be ASME Section III. This implies that a portion of the system piping will be non-safety related. SRP 9.5.4 stipulates that the demarcation between safety-related and non-safety related piping be indicated on the system drawings. There is no indication of the boundaries on FSAR Tier 2 Figure 9.5.4-1. The applicant should revise Figure 9.5.4-1 to indicate the demarcation between safety and non-safety related portions of the system.

09.05.04-7

**RAI 9.5.4-02:** The FSAR asserts that each of the four fuel oil storage tank containment structures is designed to withstand hurricane or tornado related damages, and that the systems are safe from flooding. However, the FSAR provides no evidence to demonstrate that these assertions are true. Specifically, SRP Section 9.5.4 requires that the fill line terminate above the flood level. No indication of this design feature was found within the FSAR. The applicant should provide specific design information to demonstrate protection against flooding.

09.05.04-8

**RAI 9.5.4-03:** It is not clear from the GTGFSS system description in FSAR Tier 2 Section 9.5.4.2 that all of the system components are located within a reinforced concrete, seismic Category I, missile-protected, flood-protected structure. For example, it is not clear whether the fuel oil transfer pump skids are located within such a structure. The applicant should identify any equipment that is not located within this type of structure and describe how these portions of the system are protected from natural phenomena and environmental and dynamic effects as required by GDC 2 and GDC 4.

09.05.04-9

**RAI 9.5.4-04:** Regulatory Guide 1.137 requires a seven-day fuel supply for each emergency power generator. It also clearly defines two methods that one may use to calculate the required fuel inventory volume. The FSAR states that a seven-day fuel volume is supplied for each GTG system. However, the FSAR does not provide any

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detail on how the required inventory volume was calculated. Neither the anticipated fuel consumption rate nor the accessible fuel inventory is stated within the FSAR. The same lack of detail applies to the one and one-half hour inventory in the day tanks. This information should be provided to the NRC. FSAR Tier 2 Section 9.5.4.1 states that the GTGFSS is also in accordance with ANSI/ANS-59.51-1997. Section 5.5.1 of ANSI/ANS-59.51-1997 includes a requirement that the fuel oil day tank provide sufficient capacity below the low-level alarm setpoint plus a margin of 10 percent to maintain full load operation of the engine for another 60 minutes. This section of the standard also provides guidance for additional margins for tank level instrumentation error, etc. FSAR Tier 2 Section 9.5.4 does not address the specific criteria for establishing the capacity of the storage and day tanks and does not address the design requirements or guidance in the ANSI/ANS standard. The applicant should provide more specific information on the calculation of the 7-day storage volume and to verify compliance with this ANSI/ANS-59.51 requirement/guidance or to provide an alternative design criteria with justification.

09.05.04-10

**RAI 9.5.4-05:** FSAR Tier 2 Section 9.5.4.1 states that the GTGFSS is designed in accordance with ANSI/ANS-59.51-1977. In general, there are a number of specific requirements in the ANSI/ANS-59.51-1997 standard that are not described in the FSAR or the description in the FSAR appears to be in conflict with the requirements of the standard. Some of the specific issues are addressed in the staff's RAIs, but the applicant should perform a detailed review of the ANSI/ANS standard, identify all deviations, and provide justification for the deviations.

09.05.04-11

**RAI 9.5.4-06:** The physical provisions for sampling the fuel oil are not fully described in the FSAR. Tier 2 Section 9.5.4.2.2.1 mentions a sampling connection on the fuel oil storage tanks, but does not describe the piping configuration. Industry experience has shown that some drain/sample connections at the bottom of a tank have been connected to small internal standpipes inside the tank, such that the drain/sample point was not really at the bottom of the tank, and water can accumulate at the bottom of the tank and possibly above the fuel discharge pipe. In addition, ANSI/ANS 59.51-1997 Section 6.4.1.2 states that the sampling capability should include provisions to obtain a flowing sample as well as a tank aggregate sample. The US-APWR FSAR does not mention capability for a flowing sample. FSAR Tier 2 Section 9.5.4.3 states that the fuel oil storage tank sample connections are located at grade elevation. It is not clear how the contents of a below-grade tank can be sampled from a connection at grade without some means of lifting the oil up to grade elevation. Sample connections should also be shown on FSAR Figure 9.5.4-1. The applicant should address the guidance provided by the ANSI/ANS standard and fully describe the fuel oil sampling configuration in the FSAR.

09.05.04-12

**RAI 9.5.4-07:** The guidelines of NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability," state that fuel storage tanks have a gravity drain from the

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very bottom of the tank. The fuel outlet pipe or opening should be approximately 2 or 3 inches above the bottom of the water outlet pipe to allow some tank volume for settling of water. The applicant should confirm that this guideline has been met in the US-APWR design and update the FSAR to state that the guideline has been met.

09.05.04-13

**RAI 9.5.4-08:** FSAR Tier 2 Section 9.5.4.2.2.1 describes the flame arrestor on the fuel oil storage tank and the fuel oil day tank. Both flame arrestors are vented to the outside. In order to meet the availability requirements of GDC 17, fuel oil and day tank vent flame arrestors must remain clear of insect nests, ice, etc. The applicant should provide verification that equipment and/or procedures will be in place to ensure continuous safe operation of the flame arrestor/vents and describe the design to ensure that the vents remain functional.

09.05.04-14

**RAI 9.5.4-09:** FSAR Tier 2 Section 9.5.4.3 states that fuel oil storage tanks are protected from corrosion. Section 9.5.4.2.2.1 states that a primer and a finish coat are applied to both the exterior and interior surfaces of the fuel oil storage tanks. However information regarding the tank protection materials, application, and inspection is not provided. The following information is necessary for the staff to conclude the tanks are sufficiently reliable.

1. Specify coating materials used to protect the fuel oil tank from corrosion.
2. Specify the standards used in the coating process.
3. Specify the inspections that are required and their frequency.
4. Specify any cathodic protection used as required for underground tanks by Regulatory Guide 1.137
5. Specify any cathodic protection system tests as required by Regulatory Guide 1.137

09.05.04-15

**RAI 9.5.4-10:** FSAR Tier 2 Section 9.5.4.3 states that the piping between the underground storage tank and the GTG building is routed in tunnels. The description does not indicate how the underground piping will be inspected. SRP Section 9.5.4 Paragraph 9.5.4 I.1.G, specifies that the design include the capability to detect and control system leakage, including isolating system portions in the event of excessive leakage or component malfunction. The FSAR should explain how the system design includes the capability to detect and control system leakage, including isolating system portions in the event of excessive leakage or component malfunction. In particular, the description should address the underground portions of the system.

09.05.04-16

**RAI 9.5.4-11:** SRP Section 9.5.4 Section I(L) identifies that the GTGFSS review include verification that sufficient space is provided for inspection, maintenance and repair of the

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system. However, neither drawings nor discussions are provided that allow adequate review of this aspect of the system design. The applicant should provide appropriate drawings and/or description to address this issue.

09.05.04-17

**RAI 9.5.4-12:** The on-engine fuel oil pumps are fed by gravity from the fuel oil day tank. Since each day tank feeds two GTs (there are 2 GTs per GTG), an analysis should be performed based on the as-built piping arrangement to ensure that the oil drawn by one of the two pumps, does not starve the other pump. The applicant should describe the method used to ensure that both GT on-engine pumps will receive oil at the required pressure.

09.05.04-18

**RAI 9.5.4-13:** The applicant's supplemental document, "Qualification and Test Plan of Class 1E Gas Turbine Generator System," December 2007(MUAP-07024-P(R0)), Mitsubishi Heavy Industries, Ltd. (which is referenced in the Tier 2 FSAR Section 8.3.1), lists both diesel fuel and kerosene as potential fuels for the GTG. However, ASTM D975 limits fuel selection to diesel fuels. The applicant should address this inconsistency.

09.05.04-19

**RAI 9.5.4-14:** The use of alternative fuels such as biodiesel could affect the system operating characteristics, maintenance requirements and equipment life. The effects of these new fuels may not be well known, especially the long term effects. The applicant should state whether the use of alternative fuels is anticipated and if it is, what provisions will be made to determine the possible affect on the GTGFSS and what measures will be taken to ensure continued operation of the system.

09.05.04-20

**RAI 9.5.4-15:** The FSAR Tier 2 states that the fuel oil system is protected from cold temperatures (Section 9.5.4.2.1), and that the oil is maintained above the cloud point temperature (Section 9.5.4.3). However, the FSAR does not state how the system is protected from cold temperature or how the cloud point temperature is monitored. FSAR Tier 2 Chapter 16 Surveillance Requirement 3.8.3.3 references the GTG Fuel Oil Testing Program for details of how the quality of the oil will be tested and maintained. However the GTG Fuel Oil Testing Program described in FSAR Tier 2 Chapter 16 Section 5.5.13 does not specifically mention cloud point measurement. This fuel oil testing program also references ASTM but does not specify which ASTM standard will be used as the basis for testing the oil. The GTG Fuel Oil Testing Program requirement for periodic testing includes only the measurement of particulate. It does not mention cloud point as a parameter that will be measured periodically. The initial testing (prior to adding new fuel oil to the storage tank) and periodic testing should also include measurement of other parameters, including the moisture content of the oil and the viscosity (e.g., see Regulatory Position 2.b of RG 1.137. The description of fuel oil testing in the GTG Fuel Oil Testing Program is inconsistent with the system description in FSAR Tier 2 Section

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9.5.4.2.3. The applicant should describe how the oil will be protected from cold temperatures, how the oil will be maintained above the cloud point and provide specific details on the testing and maintenance program for the oil. The FSAR should be revised to incorporate these requirements and to provide a consistent description.

09.05.04-21

**RAI 9.5.4-16:** Aging of fuel is a quality issue that is typically addressed via a testing program. The FSAR does not specifically address fuel aging. In addition, US-APWR surveillance requirement 3.8.3.5 specifies that the fuel oil storage tanks will be checked for water accumulation and any water removed every 31 days or in accordance with the Surveillance Frequency Control Program. The guidance provided in Regulatory Positions 2.d through 2.f of RG 1.137 includes tests for the day tanks as well as the storage tanks and additional guidance for checking for water accumulation, corrective action to be taken if water is found, etc. This guidance also includes the complete removal of oil from the tanks and cleaning of the tanks at 10-year intervals. The applicant should provide specific information regarding the program to address fuel oil degradation and the guidance provided in RG 1.137.

09.05.04-22

**RAI 9.5.4-17:** Section 9.5.4.2.2.2 describes the fuel oil transfer pumps as components on modularized skids. FSAR Tier 2 Table 9.5.4-1 indicates that the fuel oil transfer pumps are designed to operate with a flooded suction. From Figure 9.5.4-1, it would appear that this transfer pump skid is at grade elevation and therefore above the tank. In order to ensure the GTGFSS design meets the availability requirements of GDC 17, staff needs information regarding available NPSH based on the design and on specified fuels. In addition, the applicant should specify a minimum NPSH required by the fuel oil transfer pumps. Available/required NPSH should be based on all pump design operating conditions, including pump runout.

09.05.04-23

**RAI 9.5.4-18:** Section 5.5.2 of ANSI/ANS-59.51-1997 includes a requirement that the fuel oil transfer pump design shall allow for partial strainer blockage and for pump degradation as defined in ASME Section XI. In addition, the standard requires that the pumps shall be sized and the controls arranged to prevent excessive cycling. FSAR Tier 2 Section 9.5.4 does not address this design criterion and therefore the applicant should state the design's compliance with the requirements of the ANSI/ANS standard or provide alternative criteria with justification.

09.05.04-24

**RAI 9.5.4-19:** FSAR Tier 2 Figure 9.5.4-1 indicates a containment curb around the fuel oil transfer pumps. If these pumps are located outdoors and uncovered, the applicant should provide a description of how rainwater accumulation will be monitored and removed to ensure that pump operation is not adversely impacted by the water.

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09.05.04-25

**RAI 9.5.4-20:** The description of system filters and strainers in FSAR Tier 2 Section 9.5.4.5 is unclear and inconsistent with Figure 9.5.4-1. This section describes instrumentation for “fuel oil transfer pump discharge strainers” and separately describes instrumentation for “the filter in the discharge line to the day tank”. These are the same lines – between the pump discharge and the day tank inlet - implying that there are both strainers and a filter in the line between the pump discharge and the day tank. In addition, neither the described filter nor the strainers are shown on Figure 9.5.4-1 or described in Table 9.5.4-1. The figure indicates only a single Y-type strainer in the transfer pump suction line. ANSI/ANS-59.51-1997 requires that two strainers be provided in a parallel arrangement that allows cleaning of a dirty strainer during engine operation. In addition, according to the “Qualification and Test Plan of Class 1E Gas Turbine Generator System,” December 2007(MUAP-07024-P(R0)), Section C.2.2.6.4, a filter is provided between the day tank and the engine driven pump. Figure 9.5.4-1 does not show this filter. The applicant should resolve these inconsistencies, provide design information on the strainers/filters and revise the FSAR accordingly.

09.05.04-26

**RAI 9.5.4-21:** Section 5.5.4 of ANSI/ANS-59.51-1997 requires that filters be provided in the fill line to each fuel oil storage tank. FSAR Tier 2 Figure 9.5.4-1 does not show this filter and the system description in FSAR Tier 2 Section 9.5.4.2.4 states that a strainer is provided in the fill line. In addition, Figure A1 of the standard, while not considered a part of the standard, does provide a level of detail that reflects the design requirements of the standard and this level of detail should be used as the basis for Figure 9.5.4-1 of the FSAR. The applicant should fully and specifically address the requirements of the ANSI/ANS standard and to revise Figure 9.5.4-1 to provide a level of detail similar to that in Figure A1 of the standard and reflect the design commitments included in FSAR Tier 2 Section 9.5.4.

09.05.04-27

**RAI 9.5.4-22:** FSAR Tier 2 Section 9.5.4.2.4 states that part of the fuel oil transfer pump discharge is returned to the fuel oil storage tank via the recirculation line. The piping configuration shown on FSAR Tier 2 Figure 9.5.4-1 will not allow this function. The only path for recirculation to the storage tank is via the overflow from the day tank or by aligning the normally closed valves in the day tank drain line. The overflow is not an acceptable means to continuously return flow to the storage tank. The day tank drain line is shown on the figure with normally closed valves. The applicant should describe how the continuous recirculation function will work and show the piping for this function on Figure 9.5.4-1.

09.05.04-28

**RAI 9.5.4-23:** SRP Section 9.5.4, Paragraph 9.5.4 I.1.I specifies that adequate and acceptable sources of fuel oil are available, including the means of transporting and

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recharging the fuel storage tank, following a design basis accident. The staff considers that the combined license (COL) applicant is responsible for this in that it is a site-specific item. The DCD applicant should include a COL information item for this provision.

09.05.04-29

**RAI 9.5.4-24:** According to the “Qualification and Test Plan of Class 1E Gas Turbine Generator System,” December 2007(MUAP-07024-P(R0)), the on-engine fuel oil pump is a screw-type pump. This type of pump will likely require a fuel oil recirculation line back to the day tank to relieve excess flow. Figure 9.5.4-1 does not show a recirculation line from the engine back to either of the fuel oil tanks. Also note that Section C.2.2.6.6 (2) states that the day tanks will include a connection for “engine pressure return”. The applicant should explain how excess flow from the on-engine pump will be handled and to revise the FSAR as appropriate.

09.05.04-30

**RAI 9.5.4-25:** The NRC staff review of the quality assurance program found no specific mention of the GTGFSS within Section 9 or Section 17 of the FSAR Tier 2 document. Regulatory Guide 1.137 refers to Regulatory Guide 1.28 as the acceptance criteria for the GTGFSS quality assurance program. The applicant should describe the GTGFSS quality assurance program, including the acceptance criteria.

09.05.04-31

**RAI 9.5.4-26:** The “Qualification and Test Plan of Class 1E Gas Turbine Generator System,” December 2007(MUAP-07024-P(R0)) references ANSI N195-1976 for the fuel oil system. This standard has been replaced by ANSI/ANS-59.51-1997. The applicant should update the references in the qualification and test plan document.

09.05.04-32

**RAI 9.5.4-27:** According to the “Qualification and Test Plan of Class 1E Gas Turbine Generator System,” December 2007(MUAP-07024-P(R0)), Section C.2.2.6.6, the fuel oil day tanks shall be constructed in accordance with Underwriter's Laboratories Specification UL-142, Steel Aboveground Tanks for Flammable and Combustible Liquids. These tanks should be in accordance with ASME Section III, Class 3 as indicated in FSAR Tier 2 Table 9.5.4-1. The applicant should revise the qualification and test plan accordingly.

09.05.04-33

**RAI 9.5.4-28:** According to the “Qualification and Test Plan of Class 1E Gas Turbine Generator System,” December 2007(MUAP-07024-P(R0)), Section C.2.4.3 (2)(h) the fuel oil storage tanks will have a high-level alarm. FSAR Tier 2 Section 9.5.4.5 only

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mentions a low-level alarm for the storage tanks. The applicant should revise the FSAR to include the oil storage tank high-level alarm.

09.05.04-34

**RAI 9.5.4-29:** The SRP Section 9.5.4 states that fuel oil temperature, pressure and level should be monitored to assure proper operation of the fuel supply system. The FSAR Tier 2 Section 9.5.4 does not state if the fuel oil temperature is monitored. The NRC staff requests that the applicant justify this apparent departure from the SRP.

09.05.04-35

**RAI 9.5.4-30:** ITAAC items specific to the emergency power sources are listed in FSAR Tier 1 Table 2.6.4-1. Item 8 requires type tests and/or analyses to verify that the Class IE and ASME Section III portions of the GTG support systems are designed to seismic Category I. This item appears to be essentially the same as Item 6. The applicant should explain the distinction between Items 6 and 8 and revise the FSAR as appropriate.

09.05.04-36

**RAI 9.5.4-31:** ITAAC Item 12 requires an inspection to ensure that each GTG system is independent of the other systems. There is a typographical error in this item in the Acceptance Criteria – “are isolated each other” should be “are isolated from each other”. In addition, ITAAC Item 19 requires an inspection to ensure that the as-built GTGFSS is as described in FSAR Tier 1 Section 2.6.4.1. However the GTGFSS is described in Section 2.6.4.2.

09.05.04-37

**RAI 9.5.4-32:** ITAAC Item 20 requires an inspection of the as-built GTGFSS to ensure that it is designed and constructed to ASME Section III and seismic Category I requirements. However, an inspection of the as-built system may not be sufficient to verify compliance with ASME Section III and seismic Category I requirements. Documentation, including analyses and tests, should also be examined to verify that the acceptance criteria are met. The applicant should expand the inspection requirements as required to ensure compliance and revise the table to clearly identify the additional inspections. This RAI also requests the applicant to verify that components that are not available as ASME Section III are verified to be of equivalent quality through application of this ITAAC.

09.05.04-38

**RAI 9.5.4-33:** ITAAC Item 21 requires an inspection to ensure that each fuel oil transfer pump transfers fuel from the oil storage tank to the day tank. An inspection alone will not verify that the rate and pressure of the fuel oil delivered to the GTG is in accordance with the design. The applicant should provide testing requirements that will ensure that

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each GTGFSS can deliver oil at the required pressure and flow rate to support operation of the GTG per the design. These tests should also verify that the as-built configuration provides at least the minimum NPSH required by the as-purchased transfer pumps.

09.05.04-39

**RAI 9.5.4-34:** ITAAC Item 22 requires an inspection to validate the gravity feed system from the day tank. As in Item 21, the fuel oil flow rate and pressure should be verified by tests.

09.05.04-40

**RAI 9.5.4-35:** FSAR Tier 1 does not include an ITAAC to verify the design volumes of the fuel oil day tank and fuel oil storage tank. The applicant should include an ITAAC to verify these volumes.

09.05.04-41

**RAI 9.5.4-36:** The GTGFSS operability may be demonstrated during tests of the GTG, or testing may be performed by operation of the system in recirculation mode (bypassing the service day tank) and pumping fuel through the recirculation line back to the fuel oil storage tank. This latter method of testing has the potential to inadvertently leave the system in a configuration that would not allow the system to perform its safety function. The test procedure should include measures to ensure that the system valves are correctly aligned following completion of the test.

09.05.04-42

**RAI 9.5.4-37** FSAR Tier 2 Section 9.5.4.2.2.3 states that the fuel oil day tanks are located separately from the adjacent GTG compartments by 3-hour rated fire barriers. This is in accordance with the guidance in RG 1.189. However, FSAR Tier 2 Figure 1.2-27 does not show any wall enclosing the fuel oil day tanks, separating them from the GTG area. The applicant should confirm that each day tank is enclosed by a 3-hour fire barrier which separates the day tank from the GTG and revise Figure 1.2-27 to show these barriers.