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TOKYO, JAPAN

December 6, 2013

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

Attention: Mr. Perry Buckberg

Docket No. 52-021
MHI Ref: UAP-HF-13293

Subject: MHI's Response to US-APWR DCD RAI No. 1028-7094 (SRP 12.03-12.04)

Reference: 1) "Request for Additional Information No. 1028-7094, SRP Section: 12.03-12.04 – Radiation Protection Design Features, Application Section: 12, 6, 9," dated April 30, 2013.

With this letter, Mitsubishi Heavy Industries, Ltd. (MHI) transmits to the U.S. Nuclear Regulatory Commission (NRC) a document entitled "MHI's Response to US-APWR DCD RAI No. 1028-7094 (SRP 12.03-12.04)."

Enclosed is the response to the questions contained within Reference 1.

Please contact to 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,
Executive Vice President
Mitsubishi Nuclear Energy Systems, Inc.
On behalf of Mitsubishi Heavy Industries, Ltd.

Enclosure:

1. Response to US-APWR DCD RAI No. 1028-7094 (SRP 12.03-12.04)

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LRO

CC: P. Buckberg
J. Tapia

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Enclosure 1

UAP-HF- 13293
Docket No. 52-021

Response to US-APWR DCD RAI No. 1028-7094 (SRP 12.03-12.04)

December 2013

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/6/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 1028-7094**
SRP SECTION:	**12.03-12.04 – Radiation Protection Design Features**
APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-63

In RAI 532-4019 Question 12.02-29, the staff asked the applicant to provide information about the design features of structure housing the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tank (PMWT), provided to minimize contamination of the facility and the environment, consistent with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The applicant's response to RAI 532-4019 Question 12.02-29 dated July 10, 2012 stated that the PMWT venting line is connected to the Auxiliary Building HVAC system, as shown on Figure 9.2.6-2 "Primary Makeup Water System Flow Diagram," and that minimizes the potential for venting into the tank house. US-APWR DCD Revision 3, Subsection 9.2.6.2.6 states "Two 140,000 gallon capacity PMWTs are provided and that 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." Figure 9.2.6-2 shows the vent to the HVAC from the non-radiological (top) side of the diaphragm. The applicant's response to RAI 532-4019 Question 12.02-29 contains Figure A-2 "Detail of Cross Sections of the Tank House," section illustrations for the PMWT and the RWSAT show overflow lines from the tanks. The applicant has not committed to adding Figure A-2 to the DCD. However, neither of the illustrations on Figure A-2 have any information about siphon/vacuum breakers that may open into the building. The PMWT overflow line shown on Figure A-2 appears to originate at the bottom of the tank. Based on the experience of the staff, there is usually some type of siphon protection provided for overflow lines, but neither DCD Figure 9.2.6-2 nor the PMWT illustration on Figure A-2 contain this information, so it is not clear to the staff that the design of the PWMT prevents airborne contamination within the building from the PMWT contents due to water in the overflow line venting into the tank house building. Since the tank house building does not have any active ventilation system, any leakage and subsequent evaporation into the enclosed space could result in elevated airborne radioactive contaminants, including tritium.

Please revise and update the US-APWR DCD Subsection 9.2.6 and subsection 12.3, to describe the design features provided to prevent airborne contamination in the tank house building from the overflow line of the PMWT, or provide the specific alternative approaches used and the associated justification.

ANSWER:

A siphon breaker is installed in the top of the PMWT overflow line. The gas phase at the top of the overflow line is connected to the A/B atmosphere in order to prevent potential discharge of airborne radioactive contaminants, including tritium, to the environment. DCD Subsection 9.2.6.2.6 and Figure 9.2.6-2 are revised to reflect this siphon breaker in the top of the PMWT overflow line.

Impact on DCD

DCD Revision 4 Tier 2 Subsections 9.2.6.2.6, Figure 9.2.6-2, and Table 12.3-8 are revised as shown in Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical / Topical Report

There is no impact on any Technical / Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/6/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 1028-7094**
SRP SECTION:	**12.03-12.04 – Radiation Protection Design Features**
APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-64

In RAI 532-4019 Question 12.02-29, the staff asked the applicant to provide information about the design features of structure housing the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tank (PMWT), provided to minimize contamination of the facility and the environment, consistent with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The applicant's response to RAI 532-4019 Question 12.02-29 dated July 10, 2012, stated that the high radiation water used for refueling will not be directly transferred to the RWSAT and also contained proposed changes to DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations," which described the processes and systems to be used for water related to sources of water used for refueling. The applicant's response committed to changing DCD subsection 11.2.2.1.2.3 "Maintenance/Refueling Operations," to state that during refueling, the containment vessel reactor coolant drain pumps are used to drain water from the reactor coolant loops to the holdup tank. However, the applicant's proposed changes to DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations," does not include the statement contained in DCD subsection 11.2.2.1.2.3, to drain water from the loops to the holdup tanks. Neither Subsection 9.1.4.2.2.2 nor Subsection 11.2.2.1.2.3 include the statement in the RAI answer discussion that high radiation water used for refueling will not be directly transferred to the RWSAT. The applicant's response also stated that the new DCD Figure 9.1.4-4 "Outline of Refueling Water Storage System," provided in the RAI response, was an overview of the Refueling Water Storage System including the RWSAT. Based on the system configuration provided in the proposed Figure 9.1.4-4, high radiation water could be transferred directly from the reactor coolant system to the RWSAT without passing through the spent fuel pool demineralizers.

Please revise and update the US-APWR DCD subsection 9.1.4.2.2.2, to include information about the destination of water from the RCS loops or other sources of high radiation water, or change the system configuration depicted on Figure 9.1.4-4 so that this water must go through the Spent Fuel Pit (SFP) demineralizers prior to entering the RWSAT, or provide the specific alternative approaches used and the associated justification.

ANSWER:

Administrative control procedures discussed in DCD Chapter 13 will be in place to preclude transferring high radiation water used for refueling from the reactor coolant system to the RWSAT without first passing through the SFP demineralizers. Manual valves between the discharge of the refueling water recirculation pump and the discharge of the SFP demineralizer are used for switching the in-service lines in the discharge line of the refueling water recirculation pump (see Figure 9.1.4-4). These valves are controlled under the administrative procedures that are developed by the COL Applicant as described in DCD Subsection 13.5.2.

The high radiation water used for refueling is not directly transferred to the RWSAT. The water from the reactor coolant loops is transferred to the hold up tanks. DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations" has been revised to indicate that high radiation water from the reactor coolant loops is transferred to the holdup tanks.

Impact on DCD

DCD Revision 4, Tier 2, Subsection 9.1.4.2.2.2 is revised as indicated in Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA

Impact on Technical / Topical Report

There is no impact on the Technical / Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/6/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

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RAI NO.:	**NO. 1028-7094**
SRP SECTION:	**12.03-12.04 – Radiation Protection Design Features**
APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-65

In RAI 532-4019 Question 12.02-29, the staff asked the applicant to provide information about the design features of structure housing the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tank (PMWT), provided to minimize contamination of the facility and the environment, consistent with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The applicant's response to RAI 532-4019 Question 12.02-29 dated July 10 2012, contained proposed changes to DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations," "Phase IV - Reactor Assembly," describing how water located in the refueling cavity and fuel transfer canal is handled at the conclusion of refueling. The subsection states that most of the refueling cavity water is transferred to the Refueling Water Storage Pit (RWSP) by the CS/RHR pump. The water in the lower level of the reactor vessel flange is transferred to the RWSP by gravity. The water in the transfer canal is removed by using the transfer canal pump to transfer the water in the transfer canal is to the Spent Fuel Pit (SFP). The water in the SFP from the transfer canal is then transferred to the Refueling Water Storage Auxiliary Tank (RWSAT) through the SFP demineralizer and the SFP filter by the SFP pump. However USAPWR DCD Revision 3 Figure 9.1.4-2 "Section View of Light Load Handling System," shows a space below the refueling cavity side of the fuel transfer tube that would not be emptied by use of the SFP transfer canal pump, and the applicant's proposed changes to DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations," "Phase IV - Reactor Assembly," does not contain a description of how this area will be drained and the water cleaned prior to storage. Also, USAPWR DCD Revision 3 Figure 9.1.3-1 "Schematic of Spent Fuel Pit Purification and Cooling System (Cooling Portion)," and Figure 11.2-1 "Liquid Waste Processing System Process Flow Diagram," do not show a drain line for this portion of the refueling cavity transfer canal area. Based on staff operating experience, the water remaining around the refueling cavity transfer canal area may contain radioactive material corrosion and wear products. US-APWR DCD Revision 3 Subsection 12.3.1.3 "Minimization of Contamination and Radioactive Waste Generation," does not contain a discussion of how this area will be drained or how the radioactive material that may accumulate in this area will be removed.

Please revise and update the US-APWR DCD subsection 9.1.4.2.2.2 and subsection 12.3.1.3, to include information about the destination of water and radioactive corrosion and wear products, from the refueling cavity fuel transfer canal area, or provide the specific alternative approaches used and the associated justification.

ANSWER:

DCD Figure 9.1.4-4, which was included in MHI's response to RAI 532-4019 Revision 1 (see MHI Letter No. UAP-HF-12192) shows an outline of the refueling water storage system.

There are two depressed areas shown in the DCD figure, one (on the right side) is the reactor vessel, and the other (on the left side) is the Upper Core Internal Laydown Pit and the portion where the containment racks are installed that is the subject of discussion in this RAI. The Upper Core Internal Laydown Pit and the portion where the containment racks are installed are shown as one depressed area since the DCD figure is a simplified figure. The portion at the C/V side from the transfer tube is referred to as the refueling cavity, and the portion at the SFP side is referred to as the refueling canal.

The drain piping installed in the bottom of the refueling cavity is simply expressed in DCD Figure 9.1.4-4 with a line that is connected to the depressed area on the left side and in DCD Figure 6.2.1-9. The drain water from the depressed areas is transferred directly to the RWSP by gravity. Water drained to the RWSP is purified using the refueling water recirculation pump through the SFP demineralizer and the SFP filter.

A description is added to DCD Subsection 9.1.4.2.2.2, Phase IV, which states that water from the bottom of the refueling cavity can be drained by the drain piping installed in the bottom of the refueling cavity.

Impact on DCD

DCD Revision 4, Tier 2, Subsection 9.1.4.2.2.2 is revised as indicated in Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical / Topical Report

There is no impact on any Technical / Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

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Docket No. 52-021

RAI NO.:	**NO. 1028-7094**
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APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-66

In RAI 532-4019 Question 12.02-29, the staff asked the applicant to provide information about the design features of structure housing the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tank (PMWT), provided to minimize contamination of the facility and the environment, consistent with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The applicant's response to RAI 532-4019 Question 12.02-29 dated July 10 2012, the applicant's proposed changes to DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations," "Phase IV - Reactor Assembly," states that most of the refueling cavity water is transferred to the Refueling Water Storage Pit (RWSP) by the CS/RHR pump and that the water in the transfer canal is transferred to the Spent Fuel Pit (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. US-APWR DCD Revision 3 Subsection 6.2.2.2.1 "CS/RHR Pumps," states that the pumps are sized to deliver 3,000 gpm at a discharge head of 410 ft. US-APWR DCD Revision 3 Figure 9.1.3-1 Schematic of Spent Fuel Pit Purification and Cooling System (Cooling Portion) shows the CS/RHR pump discharge going to the SFP. DCD Figure 6.2.2-7 "Required Water Volumes vs. Pit Capacities," shows that 29,410 ft3 (~217,000 gallons) of water is transferred to the RWSAT from the refueling canal following an outage. Based on the dimensions of the SFP provided in DCD Figure 9.1.1-2 "Spent Fuel Pit," and the component design parameters specified in Table 9.1.3-3 Spent Fuel Pit Cooling and Purification System Component Design Parameters," this corresponds to an equivalent change in level in the SFP of about 25 ft, which translates to about a 7 hour evolution duration at the capacity two SFP demineralizers in parallel (265 gpm/each).

Please revise and update the US-APWR DCD subsection 9.1.4.2.2.2 and subsection 12.3.1.3, to describe the design features provided to prevent overflowing the SFP while transferring the water from the transfer canal and refueling cavity areas to the RWSAT, or provide the specific alternative approaches used and the associated justification.

ANSWER:

The refueling cavity water above the RV flange level is gravity-drained to the RWSP or drained by the CS/RHR pumps. The refueling cavity water below the RV flange level is gravity-drained directly to the RWSP. Therefore, the refueling cavity water is not transferred to the RWSAT. The refueling water in the containment is transferred to the RWSP.

The water in the refueling canal water (outside the containment) is transferred to the SFP by the refueling canal pump, and, in parallel, the water is transferred to the RWSAT by the spent fuel pit pump via SFP demineralizer and the SFP filter.

The 200 gpm refueling canal pump capacity is small when compared to the SFP. The SFP water level instrument has a high water level alarm that alerts the operator to turn off the pump in order to prevent overflowing the SFP water. A description of the SFP water level instrument will be added to DCD Revision 4, Subsection 9.1.4.2.2.2 and Table 12.3-8.

Figure 9.1.3-1 shows that the RHRS is connected to the SFPCS in order to cool the SFP during refueling operation with full core off load, but this line is not used for draining refueling water.

Impact on DCD

DCD Revision 4 Tier 2, Subsections 9.1.4.2.2.2 and Table 12.3-8 are revised as shown in Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical / Topical Report

There is no impact on any Technical / Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

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RAI NO.:	**NO.1028-7094**
SRP SECTION:	**12.03-12.04 – Radiation Protection Design Features**
APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-67

In RAI 532-4019 Question 12.02-29, the staff asked the applicant to provide information about the design features of structure housing the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tank (PMWT), provided to minimize contamination of the facility and the environment, consistent with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The applicant's response to RAI 532-4019 Question 12.02-29 dated July 10 2012 stated in the proposed changes to DCD Subsection 9.1.4.2.2.2 "Reactor Refueling Operations," "Phase IV - Reactor Assembly," that most of the refueling cavity water is transferred to the Refueling Water Storage Pit (RWSP) by the CS/RHR pump and that the water in the transfer canal is transferred to the Spent Fuel Pit (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. US-APWR DCD Revision 3 Figure 6.2.2-7 "Required Water Volumes vs. Pit Capacities," shows that 29,410 ft3 (~217,000 gallons) of water is transferred to the RWSAT from the refueling canal following an outage. The applicant's response to RAI 532-4019 Question 12.02-29 contains Figure A-2 "Detail of Cross Sections of the Tank House," depicting an illustration for the RWSAT which shows an overflow line from the tank going into a funnel located outside of the tank house building. The applicant has not committed to adding Figure A-2 to the DCD. However, neither the illustration on Figure A-2, US-APWR DCD Revision 3 Chapter 6 "Engineered Safety Features," nor US-APWR DCD Revision 3 Subsection 12.3.1.3 "Minimization of Contamination and Radioactive Waste Generation," have any information about the location of this funnel and the provision provided at the funnel for minimizing contamination of the facility or the environment. Staff experience at operating plants has been that when the tank is overflowed, water may spill out of this funnel.

Please revise and update the US-APWR DCD Chapter 6 and Subsection 12.3.1.3, to describe the location of the RWSAT overflow line and funnel and the design features provided to prevent minimize contamination of the facility and the environment from an overflow of the RWSAT, or provide the specific alternative approaches used and the associated justification.

ANSWER:

The Refueling Water Storage Auxiliary Tank (RWSAT) overflow piping is routed from the RWSAT tank house into the Auxiliary Building (A/B) Boric Acid Tank (BAT) valve area at

Elevation -8 ft-7-in. Any overflow from the RWSAT will discharge into a receiving drain line that is equipped with a funnel inside the BAT valve area. The overflow is then routed to the A/B Equipment Drain Sump Tank for collection and then pumped to the LWMS waste holdup tanks for processing. The RWSAT overflow piping and receiving drain line are sized such that they can discharge the maximum flow from the RWSAT. The early warning overflow condition is provided by the high water level alarm water level instrumentation installed on the RWSAT that alarms in the Main Control Room (MCR) for prompt operator action. The BAT valve area is epoxy coated and is equipped with a drain sump with liquid level detection instrumentation to initiate an alarm signal in the MCR for operator action should water spill out of the funnel. The overflow piping also serves as the tank vent. An exhaust air intake is located in close proximity to the overflow outlet and the receiving drain line funnel. These design features, including the early warning overflow condition instrumentation, the receiving drain line funnel, the epoxy coating, the drain sump with liquid level detection instrumentation, and exhaust air intake, are provided to prevent contamination of the facility and the environment from RWSAT overflow or leakage.

DCD Subsection 9.1.4.2.2.2 and Table 12.3-8 will be revised to incorporate these design features.

Impact on DCD

DCD Revision 4, Tier 2, Subsection 9.1.4.2.2.2 and Table 12.3-8 are revised as shown in Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical / Topical Report

There is no impact on any Technical / Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/6/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.1028-7094**
SRP SECTION:	**12.03-12.04 – Radiation Protection Design Features**
APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-68

In RAI 532-4019 Question 12.02-29, the staff asked the applicant to provide information about the design features of structure housing the Refueling Water Storage Auxiliary Tank (RWSAT) and the Primary Makeup Water Tank (PMWT), provided to minimize contamination of the facility and the environment, consistent with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The applicant's response to RAI 532-4019 Question 12.02-29 dated July 10 2012 stated in the proposed changes to DCD Subsection 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 accumulators (ACC) 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 containment vessel drain tank (CVDT). During maintenance or outages, any remaining gas is purged from the system to the gaseous waste management system (GWMS) using nitrogen."

To the staff, this statement is confusing and the staff believes that the intent is as follows:: "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). In this case, typically both CVDT pumps are used to speed up the transfer of water from these areas. In this mode, the water is transferred directly to the CVDT pumps without entering the CVDT. During maintenance or outages, any remaining gas is purged from the CVDT system to the GWMS using nitrogen. The water drained from the refueling cavity is sent directly to the refueling water storage pit (RWSP) by the CS/RHR pumps or gravity"

Please revise and update the proposed change to US-APWR DCD Subsection 11.2.2.1.2.3 to clarify the expected process for operating the CVDT pumps, or provide the specific alternative approaches used and the associated justification.

ANSWER:

DCD Subsection 11.2.2.1.2.3 "Maintenance/Refueling Operations" has been revised to incorporate the NRC's revised description.

Impact on DCD

DCD Revision 4, Tier 2, Subsection 11.2.2.1.2.3 is revised as indicated in Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical / Topical Report

There is no impact on any Technical / Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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RAI NO.:	**NO.1028-7094**
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APPLICATION SECTION:	**12, 6, 9**
DATE OF RAI ISSUE:	**04/30/2013**

QUESTION NO. : 12.03-69

Against Radiation," Section 1101(b) "Radiation protection programs" requires that Occupational Radiation Exposures (ORE) be maintained as low as is reasonably achievable (ALARA) as defined in 10 CFR 20.1003, "Definitions", that is, making every reasonable effort to maintain exposure as low as possible. The guidance contained in Regulatory Guide (RG) 8.8 "Information Relevant for Ensuring that Occupational Radiation Exposures at Nuclear Power Stations is Reasonably Achievable," and RG 1.206 "Combined License Applications for Nuclear Power Plants" Section C.I.12.3.1 "Facility Design Features," state that the design should minimize ORE through the use of maintenance requirements and chemistry controls. Response to US-APWR RAI 980-6954 Revision 0 Question 12.03-49 dated January 1, 2013 states that most resin fines are removed by circulating the holdup tank water through the Boric Acid (B.A.) evaporator feed demineralizer and the Boric Acid (BA) evaporator feed demineralizer filter and the holdup tank. The B.A evaporator feed demineralizer filter has a 0.8 micron mesh size to remove remaining fines following each back washing to the holdup tank in the above operation. This operation removes broken resin fine sediments prior to the next backwashing into the holdup tank. Removing broken resin fines minimizes localized radiation levels around the tanks, B.A evaporator feed pumps and the associated flow control valves, reduces pump maintenance frequency, and minimizes resultant ORE. However, the applicant's response to the question did not describe the design features of the Chemical and Volume Control System (CVCS) Hold Up Tanks (HUT) would prevent the development of a hot spot due to the accumulation of resin fines and crud in the bottom of the tanks. Regulatory Guide (RG) 8.8 Section C.2.h, states that systems containing resin present special hazards because of the concentrated nature of the radioactive material, and provides guidance for design features that may reduce the accumulation of radioactive material.

Please revise and update US-APWR DCD Section 12.3 "Radiation Protection Design Features" to describe the design features provided to prevent the increase in ORE due to the accumulation of resin fines in the CVCS Holdup Tanks from the backwashing of CVCS demineralizers, or describe the specific alternate approaches and the associated justification.

ANSWER:

Tanks containing radioactive particulate material have smooth welds and mixing, flushing and cleaning capabilities to prevent retention of the radioactive particulate material as described in DCD Subsection 12.3.1.1.1.2 Item E. Specifically, the CVCS Holdup Tanks are equipped with an agitator nozzle to agitate recirculation flow. The agitator nozzle fluidizes resin fines and crud in the recirculation water to prevent the accumulation of resin fines and crud in the bottom of the holdup tank that prevents an increase in ORE due to the development of a hot spot.

The agitator nozzle specification will be specified in the detailed engineering design.

Impact on DCD

There is no impact on the DCD.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical / Topical Report

There is no impact on any Technical / Topical Report.

This completes MHI's response to the NRC's question.

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 the refueling water recirculation pump from the RWSP. This is done at flow rate which will minimize scattering of activated dust.

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.

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.

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).

The RWSAT stores the water for the refueling canal, the inspection pit, and the cask pit. DCD_12.03-58
The boron concentration in the RWSAT can be maintained at a 4000 ppm concentration by using the CVCS makeup system. The RWSAT provides water source for the refueling water recirculation pump. The RWSAT and related piping is located in an enclosed tank house with unit heater to preclude freezing. DCD_12.03-56
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. DCD_12.03-64
High radiation water from the reactor coolant loop drain is not transferred to the RWSAT. High radiation water is transferred to the CVCS holdup tank via the C/V reactor coolant drain pumps. Manual valves between the discharge of the refueling water recirculation pump and the discharge of the SFP Demineralizer are used for switching the in-service lines in the discharge line of the refueling water recirculation pump. The RWSAT inlet, outlet and drain line~~s~~ isolation valves are used for leak testing. A valve is installed at the inlet to the RWSAT that allows for periodic hydraulic testing of the pipe routed from the C/V reactor coolant drain tank to the RWSAT using the C/V reactor coolant drain pumps with pump discharge pressure indication.The RWSA~~S~~T has ~~an~~ overflow ~~piping~~ and drain piping ~~to~~that are connected to DCD_12.03-67
the Auxiliary Building (A/B) equipment drain line to prevent direct release of the tank water to the environment~~the water from exposure to the environment directly~~. The RWSAT overflow piping is routed from the RWSAT tank house into the A/B Boric Acid

Tank (BAT) valve area at Elevation
-8 ft-7-in. Any overflow from the RWSAT will discharge into a receiving drain line that is equipped with a funnel inside the BAT valve area. The overflow is then routed to the A/B Equipment Drain Sump Tank for collection and then pumped to the LWMS waste holdup tanks for processing. The RWSAT overflow piping and receiving drain line are sized such that they can discharge the maximum flow from the RWSAT. High water level instrumentation is provided on the RWSAT to provide early warning of an overflow condition that alarms in the Main Control Room (MCR) for prompt operator action. The BAT valve area is epoxy coated and is equipped with a drain sump with liquid level detection instrumentation to initiate an alarm signal in the MCR for operator action should water spill out of the funnel. The overflow piping also serves as the tank vent. An exhaust air intake is located in close proximity to the overflow outlet and the receiving drain line funnel.~~The overflow alarm is installed in the overflow line to announce the operator.~~ The RWSAT drain piping is connected to the equipment drain line inside the tank house with an isolation valve upstream of the connection. The equipment drain line then penetrates the tank house wall and A/B wall. This segment of the equipment drain pipe, which is part of the equipment drainage system, is embedded into the basemat and is constructed with double-walled stainless steel piping. This double-walled drain pipe is slightly sloped with no isolation valve and gravity drains. Any leakage from the inner pipe is collected in the outer pipe and drained to the A/B sump. The double-walled drain pipe is equipped with leak detection instrumentation that initiates an alarm in the MCR for operator action. The use of the double-walled piping design eliminates the need for leak testing the inner pipe. These design features facilitate the prevention of contamination of the facility and the environment and is consistent with the guidance of RG 4.21 and the requirements of 10 CFR 20.1406.

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- 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 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.

- 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 upender, 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 5.1-2 (Sheet 3 of 3). 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.

- 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 flowing through gravity drain lines located in the bottom of the Upper Core Internal Laydown Pit, and the portion where the containment racks are installed. ~~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_12.03-65

The drainage operation for the refueling canal is performed by the refueling canal pump. The water in the refueling canal is transferred to the SFP by the refueling canal pump, and, in parallel, ~~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. These operations are under administrative control. The SFP water level instrument has a high water level alarm so that the operator can take appropriate action to prevent overflowing the SFP water. Water stored in the refueling canal, the fuel inspection pit and the cask pit is purified by the SFP demineralizer prior to DCD_12.03-66 DCD_12.03-66 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 PMWT is single-walled stainless steel piping designed to run aboveground and penetrates the building wall directly into the tank. 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 Subsection 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. A siphon breaker is installed in the PMWT overflow line and its gas phase is connected to the A/B atmosphere to prevent potential discharge of airborne radioactive contaminants, including tritium, to the environment.These design features satisfy the applicable guidance provided in RG 4.21 (Ref 9.2-11-9). DCD_12.03-63

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 Figure 9.2.6-2. Each pump is a centrifugal pump with 275 gpm capacity. Design parameters of the primary makeup water pumps are shown in Table 9.2.6-1.

9.2.6.3 Safety Evaluation

The CSF system has no safety-related function, and therefore requires no nuclear safety evaluation.

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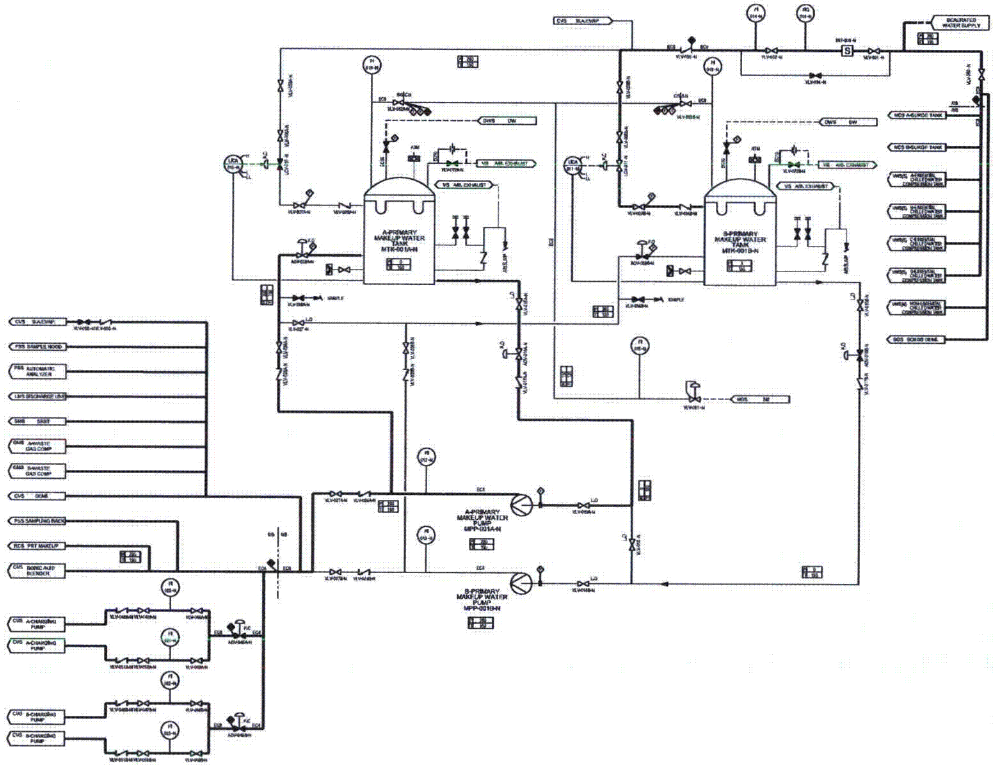

Figure 9.2.6-2 Primary Makeup Water System Flow Diagram

- RCP Number 2 seal and Number 3 seal leakage (Number 1 seal is directed to the VCT)
- Excess letdown water
- Leakage from reactor vessel flanges
- RCL drainage
- Leakage from valves inside 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 CVDT pumps are used to speed up the transfer of water from these areas. In this mode, the water is transferred directly to the ~~RWSAT~~CVDT pumps without entering the CVDT. During maintenance or outages, any remaining gas is purged from the CVDT system to the GWMS using nitrogen. The water from the refueling cavity is transferred directly to the refueling water storage pit (RWSP) by the CS/RHR pumps or gravity. DCD_12.03-68 DCD_12.03-68

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

Table 12.3-8 Regulatory Guide 4.21 Design Objectives and Applicable DCD Subsection Information for Minimizing Contamination and Generation of Radioactive Waste (Sheet 1 of 77)

Fuel Storage and Handling **(Note: The "System Features" column consists of excerpts/summary from the DCD)**

Objective		System Features	DCD Reference
1	Minimize leaks and spills and provide containment in areas where such events may occur.	New and spent fuel storage facilities are located in the fuel handling area of the Reactor Building (R/B) which is designed to meet the Seismic Category I requirements of Regulatory Guide (RG) 1.29.	9.1.1.1 9.1.2.2.2
		The fuel storage and handling area is protected against natural phenomena. The robust concrete walls and ceiling surrounding the fuel storage and handling area are designed to withstand the loads and forces caused by wind, tornadoes, hurricanes, floods, and external missiles.	9.1.1.1 9.1.2.2.2
		The spent fuel pit is constructed of reinforced concrete lined with stainless steel plate. Similarly, the refueling canal, fuel inspection pit, and cask pit are constructed of reinforced concrete lined with stainless steel plate. The liner surface will have a 2B or higher finish, selected to minimize accumulation of corrosion and fission products, and also provide easy maintenance and decontamination. This liner surface is smooth and non-porous to avoid buildup of radioactive material.	9.1.2.2.2
		Penetrations for the drain and makeup lines are located to preclude the draining of the SFP due to a break in a line or failure of a pump to stop. The connection for the SFP pumps' suction is located below normal water level and above the level needed to provide sufficient water for shielding and for cooling of the fuel if the SFPCS is unavailable. The SFP water level instrument has a high water level alarm that alerts the operator to turn off the pump in order to prevent overflowing the SFP water. This design feature aids in minimizing the leakages and spills (dispersion of water) from the SFP.	9.1.2.2.2 9.1.4.2.2.2

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Table 12.3-8 Regulatory Guide 4.21 Design Objectives and Applicable DCD Subsection Information for Minimizing Contamination and Generation of Radioactive Waste (Sheet 3 of 77)

Objective		System Features	DCD Reference
		The RWSP has a leak detection system ~~which~~that alarms in the MCR and consists of leak detection channels that interface with the RWSP liner and are routed through the RWSP floor into standpipes between the RWSP and the PCCV. These standpipes are visually inspected during refueling outages as part of the leak monitoring operational program, in accordance with RG 4.21. The leak detection instrumentation alarms in the MCR.	9.1.3.2

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Table 12.3-8 Regulatory Guide 4.21 Design Objectives and Applicable DCD Subsection Information for Minimizing Contamination and Generation of Radioactive Waste (Sheet 21 of 77)

Objective		System Features	DCD Reference
		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 crosscontamination, 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. The alarms from the liquid level switches are provided in the MCR for prompt operator action.	
		CSF tanks including PMWTs and CST and their associated piping are periodically tested / inspected for leakages.	9.2.6.4

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Table 12.3-8 Regulatory Guide 4.21 Design Objectives and Applicable DCD Subsection Information for Minimizing Contamination and Generation of Radioactive Waste (Sheet 72 of 77)

Refueling Water Storage Auxiliary Tank (RWSAT) **(Note: The "System Features" column consists of excerpts/summary from the DCD)**

Objective		System Features	DCD Reference
		The RWSAT has overflow and drain piping that are connected to the A/B equipment drain line to prevent direct release of the tank water to the environment. The RWSAT overflow piping is routed from the RWSAT tank house into the A/B Boric Acid Tank (BAT) valve area at Elevation -8 ft-7-in. Any overflow from the RWSAT will discharge into a receiving drain line that is equipped with a funnel inside the BAT valve area. The overflow is then routed to the A/B Equipment Drain Sump Tank for collection and then pumped to the LWMS waste holdup tanks for processing. The RWSAT overflow piping and receiving drain line are sized such that they can discharge the maximum flow from the RWSAT. High water level instrumentation is provided on the RWSAT to provide early warning of an overflow condition that alarms in the Main Control Room (MCR) for prompt operator action. The BAT valve area is epoxy coated and is equipped with a drain sump with liquid level detection instrumentation to initiate an alarm signal in the MCR for operator action should water spill out of the funnel. The overflow piping also serves as the tank vent. An exhaust air intake is located in close proximity to the overflow outlet and the receiving drain line funnel.	9.1.4.2.2.2

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