**MITSUBISHI HEAVY INDUSTRIES, LTD.**
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TOKYO, JAPAN

April 1, 2009

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-09140

**Subject: MHI's Response to US-APWR DCD RAI No. 251-2146 REVISION 1**

**Reference:** 1) "Request for Additional Information No.251-2146 Revision 1, SRP Section: 10.04.08 - Steam Generator Blowdown System, Application Section: 10.4.8" dates March 2, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 251-2146 Revision 1."

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

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

Sincerely,

Y. Ogata

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

Enclosure:

1. Response to Request for Additional Information No. 251-2146 Revision 1

CC: J. A. Ciocco
C. K. Paulson

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NRO

Enclosure 1

UAP-HF-09140
Docket Number 52-021

Response to Request for Additional Information
No. 251-2146 Revision 1

April 2009

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**04/01/2009**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

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|---|---|
| **RAI NO.:** | **NO. 251-2146 REVISION 1** |
| **SRP SECTION:** | **10.04.08 - STEAM GENERATOR BLOWDOWN SYSTEM** |
| **APPLICATION SECTION:** | **DCD TIER 2, SECTION 10.4.8** |
| **DATE OF RAI ISSUE:** | **3/2/2009** |

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**QUESTION NO.: 10.04.08-1**

Please provide more specific detailed information about the location of the blowdown nozzle and include it in the DCD. Discuss the basis (e.g., operating experience) for selecting the specified location. The staff did not find the location indicated on a drawing, and the DCD (Tier 2, page 10.4-63) describes it only in general terms ("a location above the tube sheet of each steam generator where impurities are expected to accumulate").

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**ANSWER:**

MHI will add the description of the location of the blowdown nozzle. DCD Tier 2 Chapter 10 Subsection 10.4.8.2.1 will be updated to modify the description SG blowdown nozzle and add the new drawing of SG blowdown nozzle as Figure 10.4.8-3. The DCD will be revised to add a description as shown in "Impact on DCD" below.

**Impact on DCD**

The following changes will be made to the Tier 2 DCD, Section 10.4.8.2.1, 6th paragraph, 1st sentence:
Additionally the new drawing of SG blowdown nozzle will be added as Figure 10.4.8-3.

**Chapter 10 (Section 10.4.8.2.1 6th paragraph, 1st sentence)**

~~The blowdown water is drawn from a location above the tube sheet of each steam generator where impurities are expected to accumulate.~~
The US-APWR SG's utilize a "peripheral" blowdown system arrangement. In this arrangement, blowdown holes are drilled from approximately 7 inches below the secondary surface of the tubesheet and intersect with the peripheral groove on the secondary face of the tubesheet. This arrangement is shown as Figure 10.4.8-3 and facilitates effective sludge removal from the tubesheet.

**Chapter 10 (Section 10.4.8 Figure10.4.8-3)**

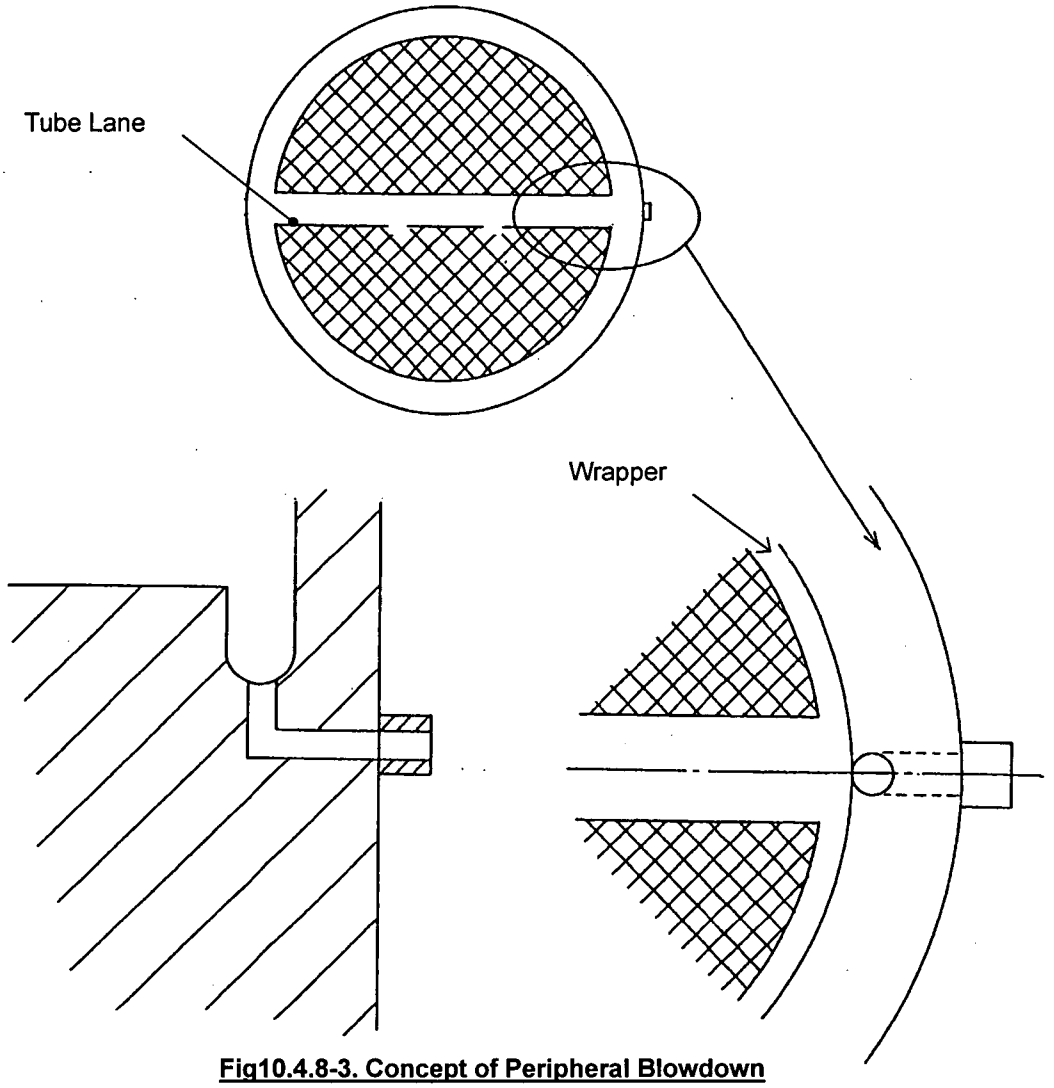


**Fig10.4.8-3. Concept of Peripheral Blowdown**

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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**QUESTION NO.: 10.04.08-2**

Please clarify the meaning of the statement, "Demineralizers include two – 100 percent trains." (DCD page 10.4-64) What quantity is defined as "100 percent?" It is the staff's understanding that this statement means each demineralizer train is capable of processing 100 percent of the maximum blowdown rate. Since the maximum blowdown rate is defined in terms of the maximum steam flow rate, but the demineralizer design information is provided in terms of gallons per minute (Table 10.4.8-1), please use both units in your response.

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**ANSWER:**

The statement "Demineralizers include two – 100 percent trains." means that each demineralizer train is capable of processing 100 percent of the blowdown which flows from the liquid phase of the SG blowdown flash tank. The blowdown water from steam generators flows to the SG blowdown flash tank, where water and flashing vapor are separated. The separated water is transferred to regenerative and non-regenerative heat exchangers for further cooling, and then sent to demineralizers. When the blowdown flow rate is 1% of maximum steaming rate (MSR) at rated power (blowdown flow rate to SG blowdown flash tank is 202,000 lb/hr), the flow rate from liquid phase of the SG blowdown flash tank is evaluated to be approx.159,000 lb/hr, which is approx.320gpm in terms of volume flow rate at the pressure and temperature condition of demineralizers.

**Impact on DCD**

There is no impact on the DCD

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

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**APPLICATION SECTION:** DCD TIER 2, SECTION 10.4.8

**DATE OF RAI ISSUE:** 3/2/2009

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**QUESTION NO.: 10.04.08-3**

Please identify the differences between your requirements and the EPRI secondary water chemistry guidelines for the steam generator blowdown system. Discuss how you determined these differences are appropriate. Table 1.9.2-5 of the DCD states the US APWR specifications for secondary-side water chemistry are, "almost consistent with EPRI Guideline." The staff notes, for example, the apparent lack of continuous pH monitoring of SG blowdown (DCD Table 9.3.2-5) appears to be inconsistent with the EPRI guidelines for blowdown sampling at power operation.

---

**ANSWER:**

The differences between requirements of US-APWR and that of the EPRI secondary water chemistry guidelines for SGBDS are shown in Table.1.

Table.1 Differences between US-APWR sampling requirements and EPRI guidelines for SGBDS

| Sampling item | US-APWR Requirements | EPRI guidelines Requirements | Remarks |
|---|---|---|---|
| (1) pH | Not required to monitor continuously | required to monitor continuously | |
| (2) Cation conductivity | Not required to monitor continuously | required to monitor continuously | |
| (3) Hydrazine | Not required | Required | During only Heat up/Hot standby and startup |
| (4) Silica | Not required | Required | |

As for pH, cation electric conductivity and hydrazine, no control value is set because it is not necessary to monitor these items with SGBDS sampling while monitoring with main feedwater sampling are performed at the same time.

Control value is not set for silica, because few troubles would be generated caused by silica considering on the fact that no silica's carry-over to steam side is found in the secondary system of PWR due to not using superheated steam.

Silica is brought in from make-up water, generally. Therefore, silica concentration should be controlled at make-up water individually per plant within the value which is decided according to

the experimental concentration based on actual concentration at the outlet of make-up water treatment facility. Therefore, we understand it is not necessary to monitor silica concentration with SGBDS sampling.
Furthermore, in SG blowdown water, control value of Na, Cl and $SO_4$ are set in order to maintain pH in SG crevice within the range of not generating IGA/SCC, because there is a possibility of becoming a different environment from SG bulk water after being concentrated at the crevice.

The analysis item and the sampling schedule of the SG blowdown sampling are shown in Table 2.

Table.2 Sampling schedule for SG blowdown water during heat up and power operation

| Monitored system Item | Condensate | Main Feedwater | SG Blowdown water |
|---|---|---|---|
| pH | | D | |
| Cation conductivity | | D | |
| Hydrazine | | D | |
| Dissolved oxygen | D | D | |
| Sodium | | | D |
| Chloride | | | D |
| Sulfate | | | D |
| Crevice pHt | | | W |
| Total Iron | | W | |
| Total copper | | F | |

Frequency: D Once/Day (Continuous monitoring by manual analysis or monitoring instruments)
W Once/Week
F As required
Once/week shall be applied for sampling SG blowdown water during cold shutdown and wet lay-up.

**Impact on DCD**

There is no impact on the DCD

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

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**04/01/2009**

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**Docket No. 52-021**

| | |
|---|---|
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**QUESTION NO.: 10.04.08-4**

Please clarify the meaning of the second sentence of the paragraph about coolant chemistry at the end of 10.4.8.3 ("Preserving these specifications is accordingly able to ensures [*sic*] the integrity of the SG tube materials."). The staff notes it would be incorrect to state that meeting the chemistry specification ensures the integrity of the SG materials, since some degradation mechanisms (e.g., wear, loose parts) may be unrelated to water chemistry.

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**ANSWER:**

In order to avoid misunderstanding, DCD will be revised to add a description as shown in "Impact on DCD" below.

**Impact on DCD**
This revision impacts Chapter10, Subsections 10.4.8.3.
Revise Subsection 10.4.8.3 as follows:

**Chapter10 (Subsection 10.4.8.3, 9th bullet)**

Coolant chemistry specifications to demonstrate compatibility with SG tube primary to secondary system pressure boundary material are addressed in Subsection 10.3.5. Preserving these specifications is accordingly able to ~~ensures~~ control secondary water chemistry needed to maintain the integrity of the SG tube materials. Furthermore the description of the bases for the selected chemistry limit and secondary coolant chemistry program for steam generator blowdown sample are specified in Subsection 10.3.5.

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

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**04/01/2009**

**US-APWR Design Certification**

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**Docket No. 52-021**

| | |
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**QUESTION NO.: 10.04.08-5**

DCD Section 10.4.8.2.2.5 says the blowdown demineralizers can remove contaminants from condenser tube leaks and radioactivity from primary-to-secondary SG tube leakage. Describe how you determined the US-APWR cleanup capability is adequate to maintain the specified secondary-water chemistry under these conditions.

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**ANSWER:**

If a main condenser tube leak occurs, the Condensate polishing system (CPS) goes into service and maintains the condensate water quality. The SGBDS is not designed to have a capability to purify the water with a condenser tube leak. However, the SGBDS can continue to operate to support purification of CPS. DCD Section 10.4.8.2.2.5 will be revised as shown in "Impact on DCD" below. The SG blowdown demineralizers are designed to have cleanup capability under SG tube leakage condition to ensure the specified DF value for radioactive materials as stated in DCD Chapter 11 Table11.2.7 (see items "Cation bed" and "SG Blowdown") and to reduce the concentration of impurities within the control value specified in DCD Chapter 10.3.5 Table 10.3.5-1.

**Impact on DCD**
This revision impacts Chapter10, Subsections 10.4.8.2.2.5.
Revise Subsection 10.4.8.2.2.5 as follows:

**Chapter10 (Subsection 10.4.8.2,2.5, first paragraph)**

10.4.8.2.2.5 Abnormal Operation

(1) Condenser Tube leakage

The CPS goes into service and maintains the condensate water quality. SG blowdown water can be purified by the SG blowdown demineralizers to support purification of CPS or diverted directly to the condenser.

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

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**04/01/2009**

**US-APWR Design Certification**

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**Docket No. 52-021**

| | |
|---|---|
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**QUESTION NO.: 10.04.08-6**

Please identify in the DCD the temperature limitation for the demineralizer inlet.
According to Table 10.4.8-1, the expected operating outlet temperature of the non-regenerative coolers is 113°F, and the measured outlet temperature determines if the water is too hot for the demineralizers. However, the staff was not able to identify the outlet temperature value that activates the demineralizer bypass circuit.

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**ANSWER:**

The recommended temperature limit of the resign which is applied to SG blowdown demineralizers is 60 °C (140 °F). Hence, to be conservative, the outlet temperature value that should activate the demineralizer bypass is decided to be 130 °F.

In order to identify the outlet temperature value that activates the demineralizer bypass circuit, we will change the DCD subsection 10.4.8.5, 4$^{th}$ paragraph, last sentence.

**Impact on DCD**

This revision impacts Chapter10, Subsections 10.4.8.5.
Revise Subsection 10.4.8.5 as follows:

**Chapter10 (Subsection 10.4.8.5, 4th paragraph, last sentence)**

A high temperature signal upstream of SG blowdown demineralizers isolates the flow to the demineralizers. A setpoint temperature of 130 °F is set to isolate the flow to the demineralizers.

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

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**04/01/2009**

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| | |
|---|---|
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**QUESTION NO.: 10.04.08-7**

Please provide additional information on how the SGBDS is designed to resist flow-accelerated corrosion (FAC). What materials are specified for the parts of the SGBDS with conditions that would be expected to cause FAC of carbon steel? If there are FAC susceptible components, please discuss the reason for not designing to prevent FAC and the controls in place to ensure these components are included in COL applicants' FAC programs.

**ANSWER:**

The US-APWR SG Blowdown System (SGBDS) is designed to resist flow-accelerated corrosion (FAC) in two ways. First, the SG blowdown system design specifies low-alloy steel and stainless steel for the piping areas that are most susceptible to FAC. Second, for the other areas of the SG blowdown system, the US-APWR design relies on a combination of water chemistry control coupled with the COL applicant's FAC monitoring program to adequately prevent a piping or component failure due to FAC. These design features are described as follows:

Low-alloy steel and stainless steel

1. The following portions of the SGBDS, including piping and/or components, specify materials (low-alloy steel and stainless steel) that are resistant to flow-accelerated corrosion (FAC). This design feature excludes the need for coverage by the COL applicant's FAC monitoring program.

a. Portion (1)
Lines which are subjected to wet steam and/or vapor with droplet flow.
These lines are made of low-alloy steel to minimize erosion-corrosion mainly.
For example, SG blowdown flash tank vent lines.

b. Portion (2)
Lines which are subjected to two-phase (liquid and flashed vapor) fluid flow.

For example, lines from angle valves to (and including) the SG blowdown flash tank and lines from angle valves to the Waste Water System (WWS) in the startup/abnormal condition blowdown line.

c. Portion (3)

Lines in which water is flushed that could be subject to two-phase fluid flows through it during the flushing.

For example, lines downstream of the outlet of the condensate water side of the SG blowdown regenerative heat exchangers to the deaerator,
lines from the outlet of the SG blowdown flash tank level control valve to the inlet of the SG blowdown filters, and lines that branch from downstream of the angle valves to the condenser.

d. Portion (4)
The lines through SG blowdown filters and demineralizers are also made of stainless steel to minimize general corrosion and to prevent corrosion products from diminishing the performance of the SG blowdown demineralizers.

Water Chemistry Control and FAC Monitoring Program

2. The other portions of the SGBDS are considered to be less susceptible to FAC and are made of carbon steel. For these portions of the SGBDS, the design relies on a combination of the water chemistry control program, as described in Subsection 10.3.5 Water Chemistry, and the FAC monitoring program as identified in the COLA, see COL Item 10.3(1) in Section 10.3.2.

For these components and piping, the FAC monitoring program includes actual inspection of the wall thickness of the piping and/or the components, which will include measurement of the piping thickness. In addition, the FAC monitoring program includes inspection of crack and substitution if required and so on are executed based on the FAC monitoring program (Refer to COL10.3(1) in Chapter 10.3.2) made as COL item

Accordingly, the event of the high energy fluid loss caused by piping and/or component rupture in the SGBDS can be adequately prevented

Subsection 10.4.8.4.2.3 of the DCD will be modified to describe the information on how the SGBDS is designed to resist flow accelerated corrosion (FAC).

The DCD will be revised to modify Subsection 10.4.8.2.3, as shown in "Impact on DCD" below.

**Impact on DCD**
This revision impacts on Chapter 10, Subsection 10.4.8.2.3
Add Subsection 10.4.8.2.3 as follows:

**Chapter10 (Subsection 10.4.8.2.3, 1st paragraph, 1st sentence)**

**10.4.8.2.3 Component Description**
Component design parameters are provided in Table 10.4.8-1.
The US-APWR SG Blowdown system design specifies low-alloy steel and stainless steel for most of the piping and components in order to preclude the need for the application of the FAC monitoring program. For any portion of the piping and /or components that are made of carbon steel, the SGBDS relies on the control of , the water chemistry as described in DCD Subsection 10.3.5, Water Chemistry. This control minimizes the potential for flow accelerated corrosion in the carbon steel piping and/or components.

In addition, for the carbon steel lines and components, the FAC monitoring program will be conducted, which includes the inspection of the wall thickness of carbon steel piping and/or components and replacement if required. The FAC monitoring program is a COL item, (see the FAC monitoring program COL Item 10.3 (1) in Chapter 10.3.2).

**Impact on COLA**

There is no impact on the COLA

**Impact on PRA**

There is no impact on the PRA

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| **APPLICATION SECTION:** | **DCD TIER 2, SECTION 10.4.8** |
| **DATE OF RAI ISSUE:** | **3/2/2009** |

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**QUESTION NO.: 10.04.08-8**

SRP 10.4.8 states that RG 1.143, Position C.1.1, is to be used to specify quality group standards, and US APWR DCD Table 1.9.1-1 states conformance with RG 1.143. RG 1.143 lists the ASME B31.3 code for the design and construction of piping and valves. However, DCD Tier 2, Table 3.2-2 indicates piping and valves in this portion of the USAPWR steam generator blowdown system (SGBDS) will be designed to the ASME B31.1 code.

For the design and construction of SGBDS piping and valves outside the containment isolation valves, the staff notes there is an inconsistency in the design codes specified in Table 3.2-2 of DCD (ASME B31.1) and Table 11.2-1 of the DCD (ASME B31.3). The design code recommended in RG 1.143 is ASME B31.3. Please verify which design code is used for the SGBDS piping, and revise the incorrect DCD reference accordingly.
If you intend to use B31.1, please discuss the basis for this decision including any specific requirements to address potential degradation of the piping from chemical and liquid radwaste fluids and make the corresponding changes to DCD Sections 11.2 (liquid radioactive waste) and 1.9 (Regulatory Guide conformance).

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**ANSWER:**

Table 1.9.2-10 SRP Section 10.4.8 on "Steam Generator Blowdown System" acceptance criteria 1.B confirms the designing of the SGBDS in accordance with Regulatory Guide 1.143, Position C.1.1 downstream of outer containment isolation valves.

Accordingly, the applicable portions of the SGBDS, including the equipment components and their associated piping and valves that are non-safety and can contain radioactive fluid, are designed in accordance with Regulatory Guide 1.143, Table 1. Specifically the design code used for the SGBDS piping and valves outside the containment isolation valves is ASME B31.3 except for the part defined as RG1.26 class C which cover the range from the outlet of the first containment isolation valves up to and including pipe anchors located in the main steam piping room wall. DCD Subsections 3.2 and Table 3.2-2 will be revised accordingly to be consistent with DCD Section 1.9.

DCD Section 11.2, the Liquid Waste Management System, is designed, constructed, installed and tested in accordance with Regulatory Guide 1.143 requirements. This is consistent with Table 1.9.2-11 US-APWR Conformance with Standard Review Plan Chapter 11.

DCD Table 3.2-2 on "Classification of Mechanical and Fluid Systems, Components, and Equipment", Equipment Class for item number "22. Steam Generator Blowdown System" will be revised from Equipment Class 4 to Equipment Class 6 similar to item number "15. Liquid Waste Management System".

**Impact on DCD**

See Attachment 1 for the mark-up of DCD Tier 2, Subsection 3.2.2.5, Revision 2, changes to be incorporated:

See Attachment 2 for the mark-up of DCD Tier 2, Subsection 3.2, Table 3.2-2"Classification of Mechanical and Fluid Systems, Components, and Equipment", Equipment Class for item number "22. Steam Generator Blowdown System", Revision 2, changes to be incorporated:

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

| | |
|---|---|
| • Pressure Vessels | ASME Code, Section VIII, Division 1 (Reference 3.2-19) |
| • Piping | ASME B31.1 (Reference 3.2-20) |
| • Pumps | Manufacturers' standards |
| • Valves | ASME B31.1 (Reference 3.2-20) |
| • Atmospheric Storage Tanks | API-650 (Reference 3.2-21), AWWA D-100 (Reference 3.2-22), or ASME B96.1 (Reference 3.2-23) |
| • 0-15 psig Storage Tanks | API-620 (Reference 3.2-24) |
| • Supports | Manufacturers' standards |

### 3.2.2.5 Other Equipment Classes

**Equipment Class 5**

Equipment Class 5 is assigned to non safety-related components that are not part of the RWMS and not within the purview of RG 1.26 (Reference 3.2-13).

This equipment class is also assigned to non safety-related structures and structural components, instrumentation, controls, and electrical components.

Equipment Class 5 SSCs are classified NS or seismic category II, and 10 CFR 50, Appendix B (Reference 3.2-8) is not applied. Specific quality assurance program controls are applied to non safety-related SSCs, to a degree consistent with their importance to safety (graded approach), as described in Chapter 17. Codes and standards, as defined in the design bases, are applied to equipment Class 5 components.

**Equipment Class 6**

Equipment Class 6 is assigned to the components of the RWMS and a part of SGBDS which cover outside the containment isolation valves except for class 3 components.

The seismic category defined in RG 1.143 (Reference 3.2-10) is applied and 10 CFR 50, Appendix B (Reference 3.2-8) is not applied.

The codes and standards defined in RG 1.143 (Reference 3.2-10), Table 1, are applied to equipment Class 6 components.

**Equipment Class 7**

Equipment Class 7 is assigned to the system, design, and components of the Fire Protection Program.

**Table 3.2-2 Classification of Mechanical and Fluid Systems, Components, and Equipmen**
**(Sheet 37 of 53)**

| System and Components | Equipment Class | Location | Quality Group | 10 CFR 50 Appendix B (Reference 3.2-8) | Codes and Standards[3] | Seismic Category | Notes |
|---|---|---|---|---|---|---|---|
| **22. Steam Generator Blowdown System** | | | | | | | |
| System components | ~~4~~ 6 | T/B<br>R/B<br>A/B | ~~D~~ N/A | N/A | ~~4~~ 6 | ~~NS~~ Note 1 | |
| Steam generator Blowdown system piping and valves from steam generators up to and including the first containment isolation valves, on the outboard side of containment | 2 | PCCV<br>R/B | B | YES | 2 | I | |
| Steam generator Blowdown system piping and valves from the outlet of the first containment isolation valves up to and including pipe anchors located in the main steam piping room wall | 3 | R/B | C | YES | 3 | I | |
| Steam generator Blowdown system piping and valves in the reactor building, auxiliary building, and turbine building | ~~4~~ 6 | R/B,A/B,T/B | ~~D~~ N/A | N/A | ~~4~~ 6 | ~~NS~~ Note 1 | |
| **23. Fire protection water supply System** | | | | | | | |
| Fire protection water supply system containment isolation valves and piping between the valves. | 2 | PCCV<br>R/B | B | YES | 2 | I | |
| Fire protection water supply system piping and valves except the containment penetration noted above | 7 | PCCV<br>R/B,A/B<br>AC/B,PS/B<br>T/B | N/A | N/A | 5 | Note 2 | |
| **24. Process and Post-accident Sampling System** | | | | | | | |
| Sample heat exchanger –tube side | 4 | R/B | D | N/A | 4 | NS | |