REQUEST FOR ADDITIONAL INFORMATION 895-6172 REVISION 3

1/27/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 12.03-12.04 - Radiation Protection Design Features
Application Section: 12

QUESTIONS for Health Physics Branch (CHPB)

12.03-12.04-40

The applicant's response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity. In their response, the applicant referred to Figure l "Locations of the Containment Racks" that was provided as part of the RAI response.

However, these racks are not depicted in any of the following US-APWR DCD Tier 2 Revision 2 figures:

Figure 3.8.3-6 "Interior Compartments Wall Layout and Configuration"
Figure 5.1-3 "Reactor Coolant System Loop Layout"
Figure 5.1-4 "Reactor Coolant System-Elevation"
Figure 9.1.2-2 "Spent Fuel Rack Array"
Figure 9.1.4-2 "Section View of Light Load Handling System"
Figure 12.3-1 "Radiation Zones for Normal Operation/Shutdown"

In addition, the involved subsections of the US-APWR DCD Tier 2 Revision 2 do not contain a description of or state the purpose of these racks, including:

- Subsection 3.8.3.1.7 "Refueling Cavity," which does not discuss temporary storage of fuel in the Refueling Cavity,
- Subsection 1.2.1.5.4.3 "Fuel Storage and Handling System," which states that spent fuel is stored in the spent fuel pit, without any mention of the temporary fuel storage racks in the Refueling Cavity,
- Subsection 1.2.1.7.2.1 "Reactor Building (R/B)," which describes the Refueling Cavity and fuel storage and handling area, without mentioning the temporary fuel storage racks in the Refueling Cavity,
- Table 1.9.2-9 "US-APWR Conformance with Standard Review Plan Chapter 9 Auxiliary Systems," which does not contain any discussion of the regulatory guidance applicable to the temporary storage of fuel in the Refueling Cavity,
- Subsection 9.1.2.2.2 "Spent fuel storage," which does not describe the use of temporary storage of fuel in the Refueling Cavity,
- Subsection 12.2.1.1.10 "Miscellaneous Sources," 12.2.1.2 "Sources for Shutdown," and 12.2.1.2.3 "Spent Fuel," do not discuss temporary storage of fuel in the Refueling Cavity.

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 "Domestic Licensing of Production and Utilization Facilities" Appendix A "General Design Criteria for Nuclear Power Plants" (GDC) 61 "Fuel storage and handling and radioactivity control," requires

that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. Based on the guidance contained in Standard Review Plan (SRP) subsection 9.1.2 “New and Spent Fuel Storage,” the staff reviews the information on the facility design criteria, system description, and layout drawings for areas containing new and spent fuel. The guidance in SRP Section 12.2 “Radiation Sources,” states that the descriptions of sources requiring shielding and special storage locations, including plan scale drawings, should be identified.

Please revise and update the US-APWR DCD to describe the temporary fuel storage racks located in the Refueling Cavity, including the purpose, drawings depicting the location, physical dimensions and elevations, the source terms and the regulatory basis, as noted in the subsections above, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-41

The applicant’s response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity.

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 “Domestic Licensing of Production and Utilization Facilities” Appendix A “General Design Criteria for Nuclear Power Plants” (GDC) “Fuel storage and handling and radioactivity control,” requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. GDC 62 “Prevention of criticality in fuel storage and handling,” requires provisions to prevent unintended criticality. GDC 63 “Monitoring fuel and waste storage,” requires systems to detect excessive radiation levels. The guidance in Standard Review Plan Section 9.1.4 “Light Load Handling System (Related to Refueling)” addresses handling of fuel and spent fuel, which, if dropped, mishandled, or damaged, could cause releases of radioactive materials or unacceptable personnel radiation exposures, and states that ANSI/ANS 57.1-1992 “Design Requirements for Light Water Reactor Fuel Handling Systems,” provides guidance for meeting the requirements of GDC 61 and 62. ANSI/ANS-57.1-1992 in turn states that temporary storage locations shall be designed in accordance with ANSI/ANS 57.2-1983 “Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants.”

US-APWR DCD Tier 2 Revision 2 Chapter 16, “Technical Specifications,” (TS) Subsection 1.1 “Definitions,” states that a MODE shall correspond to any one inclusive combination of core reactivity condition, power level, average reactor coolant temperature, and reactor vessel head closure bolt tensioning specified in Table 1.1-1 “Modes,” with fuel in the reactor vessel. Based on this statement, Mode 6 “Refueling,” is only applicable as long as there is fuel in the reactor vessel. TS Subsections 3.9.1 “Boron Concentration,” TS 3.9.2 “Unborated Water Source Isolation Valves,” 3.9.3 “Nuclear Instrumentation,” 3.9.4 “Containment Penetrations,” 3.9.5 “Residual Heat Removal (RHR) and Coolant Circulation - High Water Level,” which provides for reactivity controls, spent fuel cooling, separation of the containment atmosphere from the environment, monitoring of neutron radiation from fuel and maintaining Refueling Cavity water level will be maintained when in Mode 6 “Refueling.”

However, the Technical Specifications provided in Chapter 16 of the US-APWR DCD do not describe the required controls and limits when fuel is stored in the temporary fuel racks depicted in Figure I "Locations of the Containment Racks," when all fuel is out of the reactor vessel.

Please revise and update the US-APWR DCD Technical Specification section 3.9 "Refueling Operations," to provide reactivity controls, spent fuel cooling, separation of the containment atmosphere from the environment, monitoring of neutron radiation from fuel and maintaining Refueling Cavity water level when the plant is not in Mode 6 (i.e. all fuel is out of the reactor vessel) while fuel is still present in the Refueling Cavity, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-42

The applicant's response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity.

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 "Domestic Licensing of Production and Utilization Facilities" Appendix A "General Design Criteria for Nuclear Power Plants" (GDC) 61 "Fuel storage and handling and radioactivity control," requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. GDC 62 "Prevention of criticality in fuel storage and handling," requires provisions to prevent unintended criticality. Standard Review Plan (SRP) Subsection 9.1.1 "Criticality Safety of Fresh and Spent Fuel Storage and Handling," states that for Pressurized Water Reactors, where credit is taken for soluble boron in the pools containing fuel, reactivity design features are to be provided to ensure that K(eff) is less than 1.0 for all conditions, and that at the minimum allowable boron concentration that K(eff) be no greater than 0.95.

US-APWR DCD Tier 2 Revision 2 Subsection 9.1.1 "Criticality Safety of New and Spent Fuel Storage," states that under the new fuel assumption, the fuel assembly is assumed to have a maximum enrichment of 5 weight percent. Credit is taken for the neutron absorption in the rack structural stainless steel and a neutron poison, Metamic, built into the racks. US-APWR DCD Tier 2 Section 12.3 "Radiation Protection Design Features," states that the design of the fuel pool racks precludes criticality under all postulated normal and accident conditions.

However, the US-APWR DCD Subsections 9.1.1 and 12.3 do not describe the design features provided to preclude inadvertent criticality from the storage of 6 new fuel assemblies, containing the maximum enrichment of 5 weight percent, in the temporary fuel storage racks in the Refueling Cavity as described in Figure I "Locations of the Containment Racks."

Please revise and update the US-APWR DCD Subsections 9.1.1 and 12.3 to describe the design features provided to prevent inadvertent criticality of new fuel bundles temporarily stored in the Refueling Cavity temporary fuel storage racks, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-43

The applicant's response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity.

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 "Domestic Licensing of Production and Utilization Facilities" Appendix A "General Design Criteria for Nuclear Power Plants" (GDC) 61 "Fuel storage and handling and radioactivity control," requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. The guidance in Regulatory Guide (RG) 1.183 "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Appendix B "Assumptions for Evaluating the Radiological Consequences of a Fuel Handling Accident," states that if depth of water above is less than 23 feet above spent fuel, the assumed decontamination factors will need to be determined on an individual basis. The guidance in RG-1.13 Revision 2 "Spent Fuel Storage Facility Design Basis," states that the minimum water depth above spent fuel should be 10 feet.

The applicant's response to RAI 524-4020, Question 12.03-12.03-35 Items 2 & 4 stated that the consequence analysis assumed that because fuel transfers were in progress, the isolation valve and weir gate between the Refueling Cavity and the spent fuel pool were open. With the spent fuel pool and the Refueling Cavity connected, the level of the water in the pools would only drop 5 feet, so the minimum depth above the reactor vessel flange would remain greater than 23 feet. However, if either the fuel transfer tube gate valve or the transfer canal weir gate were closed at the time of the event, the decrease in water level would be some value greater than 5 feet, increasing the dose rates around the Refueling Cavity to above the calculated values, and possibly reducing the water above the spent fuel to less than the depth provided in the guidance of RG 1.13 and RG 1.183.

Since the assumptions for the safe use of the temporary fuel storage racks in the Refueling Cavity depicted in Figure I "Locations of the Containment Racks," are not described in US-APWR DCD Tier 2 Subsections 9.1.2.2.2 "Spent fuel storage," 5.4.7.2.3.5 "Refueling," 12.3.2.2.4 "Fuel Handling Area Shielding Design," or Technical Specification (TS) section 3.9 "Refueling Operations," the staff is unable to determine if the requirements of GDC 61 would be met.

Please revise and update the US-APWR DCD to describe the plant configuration needed to meet the requirements of GDC 61 when spent fuel is stored in the temporary fuel storage racks located in the Refueling Cavity, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-44

The applicant's response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity.

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 “Domestic Licensing of Production and Utilization Facilities” Appendix A “General Design Criteria for Nuclear Power Plants” (GDC) 61 “Fuel storage and handling and radioactivity control,” requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. GDC 63 “Monitoring fuel and waste storage,” requires systems to ensure fuel safety. The guidance in RG-1.13 Revision 2 “Spent Fuel Storage Facility Design Basis,” states that the minimum water depth above spent fuel should be 10 feet.

The applicant’s response to RAI 524-4020, Question 12.03-12.03-35 Items 2 & 4 stated that MHI believes a rapid cavity drain down event is not considered feasible because the US-APWR permanent cavity seal (PCS) design prevents a seal cavity failure rapid drain down event and all cavity drain valves are administratively locked closed during fuel movement.

This RAI response appears to be inconsistent with the description of potential loss of coolant events during refueling conditions, as described in the US-APWR DCD Tier 2 Revision 2 Subsection 19.1.6.1 “Description of the Low-Power and Shutdown Operations PRA,” which in the “Loss of coolant accident (LOCA),” and “LOCA [loss-of-coolant accident] with failure of isolation and RCS makeup,” which involve mis-positioned or inadvertent opening of motor operated residual heat removal (RHR) system valves with the RHR pump running. US-APWR Table 5.4.7-2 “Equipment Design Parameters,” states that the RHR pumps maximum flow rate is 3650 gpm, and Table 9.1.3-3 “Spent Fuel Pit Cooling and Purification System Component Design Parameters,” states that the design flow rate of the spent fuel pool cooling pump is 3865 gpm. Since the assumptions for the maximum gravity driven drain down rate are based on a lower flow rate than could be achieved by a pump driven drain down rate, it is not clear to the staff that the projected dose calculation represents a conservative assessment of the projected dose rates from irradiated core components.

Please revise and update the US-APWR DCD to describe drain down dose rate calculation assumptions that are consistent with assumptions used in US-APWR DCD Chapter 19 “Probabilistic Risk Assessment and Severe Accident Evaluation,” or provide the specific alternative approaches used and the associated justification.

12.03-12.04-45

The applicant’s response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity.

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 “Domestic Licensing of Production and Utilization Facilities” Appendix A “General Design Criteria for Nuclear Power Plants” (GDC) 61 “Fuel storage and handling and radioactivity control,” requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. The guidance in Regulatory Guide (RG) 1.183 “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” Appendix B “Assumptions for Evaluating the Radiological Consequences of a Fuel Handling Accident,” states that if depth of water above is less than 23 feet, the

assumed decontamination factors will need to be determined on an individual basis. The guidance in RG-1.13 Revision 2 “Spent Fuel Storage Facility Design Basis,” states that the minimum water depth above spent fuel should be 10 feet.

US-APWR DCD Tier 2 Revision 2 Subsection 19.1.6.1 “Description of the Low-Power and Shutdown Operations PRA,” Plant Operation State (POS) 6 “No fuel in the core,” states that for refueling and examination of fuel, fuel is transported from the reactor vessel (RV) to the spent fuel pool (SFP) during this POS. This state is excluded from the analysis because there is no fuel in the reactor. The end of POS 6 is defined as the time at which fuel is loaded into the reactor core. However, the risk analysis described in US-APWR DCD Tier 2 Revision 2 Chapter 19 “Probabilistic Risk Assessment and Severe Accident Evaluation,” does not address the storage of fuel bundles in the Refueling Cavity temporary storage racks after all fuel has been removed from the reactor.

Please revise and update the US-APWR DCD the Chapter 19 “Probabilistic Risk Assessment and Severe Accident Evaluation,” description of the POS 6 “No fuel in the core,” to be consistent with the use of the temporary fuel storage racks located within the Refueling Cavity, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-46

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 “Domestic Licensing of Production and Utilization Facilities” Appendix A “General Design Criteria for Nuclear Power Plants” (GDC) 61 “Fuel storage and handling and radioactivity control,” requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. GDC 63 “Monitoring fuel and waste storage,” requires systems to ensure fuel safety. The guidance contained in Regulatory Guide (RG) 1.13 “Spent Fuel Storage Facility Design Basis,” states that reliable and frequently tested instruments, with local and remote alarms, should be provided for storage pool water level. The guidance contained in Standard Review Plan (SRP) section 9.1.2 “New and Spent Fuel Storage” for meeting GDC 63, refers to the guidance contained in RG 1.13.

The applicant’s response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity. The applicant’s response to Items 2 and 4 stated that a water level alarm from LIA 011–N, which is shown on DCD Rev. 2 Figure 5.1-2 “Reactor Coolant System Piping and Instrumentation Diagram,” would detect a decrease in the Refueling Cavity water level. The operators were expected to be able to take action to isolate the source of the leakage within 30 minutes of receiving an alarm from LIA 011–N. However, the staff reviews of US-APWR DCD Chapters 5, 7, 9, 12, and 16 seem to indicate that there is no requirement to have this instrument in service while fuel is in the Refueling Cavity (RC), that there is no discussion of the required alarm setpoint for the minimum RC water level while fuel is in the RC and there is no discussion of what actions are required to be taken should the instrument not be in service. Also, since these instruments are normally provided for operation at the mid-loop reactor coolant system level, it is not clear to the staff that LIA 011-N alarm function is intended to be used for both cavity level control and mid-loop level control, or just cavity level control.

Please revise and update the US-APWR DCD to describe Refueling Cavity water level monitoring instrument, the operability requirements and the allowable set point used to assure adequate shielding of fuel in the RC, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-47

Title 10 of the Code of Federal Regulations (10 CFR), Part 50 “Domestic Licensing of Production and Utilization Facilities” Appendix A “General Design Criteria for Nuclear Power Plants” (GDC) 61 “Fuel storage and handling and radioactivity control,” requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. GDC 63 “Monitoring fuel and waste storage,” requires systems to ensure fuel safety.

The applicant’s response to RAI 524-4020 Revision 1, dated 14 September 2010; Question 12.03-12.03-35 Item 1 stated that the Refueling Cavity has two fuel containment racks that are capable of temporarily storing a total of six fuel bundles in the Refueling Cavity. The applicant’s response to Items 2 and 4 stated that a water level alarm from LIA 011–N, which is shown on DCD Rev. 2 Figure 5.1-2 “Reactor Coolant System Piping and Instrumentation Diagram,” would detect a decrease in the Refueling Cavity water level, prompting the operators to place the fuel in transfer into a containment rack and evacuate from the vicinity of the Refueling Cavity. However, the staff reviews of US-APWR DCD Chapters 5, 7, 9, 12 and 16 have not identified any requirements to have one or more spaces in the temporary storage racks empty and available for this purpose during fuel movements.

Please revise and update the US-APWR DCD to describe Refueling Cavity temporary storage rack space availability requirements or an associated COL Item, or provide the specific alternative approaches used and the associated justification.