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July 10, 2012

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-12192

Subject: MHI's Final Amended Response to US-APWR DCD RAI No. 532-4019 Revision 1 (SRP12.02)

References:
1) "Request for Additional Information No. 532-4019 Revision 1, SRP Section: 12.02 – Radiation Sources, Application Section: 12.2," dated February 22, 2010 (ML100550987).
2) "MHI's Amended Response to US-APWR DCD RAI No.524-4020 Rev.1 and No. 532-4019 Rev. 1", UAP-HF-10253, dated September 15, 2010 (ML11270A114).
3) "MHI's Response to US-APWR DCD RAI No. 532-4019 Rev. 1 and No. 561-4441 Rev.2", UAP-HF-10099, dated April 9, 2010 (ML101050111).
4) "United States – Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation with Open Items for Chapter 12, 'Radiation Program'", dated March 21, 2011 (ML110770408).

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") documents entitled "Final Amended Response to Request for Additional Information No.532-4019 Revision 1". In Reference 2, MHI provided the amended response to the NRC's Request for Additional Information ("RAI") in Reference 1. MHI has revised the response to Question 12.02-29 of Reference 2 in order to address NRC concerns identified as Open Item 12.02-1 in Reference 4. This letter transmits only the revised response to RAI 532-4019 Question 12.02-29; the responses to the other questions transmitted by Reference 2 are not revised by this letter.

This response is being submitted in two versions. One version (Enclosure 2) includes certain information, designated pursuant to the Commission guidance as sensitive unclassified non-safeguards information, referred to as security-related information ("SRI"), that is to be withheld from public disclosure under 10 C.F.R. § 2.390. The information that is SRI is identified by brackets. Enclosure 2 also contains information that MHI considers proprietary, and therefore should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential. The second version (Enclosure 3) omits the SRI and the proprietary information and is therefore suitable for public disclosure. In the non-proprietary and SRI excluded version (Enclosure 3) the information identified as proprietary is redacted and replaced by designation "[ ]" and the SRI is replaced by the designation "[Security-Related Information - Withheld under 10 CFR 2.390]."

This letter includes a copy of the proprietary and SRI included version (Enclosure 2), a copy of the non-proprietary and SRI excluded version (Enclosure 3) and the Affidavit of Yoshiki

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Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all materials designated as "Proprietary" in Enclosure 2 be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

Please contact Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

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

Enclosure:

1. Affidavit of Yoshiki Ogata

2. Final Amended Response to Request for Additional Information No.532-4019 Revision 1 (Proprietary and SRI included version)

3. Final Amended Response to Request for Additional Information No.532-4019 Revision 1 (Non-proprietary and SRI excluded version)

CC: J. A. Ciocco
J. Tapia

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Enclosure 1

Docket No.52-021
MHI Ref: UAP-HF-12192

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, state as follows:

1. I am Director, APWR Promoting Department, of Mitsubishi Heavy Industries, LTD ("MHI"), and have been delegated the function of reviewing MHI's US-APWR documentation to determine whether it contains information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential.

2. In accordance with my responsibilities, I have reviewed the enclosed "Final Amended Response to Request for Additional Information No.532-4019 Revision 1" and have determined that the document contains proprietary information that should be withheld from public disclosure. Those pages containing proprietary information are identified with the label "Proprietary" on the top of the page and the proprietary information has been bracketed with an open and closed bracket as shown here "[ ]". The first page of the document indicates that all information identified as "Proprietary" should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a) (4).

3. The information identified as proprietary in the enclosed document has in the past been, and will continue to be, held in confidence by MHI and its disclosure outside the company is limited to regulatory bodies, customers and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.

4. The basis for holding the referenced information confidential is that it describes the unique design and methodology developed by MHI for performing the nuclear design of the US-APWR reactor. This information was developed at significant cost to MHI, since it required the performance of Research and Development and detailed design for its software and hardware extending over several years.

5. The referenced information is being furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of information to the NRC staff.

6. The referenced information is not available in public sources and could not be gathered readily from other publicly available information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.

7. Public disclosure of the referenced information would assist competitors of MHI in their design of new nuclear power plants without incurring the costs or risks associated with the design of the subject systems. Therefore, disclosure of the information contained in the referenced document would have the following negative impacts on the competitive position of MHI in the U.S. nuclear plant market:

A. Loss of competitive advantage due to the costs associated with development of the US-APWR Radiation Protection. Providing public access to such information permits competitors to duplicate or mimic the Radiation Protection information without incurring the associated costs.

B. Loss of competitive advantage of the US-APWR created by benefits of enhanced US-APWR Radiation Protection development costs associated with the Radiation Protection design.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 10th day of July, 2012.

Y. Ogata

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

Enclosure 3

UAP-HF-12192
Docket No. 52-021

Final Amended Response to Request for Additional Information No. 532-4019 Revision 1

July 2012
(Non-Proprietary and Security-Related Information Excluded)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/10/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 532-4019 REVISION 1**

SRP SECTION: **12.02 – Radiation Sources**

APPLICATION SECTION: 12.02

DATE OF RAI ISSUE: 2/22/2010

QUESTION NO.: 12.02-29

RAI 427-2909, Question 12.02-21 (a supplemental question derived from RAI 144-1738 12.02-12), requested additional information about the controls associated with the Refueling Water Storage Auxiliary Tank and the Primary Makeup Water Tank following removal of the concrete shielding, noted in the response to Question 12.02-12. In the response, the applicant noted that the design will be changed to enclose the tanks in a "tank house". Contrary to the response provided, Figure 12.3-1 (Sheet 1 of 34) provided as part of the response to Question 12.02-12 does not show the "tank house" structure. The applicant stated that the enclosure would be established as a Zone II, however, Figure 12.3-1 (Sheet 1 of 34) does not depict a Zone II area in the vicinity of the tanks. In addition, based on the activity concentration assumed in Table 12.2-50, the NRC staff calculated dose rates inside the tank enclosure indicate that the area would meet the specifications for a Zone IV area. The response indicates controls limiting the activity in the tanks would be part of some program, such as the Radiation Protection Program and that dose rate at 2 meters tank surface will be limited to less than 0.25 mrem/h. However, the "Impact on the DCD" section of the response did not provide a COL Action Item stating the requirement to provide a program to limit tank activity. Additionally, because the applicant, provided insufficient information regarding the design of the tank area enclosure, the NRC staff is unable to evaluate the adequacy of design features of the facility, such as the entry and egress points for the area, and the ventilation controls and effluent monitoring for the area,

The applicant should revise and update the USAPWR DCD Tier 2 Chapter 12.2 to fully and accurately describe the tank enclosure facility and the associated required COL Action Items, or provide the specific alternative approaches used and the associated justification.

ANSWER:

As stated in the response to RAI 427-2909, Question 12.02-21, the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tanks (PMWTs) are to be located inside a tank house adjacent to the north wall of the Auxiliary Building (A/B) as shown on DCD Figure 12.3-1 (Sheet 1 of 34). The tank house consists of a concrete floor and walls, a roof,

and has two internal compartments for the PMWTs and the RWSAT. The primary purpose of the tank house is to protect the tanks from the elements (rainfall, snow, direct sun, etc.) and thus prevent erroneous actuation of the leakage detection system.

Since these tanks were originally located outdoors, the tank house does not include any shielding functions or a ventilation system for airborne radioactivity removal. However, a leak detection system is to be installed in order to prevent unexpected leakage from these tanks as described in the response to RAI 91-1496, Question 12.03-12.04-2. Similarly, in the case of the PMWTs, the boric acid is likely to precipitate when the primary makeup water and the boric acid concentrate are mixed in the boric acid blender under the condition of low primary makeup water temperature. In order to prevent this situation, a heater is installed in the PMWTs, and thus water in the PMWT will not freeze.

The new DCD Figure 12.3-12 shows the layout of the tank house. The tank house is located immediately adjacent to the north wall of the A/B. There is no passageway between the tank house and the A/B or the Reactor Building (R/B). The tank house has two internal compartments; one for the PMWTs and another for the RWSAT. There is only one entrance/exit on the west side of the tank house enclosure which opens directly into the PMWTs compartment. The tank house design assures a minimum distance of 2 meters between any tank surface and an outer wall of the tank house in order to meet the dose rate requirements described in the DCD.

Each of the internal tank house compartments includes a level II epoxy-coated weir designed to contain the entire contents of the tank(s) located within the compartment as shown in the PDF markup for DCD Subsection 9.2.6.2.6. The entrance to each compartment is elevated to ensure that the entire volume of water in the tank(s), if the tank ruptures, can be contained within the compartment (see Figure A-1 sheets 1 of 2 and 2 of 2). A drain funnel is installed in the floor of each compartment and is connected to the drain pipe. A leakage detector is installed inside the floor drain piping where the drain pipe is connected at the valve pit. In the case of tank leakage the water flows into the drain piping via the funnel, activating the leakage detector, which alarms in the main control room, and then the leakage water gravity feeds to the A/B Sump. (Refer to Figure 12.03-1 in the response to RAI No. 91-1496 in MHI letter UAP-HF-09003 for a sample drawing.) The overflow piping installed with the upper side of the RWSAT is connected to the A/B. (See Figure A-2 and the new DCD Figure 9.1.4-4). The overflow piping installed with the RWSAT also serves as a venting line. Meanwhile, the venting line of the PMT is connected to the Auxiliary Building HVAC system as shown on DCD Figure 9.2.6-2. These design features minimize the potential for contamination of the environment by (1) ensuring that overflow water does not discharge to the individual compartment in the tank house and (2) preventing venting to the inside of the tank house and local atmosphere.

The RWSAT is designed to store refueling water for the refueling canal, the fuel inspection pit and the cask pit. Water stored in the refueling canal, the fuel inspection pit and the cask pit is transferred to the RWSAT through the Spent Fuel Pit Cooling and Purification System. Regardless of the source, the refueling canal water is processed by the SFP demineralizer to reduce the radioactivity of the fluid prior to being pumped to the RWSAT as discussed in the markup to DCD Subsection 9.1.4.2.2.2 Phase IV. The high radiation water used for refueling will not be directly transferred to the RWSAT. The water in the Refueling Cavity inside the Containment Vessel (C/V) is transferred to the Refueling Water Storage Pit (RWSP) provided at the lower part of the C/V by the force of CS/RHR pumps or the force of gravity. The new DCD Figure 9.1.4-4 provides an overview of the Refueling Water Storage System including the RWSAT.

DCD Revision 2 Table 12.2-50 provides the maximum allowable source term that meets the provision to limit the dose rate to 0.25 mrem/hr at 2 meters from the tank surface. Similarly, the water stored in the PMWTs is diluted up to 1/10,000 and degasified by the boric acid evaporator prior to storage in the tanks. DCD Revision 2 Table 12.2-51 provides the maximum allowable source term that meets the dose rate provision for the PMWTs. If the source term requirement cannot be met, the water is transferred to the Liquid Waste Management System for additional processing instead of being stored in the PMWTs. These requirements on the tank source term in conjunction with the fact that the tanks have no vent to the atmosphere results in the airborne radioactivity associated with tank leakage to be negligible and have no impact on the radiological protection considerations of the tank house enclosure.

Concerning the radioactivity concentration limit, two new COL Action Items were added to DCD Rev. 3 Subsection 12.2.3. One requires the COL Applicant to include provisions in the Radiation Protection Program (RPP) to ensure that both the radioactivity concentration and the radiation level of the tanks will meet the values described in the DCD. The second requires implementation of a method of ensuring that the radioactivity concentration of both the RWSAT and PMWTs remain under the value described in the DCD.

As noted in MHI's previous response to RAI 427-2909 Question 12.02-21, the tank house enclosure is designated as Radiation Zone II on DCD Figure 12.3-1 (sheet 1 of 34). This tank house is within the Radiologically Controlled Area (RCA), and requires personnel to monitor themselves for contamination prior to exiting from the tank house to prevent the unauthorized release of radioactive material to unrestricted areas. Instrumentation to monitor for contamination of personnel, materials, and equipment shall be employed at the monitoring area around the entrance/exit of the tank house to minimize personnel exposure and avoid the spread of contamination.

RG 4.21 "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" provides guidance regarding design features used to minimize contamination and generation of radioactive waste and facilitate decommissioning. As described above, the US-APWR tank house incorporates design features such as the use of piped venting and overflow paths, epoxy-coated weirs, a drainage system, a leak detection system, etc. to ensure timely leak detection and minimize the potential for contamination (see Table 12.3-8, Sheet 35 of 62). Therefore, the tank house design meets the intent of the requirements of 10 CFR 20 Subpart H and 10 CFR 20.1406 regarding minimizing the potential for contamination of the environment.

[Supplemental Information]

Supplemental information about the tank house structure and how the design complies with the requirements of RG 4.21 are provided below.

1) Watertight Compartment of the Tank House

The layout drawing of the tank house provided in the new DCD Figure 12.3-12 shows that there are two compartments. One for the RWSAT and the other for the PMWTs. As shown in Figure 1, each tank is installed below grade, but placed in a watertight compartment providing a barrier to prevent leakage to the environment. The capacity of the watertight compartment is sufficient to hold the entire tank water volume within the compartment in the case of a complete tank rupture. Therefore, potential leakage from these tanks to the environment is prevented by the design of the compartment.

2) Leak Detection System of the Tank House

The detailed cross section drawings of the tank house are shown in Figure A-2. In case tank leakage occurs, the leakage water flows into the floor drain piping via funnels with the valve to the A/B closed. Leakage water accumulates in the drain piping, eventually activating the leakage detector which alarms in the main control room.

After the leakage is detected, the tank house is accessed from the west side of the tank house through a corridor that leads down into the valve pit. The valve is opened and water in the drain piping gravity feeds to the A/B sump tank. It is important to note since the valve pit is located outside the watertight compartments within the tank enclosure, this area remains dry should a tank leak or failure occur.

3) Piping Connected Between Tank House and Buildings and Countermeasures Against Leakage at the Connection

As described above, the drain piping for each tank is connected to the A/B below grade elevation. Figure A-3 shows a representative depiction of the piping connection between buildings. A countermeasure against leakage at the connection is a piping sleeve that retains any leakage within the piping sleeve. The overflow line of the RWSAT is not embedded in the concrete base mat, but an aerial pipe run and the PMWTs overflow is partially embedded. Since these pipings are connected to A/B at below grade elevation, the same measure against leakage that is shown in Figure A-3 is adopted. Additionally, pipes from the RWSAT are connected to R/B (EL -8'-7" floor) by way of the pipe chase that is located on the east side of the tank house as shown in the markup to DCD Figure 12.3-1 (Sheet 5 of 34). The same countermeasure against leakage shown in Figure A-3 is also adopted. No piping is directly connected to R/B.

Impact on DCD

The US-APWR DCD Subsection 9.1.4.2.2.2 has been revised to describe the design features of the Refueling Water Storage System, including the RWSAT. Additionally, the new Figure 9.1.4-4 is added to the DCD.

A new paragraph has been added to DCD Subsection 9.2.6.2.6 second paragraph regarding the epoxy-coating used in the tank house:

"The epoxy coating in the tank house is Service Level II as defined in RG 1.54 (Ref 9.2.11-10) and is subject to the graded QA provisions, selection, qualification, application, testing, maintenance, and inspection provisions of RG 1.54 and standards referenced therein, as applicable to Service Level II coatings. Post-construction initial inspection is performed by personnel qualified using ASTM D 4537 (Ref. 9.2.11-11) using the inspection plan guidance of ASTM D 5163 (Ref. 9.2.11-12)."

The above description is included in RAI 578-4483 Revision 2 response for Question 12.03-12.04-38.

The US-APWR DCD Subsection 11.2.2.1.2.3 was previously in response to DCD RAI 532-4019 Question 29; however, there was editorial error in the DCD markup. DCD Subsection 11.2.2.1.2.3 has been revised to correct the editorial error as shown in the attachment.

The US-APWR DCD Subsection 12.3.2.2.9, Figure 12.3-1 (sheet 5 of 34) has been revised and the new Figure 12.3-12 is added that describes the Tank House ALARA design features.

The US-APWR DCD Table 12.3-8 (sheet 35 of 62) will be revised to add the description of the seal between the tank house and the R/B.

All these changes are shown in the attached DCD markups.

Impact on R-COLA

There is no impact on the RCOLA.

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 any Technical or Topical Report.

Security-Related Information – Withheld Under 10 CFR 2.390

Figure A-1 (1/2) Watertight Compartment in the Tank House (RWSAT)

Security-Related Information – Withheld Under 10 CFR 2.390

Figure A-1 (2/2) Watertight Compartment in the Tank House (PMWTs)

Security-Related Information – Withheld Under 10 CFR 2.390

Figure A-2 Detail of Cross Sections of the Tank House

Figure A-3 An Example of a Countermeasure Against Leakage from the Connecting Piping Between Buildings

sufficient time will be available to place any fuel in transit in the nearest suitable safe storage location. before the refueling cavity water level drops below the minimum level necessary to maintain proper shielding. DCD_12.03-12.04-40 DCD_12.03-12.04-46

9.1.4.2.2 Fuel Handling Operations

9.1.4.2.2.1 New Fuel Receipt

New fuel is shipped to the site in a new fuel shipping container. The new fuel shipping container is received into the R/B by way of the refueling area truck access bay at elevation 3 ft - 7 in.

The new fuel shipping container is raised from the truck using the auxiliary hoist on the spent fuel cask handling crane through the access hatch in the refueling area floors at elevations 25 ft - 3 in and 76 ft - 5 in. Elevation 76 ft - 5 in is the operating level of the refueling area.

The new fuel container is set on the operating floor. Using the suspension hoist on the spent fuel cask handling crane, new fuel is removed from the shipping container and stored in the new fuel storage pit. During this operation, the new fuel assemblies are suspended using a short fuel handling tool to permit surface inspection prior to being placed into a new fuel storage rack.

A new fuel assembly stored in the new fuel storage racks is transferred to the spent fuel pit to prepare for refueling.

A new fuel assembly stored in the new fuel racks is lifted using the suspension hoist of the spent fuel cask handling crane, and transferred to the new fuel elevator located in the fuel inspection pit. The new fuel assembly is then lowered using the new fuel elevator for access by the fuel handling machine. The new fuel assembly is latched by the spent fuel assembly handling tool on the fuel handling machine, and is lifted using the fuel handling machine mast tube or auxiliary hoist and then transferred to the spent fuel pit for temporary storage in the spent fuel rack.

General arrangement figures for the US-APWR are presented in Subsection 1.2.1.7.

9.1.4.2.2.2 Reactor Refueling Operations

During refueling, the refueling cavity is filled with water transferred from the RWSP. If a leakage from the refueling cavity occurred, the water level drops and alarms the MCR. Upon alarm and MCR action, the water level will be recovered by transferring water from the RWSP, using the refueling water recirculation pump. A sufficient quantity of water remains in the RWSP after the refueling cavity is initially filled with water to maintain the water level of the refueling cavity. DCD_09.01.04-22

Reactor refueling operations are divided into four phases: preparation, reactor disassembly, fuel handling, and reactor assembly. The overall system configuration is shown in Figure 9.1.4-4. Refueling operations are outlined below and performed in accordance with operating procedures defined in Subsection 13.5.2. DCD_12.02-29

- Phase I - Preparation

The reactor is placed into cold shutdown mode as defined in the Technical Specifications, Chapter 16. The refueling water and reactor coolant are borated to assure the core remains approximately 5% below criticality during refueling operations based on the maximum reactivity of the fuel to be cycled through an US-APWR. Lines that are potential sources of unborated water are closed administratively. DCD_12.03-12.04-40 DCD_12.03-12.04-46 and 47

The water level in the refueling cavity and the spent fuel ~~handling~~ pit and interconnected pits is maintained at an elevation sufficient to keep radiation levels within personnel access limits when the fuel assemblies are being removed and transported from the core to the spent fuel racks in accordance with RG 1.13. The refueling cavity, spent fuel pit, fuel inspection pit, and fuel transfer canal are interconnected. The fuel transfer tube valve and the gates between the fuel transfer canal and these pits are opened during refueling operations. Thus, the water level of the cavity, canals and pits are kept at the same level. The level meter of the SFP acts as alternative measurement of the refueling cavity level during the transfer of fuel. DCD_12.02-29 DCD_12.03-12.04-40 DCD_12.03-12.04-46 and 47

The water level is maintained above low water level to keep radiation levels within personnel access limits when the fuel assemblies are being removed and transported from the core to the spent fuel racks in accordance with RG 1.13. The low water level alarm of the refueling cavity is set at the required water depth for radiation shielding described in Subsection 12.3.2.2.4. The radiation and environmental levels are monitored to assure levels do not exceed personnel access limits.

Upon achieving safe radiation and environmental conditions, the LLHS system is tested and the refueling machine overload is verified to be within operable. This is accomplished by using the mockup fuel assembly nozzle attached to the floor of the refueling cavity.

- Phase II – Reactor Disassembly

The reactor vessel head assembly is prepared for refueling by disconnecting electrical cabling, seismic support tie rods, in-core instrumentation, and cooling duct work. The refueling cavity is prepared by:

- Closing and locking the reactor cavity drain line
- Removing the blind flange of the fuel transfer tube
- Verifying functionality of the reactor cavity lighting
- Verifying tools are in place and functional
- Verifying the fuel transfer system is functional

After the reactor head bolting is de-tensioned, but prior to lifting the head and overflowing from the reactor vessel, the lower levels of the refueling cavity are flooded using ~~a fill line which enters through the refueling cavity floor~~the refueling water recirculation pump from the RWSP. This is done at flow rate which will minimize scattering of activated dust. DCD_12.02-29

When the lower levels of the refueling cavity are flooded, the reactor vessel head assembly is unseated and raised 2.5 ft above the flange. At this point, disconnection of the control drive shafts is verified. Upon verification of disconnection, the reactor vessel head assembly is raised while maintaining a maximum of one foot clearance above the refueling cavity water to provide shielding. The water level of the refueling cavity is gradually increased by overflowing the reactor vessel by CS/RHR pump from the RWSP. DCD_12.02-29

When the water level reaches the normal refueling water level, the reactor vessel head assembly is transported to the lay down area. Concurrently, refueling cavity lighting and the refueling cavity water filtration system is placed in service. The refueling water in the refueling cavity is transferred to the spent fuel pit (SFP) demineralizer and the spent fuel pit (SFP) filter for purification. After that, the water is returned to the refueling cavity. DCD_12.02-29

The upper reactor internals with the in-core instrumentation system (ICIS) thimble assemblies is lifted using the lift rig with a load cell in the lift rigging. The load cell monitors the force applied when lifting the internals and provides indication of interference with other core structures and fuel assemblies. When the upper reactor internals is clear of the reactor vessel, it is transferred to its storage location in the lower refueling cavity. The core is then ready for refueling.

In parallel, the operators perform water filling operation for refueling canal through the SFP. The water for refueling canal is transferred by the refueling water circulation pump from the refueling water storage auxiliary tank (RWSAT). DCD_12.02-29

The RWSAT stores the water for the refueling canal, the inspection pit, and the cask pit. The RWSAT provides water source for the refueling water recirculation pump and the charging pump. The RWSAT has connections with the SFP demineralizer and the refueling water recirculation pumps. In addition, the RWSAT has a connection from the C/V reactor coolant drain pump to receive the accumulator water. If the accumulator is required to drain all the water, the water is transferred by using C/V reactor coolant drain pump directly. The RWAST has an overflow piping and drain piping to the Auxiliary Building (A/B) to prevent the water from exposure to the environment directly. The overflow alarm is installed in the overflow line to announce the operator.

- Phase III – Fuel Handling

  All irradiated fuel assemblies are removed from the core and relocated to the SFP. The partially used fuel and new fuel assemblies are then transferred and installed into their designated positions in the reactor core.

  In general, the fuel handling procedure is as follows:

  - The refueling machine is indexed over a fuel assembly in the core.

- The refueling machine mast latches onto a fuel assembly. The fuel assembly is raised to the designated height clearing the vessel flange while maintaining the established satisfactory radiation shielding depth below the water surface.

- The fuel transfer car is moved into the containment from the fuel storage area where the fuel container is pivoted into the vertical position.

- The refueling machine loaded with an irradiated fuel assembly traverses the ~~reactor~~refueling cavity until it is indexed over the vertical fuel transfer system fuel container. The irradiated fuel assembly is lowered into the container and unlatched. DCD_12.02-29

- The fuel container is pivoted to the horizontal position. The fuel transfer car is moved back through the transfer tube to the refueling area in R/B. The fuel container is pivoted to the vertical position again.

- The irradiated fuel is grasped by the fuel handling machine. The fuel is then transferred to the spent fuel rack. If needed, the spent fuel is transferred to fuel inspection pit to perform underwater visual inspections before transferring to the spent fuel rack, or inspected after completion the refueling (during normal operation). This process is continued until the core is off loaded. SFP level is maintained at normal throughout the refueling process to assure adequate radiation protection for personnel.

- The rod control clusters, the thimble plugs, and the burnable poison rod assemblies are shuffled in the SFP by using long handled tools on the fuel handling machine bridge.

- Irradiated and new fuel assemblies are individually lifted from a spent fuel rack by using the fuel handling machine, transferred to the up ender, and transferred to inside containment by reversing the core unloading process.

The water level of the refueling cavity is monitored by water level instruments. These instruments are shown in the Figure 5.3-1. There are totally four kinds of instruments in the refueling cavity. One is wide range instrument to monitor the normal refueling cavity level, and the one is middle range instrument to monitor near the reactor vessel flange level, and the rest two are narrow range instruments to monitor the mid-loop water level precisely. The wide range instrument has low level alarm to notify the operator. DCD_12.02-29

- Phase IV – Reactor Assembly

  The reactor assembly is accomplished by reversing the process described in Phase II – Reactor Disassembly.

Most of the refueling cavity water is transferred to the RWSP by the CS/RHR pump. The drainage of the lower level of the reactor vessel flange is transferred to the RWSP by gravity. If purification of the RWSP is required, the purification operation can be performed by using the refueling water recirculation pump though the SFP demineralizer and SFP filter. DCD_12.02-29

The drainage operation for the transfer canal is performed by the transfer canal pump. The water in the transfer canal is transferred to the SFP by the transfer canal pump and then the water in the SFP is transferred to the RWSAT by the SFP pump via SFP demineralizer and the SFP filter. In the case of the inspection pit water and the cask pit water, similar operations are performed by the fuel inspection pit pump and the cask pit pump, respectively. Water stored in the refueling canal, the fuel inspection pit and the cask pit is purified by the SFP demineralizer prior to be transferred to the RWSAT. DCD_12.02-29

Plant procedures contain measures to prevent and mitigate inadvertent reactor cavity drain-down events. Reactor refueling procedures require that valve positions of potential reactor cavity drain paths are verified prior to filling the refueling cavity. Operating procedures direct operators to monitor control room indications for reactor cavity seal leakage during refueling operations. Maintenance procedures address periodic maintenance and inspection of the permanent cavity seal and other seals and plugs in accordance with vendor recommendations. Emergency response procedures provide direction to operators regarding the proper response to pool drain down events. During an inadvertent drain down event, containment personnel will be notified immediately upon actuation of refueling cavity low-level water alarm RCS-LIA-011-N. Fuel handling operating procedures will require that the operators place any fuel in transit in the nearest suitable safe storage location. Operating procedures are defined in Subsection 13.5.2. DCD_12.02-29 DCD_12.03-12.04-40 DCD_12.03-12.04-46 and 47

9.1.4.2.2.3 Spent Fuel Storage

The spent fuel assemblies are stored in the SFP until fission product activity is low enough to permit shipment from the site or to be placed in dry storage. Spent fuel storage and cooling is discussed in Subsections 9.1.2 and 9.1.3, respectively.

9.1.4.2.2.4 Spent Fuel Shipment

The procedure for the spent fuel shipment is as follows:

- The spent fuel cask is received into the R/B by way of the refueling area truck access bay at elevation 3 ft - 7 in. The spent fuel cask is raised from the truck using the spent fuel cask handling crane through the access hatch in the floors at elevation 25 ft - 3 in and 76 ft - 5 in the R/B refueling area.
- The cask is moved to the cask washdown pit and washed to clean off dust and adhered material from the outside surface of the cask.
- The cask lid is removed and lay down on the operating floor. Then, O-ring of the lid is visually inspected.
- The cask is then placed into an encapsulating flexible barrier (baggy) to the top flange to prevent surface contamination. Additionally, the cask is filled with clean demineralized water.
- The water levels are raised in the refueling canal and the cask pit. The water is supplied from the refueling water auxiliary tank. Prior to opening the SFP and cask

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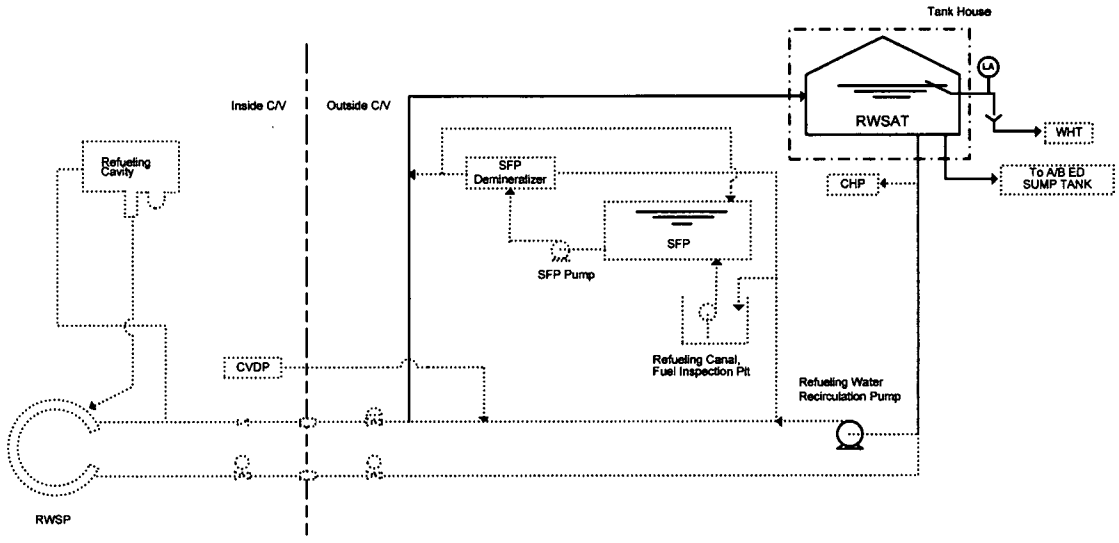

Figure 9.1.4-4 Outline of Refueling Water Storage System

9.2.6.2.6 Primary Makeup Water Tanks

Two 140,000 gallon capacity PMWTs are provided. Each tank is provided with a diaphragm that is in continuous contact with the tank water to prevent absorption of oxygen from air. The top of the diaphragm is blanketed with deaerated, demineralized water. The tanks receive deaerated, demineralized water from the DWST. They also receive distilled water discharged from the boric acid evaporator (subsection 9.3.4). Normally, one tank supplies water to the users, while the other tank is standby. Each tank has sufficient capacity to serve all users. Each tank is provided with level and other instrumentation as shown in Figure 9.2.6-2. Design parameters of the PMWT are shown in Table 9.2.6-1.

The piping to and from the PMW Tank is single-walled stainless steel piping designed to run aboveground and penetrates the building wall directly into the tank. This piping is mostly inside the A/B in pipe chases. For piping between buildings, penetration sleeves are provided to collect and direct any leakages back into the building for further processing. The piping may require heat tracing to protect against freezing. The PMWTs employ non-leakage type valves such as diaphragm-type valves, or leak control valves with graphite packing for handling radioactive fluid, or leak-off connection is provided to prevent leakage to environment. Similar piping is provided for the PMW Tanks carrying recycle water back to the A/B. This design is supplemented by operational programs which includes periodic hydrostatic or pressure testing of pipe segments, and visual inspections to maintain piping integrity. A discussion on minimizing radioactive contamination of the system is contained in DCD Section 12.3.1.3.

The tank house for the RWSAT and the two smaller PMWTs consists of a low porosity concrete foundation and concrete retaining walls around the tanks. To prevent cross-contamination, the tanks are protected by walls and a roof to prevent infiltration of rain and other precipitation. The surface of the tank house foundation is sloped to facilitate drainage of the leakage from the tanks. The leakage water flows into the piping embedded in the concrete base mat via the funnel to the valve pit located outside the PMWTs and RWSAT watertight compartments and is equipped with a normally closed valve. The piping located at the valve pit has a leak detection instrument that sends a signal to the main control room in the instance of the accumulation of leakage. The concrete foundation, the walls, and the valve pit are coated with epoxy to facilitate easy decontamination in the event of contaminated water leakage. The epoxy coating in the tank house is Service Level II as defined in RG 1.54 (Ref 9.2.11-10) and is subject to the graded QA provisions, selection, qualification, application, testing, maintenance, and inspection provisions of RG 1.54 and standards referenced therein, as applicable to Service Level II coatings. Post-construction initial inspection is performed by personnel qualified using ASTM D 4537 (Ref. 9.2.11-11) using the inspection plan guidance of ASTM D 5163 (Ref. 9.2.11-12). Segments of drain pipe are embedded into the low porosity concrete foundation. The embedded segments are kept as short as practicable to minimize unmonitored leakage from the drain pipe. These design features satisfy the applicable guidance provided in RG 4.21 (Ref 9.2-11-9). DCD_12.02-29

9.2.6.2.7 Primary Makeup Water Pumps

Two 100% capacity primary makeup water pumps are provided. The pumps take suction from the PMWT and supply deaerated, demineralized water to plant users as shown in

9.2.11-2 Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27 Revision 2, January 1976.

9.2.11-3 Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants, NRC Regulatory Guide 1.26 Revision 4, March 2007.

9.2.11-4 National Primary Drinking Water Standards, Environmental Protection Agency, Title 40, Code of Federal Regulations, 40CFRPart 141.

9.2.11-5 Occupational Safety and Health Standard, Occupational Safety and Health Administration, Department of Labor, Title 29, Code of Federal Regulations, 29CFRPart 1910.

9.2.11-6 American Nuclear Society Standards Committee Working Group, American National Standard for Decay Heat Power in Light Water Reactors, ANS 5.1, August 1979.

9.2.11-7 Electric Power Research Institute Palo Alto, California, Advanced Light Water Reactor Utility Requirements Document, Rev.8.

9.2.11-8 ANSI B31.1 Power Piping Code.

9.2.11-9 Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning. RG 4.21, Rev 0, U.S. Nuclear Regulatory Commission, Washington, DC, June 2008.

9.2-11-10 Nuclear Regulatory Commission, Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants, Regulatory Guide 1.54, Rev. 2, October 2010. DCD_12.02-29

9.2.11-11 American Society for Testing and Materials, Standard Guide for Establishing Procedures to Qualify and Certify Personnel Performing Coating Work Inspection in Nuclear Facilities, ASTM D 4537-04a.

9.2.11-12 Standard Guide for Condition Assessment of Coating Service Level Coating Systems in Nuclear Power Plants, American Society for Testing and Materials, ASTM D 5163-08.

- RCP Number 2 seal and Number 3 seal leakage (Note: Number 1 seal is directed to the VCT)
- Excess letdown water
- Leakage from reactor vessel flanges
- RCL drainage
- Leakage from valves inside the containment
- RCS vent drainage
- ACC drainage
- Pressurizer relief tank drainage

These liquids drain to the CVDT or to the suction of the containment vessel reactor coolant drain pump which is located inside the containment. A nitrogen cover gas is maintained over the liquid in the tank to preserve the quality of the water and to minimize the potential for the buildup of a flammable mixture. The water entering the tank can be at a relatively high temperature (up to 200 °F), therefore, the tank is equipped with instrumentation to monitor the temperature. Prior to transferring the water to the holdup tank (HT) in CVCS via one of two containment vessel reactor coolant drain pumps, the water temperature is decreased below 200 °F by the addition of PMW. The tank is generally maintained at a near constant level to minimize both the amount of gas sent to the GWMS and the amount of nitrogen cover gas required.

11.2.2.1.2.2 Other Anticipated Operations

In the event that the liquid collected in the CVDT is either oxygenated or above the specified radiation limits, it is sent to the WHTs for processing.

11.2.2.1.2.3 Maintenance/Refueling Operations

During refueling, the containment vessel reactor coolant drain pumps are used to drain water from the reactor coolant loops to the holdup tank and the emergency core cooling system ACCs to the refueling water storage auxiliary tank (RWSAT) while the drain water from the refueling cavity is directly sent to the refueling water storage pit (RWSP) by the CS/RHR pumps or gravity. In this case, typically both pumps are used to speed up the transfer of water from these areas. In this mode, the water is transferred directly to the RWSAT without entering the CVDT. During maintenance or outages, any remaining gas is purged from the system to the GWMS using nitrogen. DCD_12.02-29

Recyclable reactor-grade effluents enter this subsystem from various locations inside the containment and are collected without exposure to air (which would degrade the quality of the water). These liquids are collected in the CVDT which is situated inside the containment. The contents of the tank are maintained in a nitrogen-rich environment to minimize the potential for degradation of the water quality and minimize the potential for formation of a flammable mixture. The tank is a cylindrical stainless steel vessel and

Administrative control of the fuel transfer tube inspection and the access control of the area near the seismic gap below the fuel transfer tube is to discussed by the COL Applicant.

12.3.2.2.9 Miscellaneous Plant Areas and Plant Yard Areas

Sufficient shielding is provided for all plant buildings containing radiation sources so that the radiation levels at the outside surfaces of the buildings are maintained below Zone I levels. The plant yard areas that are frequently occupied by plant personnel are fully accessible during normal operation and shutdown. These areas are surrounded by a security fence and closed-off from areas accessible to the public. ~~Access to the outside storage tanks that have a contact dose rate greater than 0.25 mrem/h is restricted by a fence so that dose rates to personnel in the plant yard areas are limited to less than 0.25 mrem/h.~~The RWSAT and PMWTS are outside storage tanks that have a contact dose rate greater than 0.25 mrem/h. These tanks are located inside of the tank house enclosure next to the A/B. The primary purpose of the tank house is to protect the tanks from the elements (rainfall, snow, direct sun, etc.) and thus prevent erroneous actuation of the leakage detection system. The dose rate outside of the tank house is less than 0.25 mrem/h. Figure 12.3-12 shows the layout of the tank house enclosure including the RWSAT and the PMWTs. DCD_12.02-29

12.3.2.3 Shielding Calculation Methods

The shielding thicknesses provided to ensure compliance with the plant radiation zoning and to minimize the plant personnel exposure are based on the maximum equipment activities described in Chapter 11, Section 11.1, and Section 12.2.

The thickness of each shield wall surrounding the radioactive equipment is determined by approximating, as closely as possible, the actual geometry, and the physical condition of the source or sources. The isotopic concentrations are converted to energy group sources using data from standard references (Reference 12.3-11, 12.3-12).

The geometric model assumed for shielding evaluation of tanks, heat exchangers, demineralizers, evaporators, and the containment is a finite cylindrical volume with maximum source volume capacity. Filters are assumed to be a finite cylindrical annulus in a cylindrical shield. Shielding evaluation of radioactivity in piping uses a cylindrical volume. In cases where radioactive materials are deposited on surfaces, such as pipes, sources are modeled as an annular cylindrical surface source. For spent fuels, the geometric model is a rectangular parallel pipe.

Shielding that is only for gamma ray attenuation is designed using codes that use the point kernel method (buildup factor, exponential attenuation, and geometry factor). The industry accepted program, MICROSHIELD (Reference 12.3-11), is the code used for these calculations.

Shielding for neutron fields and mixed gamma ray/neutron fields is designed using the industry-accepted computer codes ANISN, DORT (Reference 12.3-13), and MCNP (Reference 12.3-14), as necessary. ANISN and DORT are multi-group, discrete ordinates transport codes that solve the Boltzmann transport equation for neutrons and gamma rays. Using a finite-difference technique, ANISN and DORT allow for general

Table 12.3-8 Regulatory Guide 4.21 Design Objectives and Applicable DCD Subsection Information for Minimizing Contamination and Generation of Radioactive Waste (Sheet 35 of 62)

Objective		System Features	DCD Reference
		Design features to provide containment - Tank cubicles are coated with non-porous material up to a wall height to contain the entire tank content. The cubicles are equipped with drainage system to direct any leakage and overflows to sumps with pumps to redirect flow to other tanks. - In addition, the primary makeup water tanks and refueling water storage auxiliary tank, which are located in a tank house, also have same design features. The walls and floors of the tank house are coated with non-porous material. The floor is sloped towards the drainage pit or funnel. The drainage system is equipped with a liquid detection. - RWS piping from the RWSAT is connected to the R/B through the piping tunnel located at the east side of the tank house. There are construction joints (seal) between the tank house - piping tunnel and the piping tunnel - R/B. This connection is made of elastomeric and watertight material that serves as a seal between the two structures to prevent leakage from the floor of the tunnel connection. These construction joints will be preserved the seal function continuously by the appropriate installation and the periodic maintenance.	12.3.1.1.1.2.E DCD_12.02-29
2	Provide for adequate leak detection capability to provide prompt detection of leakage for any structure, system, or component which has the potential for leakage.	- The drainage system is equipped with a liquid detection instrument which can provide early warning for leakage and/or overflow condition. - The floors of these cubicles containing radioactive fluid are sloped to facilitate faster drainage and to minimize liquid accumulation, and provided with coating with non-porous material to prevent cross contamination.	12.3.1.1.1.2.E

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Security-Related Information – Withheld Under 10 CFR 2.390

Figure 12.3-1 Radiation Zones for Normal Operation/Shutdown (Sheet 5 of 34)
Reactor Building at Elevation -8'-7"

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Security-Related Information – Withheld Under 10 CFR 2.390

Figure 12.3-12 Layout Drawing of the Tank House