RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**475-8596**
SRP Section:	**10.04.08 – Steam Generator Blowdown System**
Application Section:	**10.4.8**
Date of RAI Issue:	**05/04/2016**

Question No. 10.04.08-6

The response to RAI 381-8467, Question 10.04.08-1, provided additional information about the containment isolation signals related to the steam generator blowdown system. The response is dated April 2, 2016, ADAMS Accession Number ML16093A018. The response did not provide all of the information the staff needs to complete its review. The staff requests the following additional information:

a. The response proposes listing additional control signals in Tier 1 Table 2.7.1.8-1, but there is no corresponding change proposed for Tier 1 Figure 2.7.1.8-1. Since Figure 2.7.1.8-1 shows the control signals associated with containment isolation valves, provide your plans for revising Figure 2.7.1.8-1 or the basis for not revising it.

b. The response indicates that Tier 2 Chapter 7 intentionally discusses the instrumentation and controls at a higher level and does not describe individual signals. The staff determined that for consistency and clarity, the signals that activate the containment isolation valves should be identified in Chapter 7, especially in the functional diagrams. Please discuss your plans to add this information to the FSAR.

Response

a. DCD Tier 1 Figure 2.7.1.8-1 and ACRONYM AND ABBREVIATION LIST will be revised to include the HRAS and the BFTHHLAS signals as indicated in the Attachment. And the signal lines in DCD Tier 2 Figure 10.4.8-1 will be revised to a dashed line as indicated in the Attachment.

b. To activate the containment isolation valves (CIVs), following signals are used:

   1. ESFAS (e.g., SIAS, CSAS, CIAS, MSIS, and AFAS) and DPS (e.g., DPS-AFAS) signals

- Each signal is provided to the associated CIV.

2. Process interlock signal

   DCD Tier 2 Chapter 7.3 and 7.8 describe how the ESFAS and DPS signals are generated based on SRP 7.3 and 7.8. However, there is no discussion about how the ESFAS and DPS signals activate each component in DCD Tier 2 Chapter 7. It is not necessary to describe the component logic description in DCD Tier 2 Chapter 7. The detail information to activate each component is described in the related DCD section such as Chapter 10.

   The process interlock signals are also described in the related DCD section such as Chapter 10.

   Section 7.3 will be revised to state that the CIVs in the CIS are automatically actuated by CIAS and other ESFAS signals (SIAS, CSAS, MSIS, and AFAS) and process interlock signals, which are generated in the individual process systems such as steam generator blowdown system and etc. (see Attachment).

   For example, steam generator blowdown system CIVs 005, 006, 007, and 008 in Figure 2.7.1.8-1 of DCD Tier 1 are actuated by the CIAS, AFAS, MSIS, and DPS-SIAS. However, those CIVs are not related with the SIAS and CSAS.

Impact on DCD

DCD Tier 1, Figure 2.7.1.8-1 and ACRONYM AND ABBREVIATION LIST, DCD Tier 2, Figure 10.4.8-1, and Subsection 7.3.1.9 will be revised as indicated in Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

BFTHHLAS	Blowdown Flash Tank High-high Level Actuation Signal

ACRONYM AND ABBREVIATION LIST

AAC	alternate alternating current
AB	auxiliary building
AC	alternating current
ACC	analysis computer cabinet
ACP	auxiliary charging pump
ACU	air cleaning unit
AFAS	auxiliary feedwater actuation signal
AFW	auxiliary feedwater
AFWS	auxiliary feedwater system
AFWST	auxiliary feedwater storage tank
AHU	air handling unit
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
AOO	anticipated operational occurrence
AOV	air-operated valve
APC	auxiliary process cabinet
ARMS	area radiation monitoring system
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
BAMP	boric acid makeup pump
BAST	boric acid storage tank
BISI	bypassed and inoperable status indication
BOP	balance of plant
CCF	common cause failure
CCS	component control system
CCW	component cooling water
CCWS	component cooling water system
CEA	control element assembly
CEACP	CEA change platform

HRAS	High Radiation Actuation Signal
FPS	fire protection system
FTS	fuel transfer system
FWCS	feedwater control system
GCB	generator circuit breaker
GDC	general design criteria (of 10 CFR Part 50, Appendix A)
GTG	gas turbine generator
GWMS	gaseous waste management system
HFE	human factors engineering
HJTC	heated junction thermo couple
HSI	human-system interface
HVAC	heating, ventilation, and air conditioning
HVT	holdup volume tank
HX	heat exchanger
I&C	instrumentation and control
ICI	in-core instrumentation
IHA	integrated head assembly
IPS	information processing system
IRWST	in-containment refueling water storage tank
ISV	intermediate stop valve
ITAAC	inspections, tests, analyses, and acceptance criteria
ITP	interface and test processor
IWSS	in-containment water storage system
LBB	leak before break
LC	load center
LCS	local control station
LLHS	light load handling system
LOCA	loss of coolant accident
LOOP	loss of offsite power
LPD	local power density
LPZ	low population zone

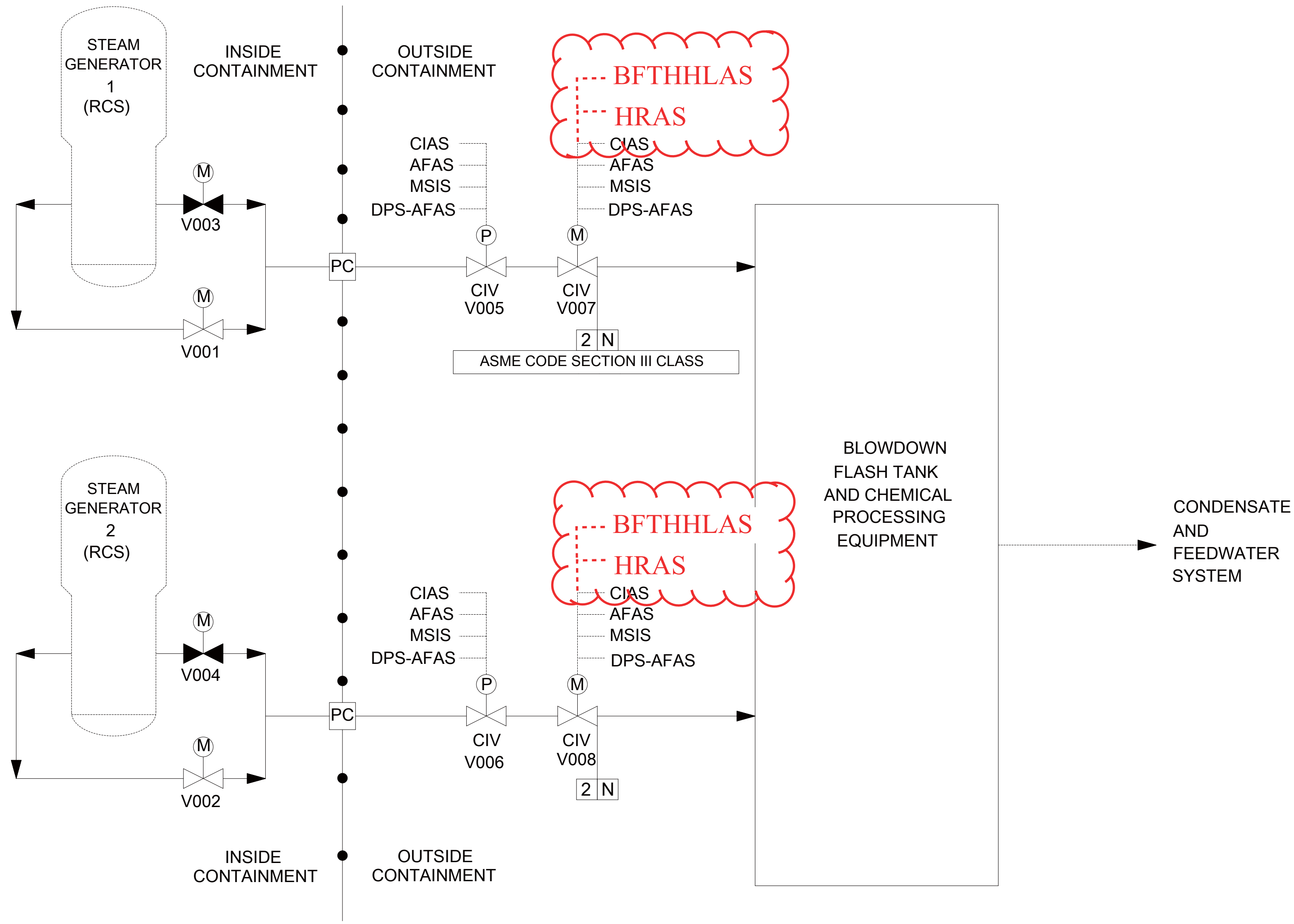

Figure 2.7.1.8-1 Steam Generator Blowdown System

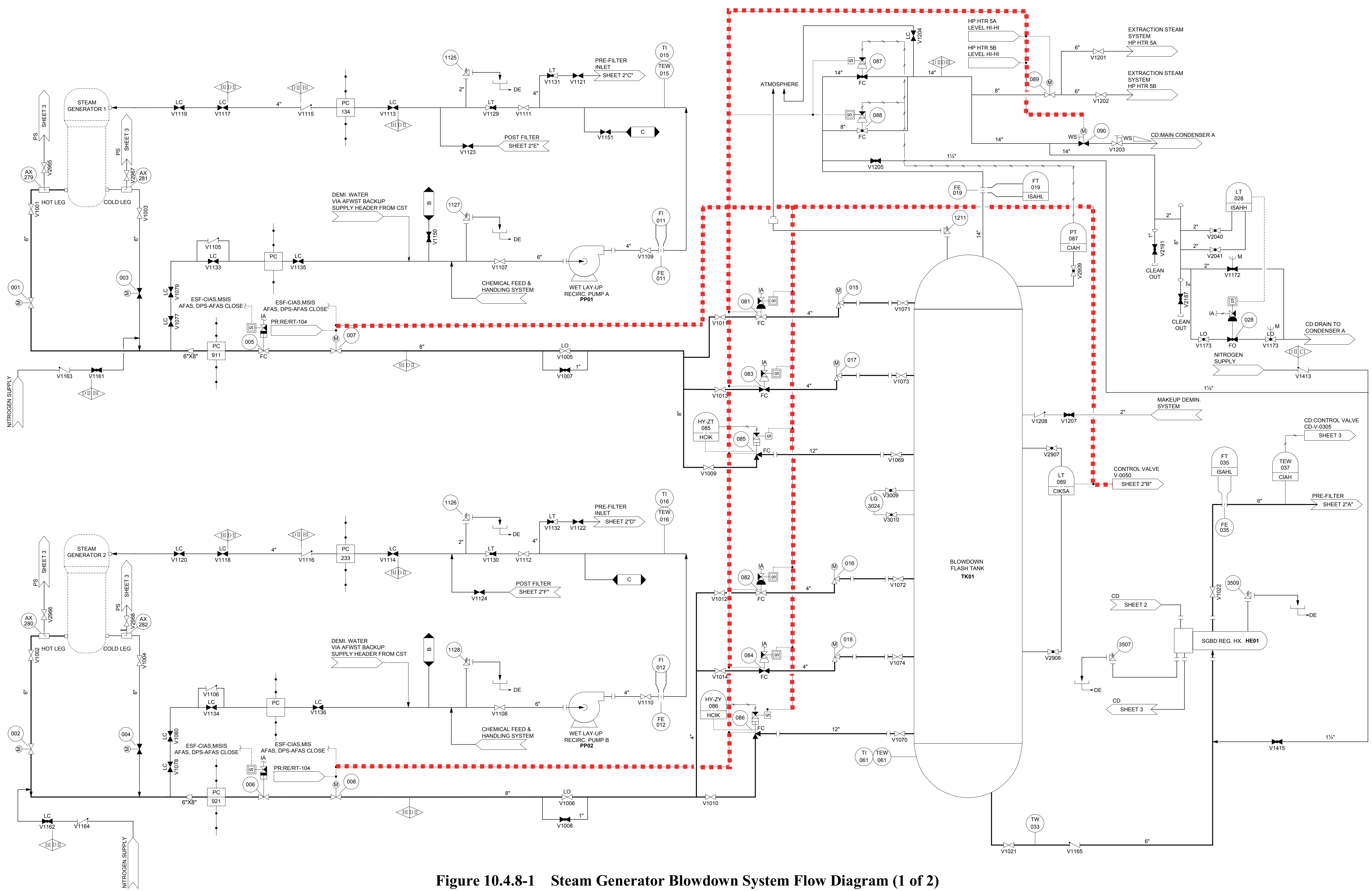

Figure 10.4.8-1 Steam Generator Blowdown System Flow Diagram (1 of 2)

Subsection 6.2.4 contains the description of the containment isolation system (CIS). The actuation system is composed of redundant divisions A and B. The instrumentation and controls of the two divisions are physically and electrically separate and independent so that the loss of one division will not impair the safety function.

The CIS instrumentation and controls are designed for operation during all phases of plant operation. However, the system is removed from service prior to containment leak checking at refueling period intervals in order to prevent undesired system actuation. The removal from service is accomplished in accordance with the procedures prepared by the site operator.

~~The CIS is automatically actuated by a CIAS.~~

Remotely operated (automatic or manual) containment isolation valves (CIVs) are provided with control and indication capability in the MCR. Additionally, a closed position signal of each valve inputs into the IPS, QIAS-P, and QIAS-N for critical function monitoring, which detects unisolated containment penetrations by monitoring the status of valves that are required to close upon a CIAS.

The process information is provided in the MCR, which the operator uses to determine when to isolate the fluid systems.

All systems that provide a path from the containment to the environment (e.g., containment purge and vent systems) have their CIVs closed upon a CIAS.

b. Containment spray system

Subsection 6.5.2 contains the description of the containment spray system (CSS). The CSS is actuated by a CSAS. The containment spray pumps are also actuated by an SIAS. When used in the containment spray configuration, the shutdown cooling pumps are actuated by an SIAS or CSAS.

The actuation system is composed of redundant divisions A and B. The instrumentation and controls of each division are physically and electrically separate and independent. Each division has 100 percent capacity. Therefore, the CSS can sustain the loss of an entire division and still provide its required

The CIVs in the CIS are automatically actuated by CIAS and other ESFAS signals (SIAS, CSAS, MSIS, and AFAS) and process interlock signals, which are generated in the individual process systems such as steam generator blowdown systems and etc.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**475-8596**
SRP Section:	**10.04.08 – Steam Generator Blowdown System**
Application Section:	**10.4.8**
Date of RAI Issue:	**05/04/2016**

Question No. 10.04.08-7

The response to RAI 381-8467, Question 10.04.08-3, provided additional information about addressing flow accelerated corrosion (FAC) in the steam generator blowdown system. The response is dated April 2, 2016, ADAMS Accession Number ML16093A018. The response proposes a new FSAR Subsection 10.4.8.2.2.f to describe how the design addresses FAC for the SGBS. The staff finds some parts of the proposed subsection unclear and requests that the applicant provide additional information to address the following issues:

a. The staff recognizes that specifying stainless steel is one way to meet staff guidance for preventing FAC. However, since FAC is a form of corrosion (flow-accelerated corrosion), the staff does not understand the statement that stainless steel is "not applied for preventing FAC, but for corrosion." If this subsection of the FSAR provides the reason (other than FAC) for using stainless steel, that reason needs to be clarified.

b. The proposed description states that upstream and downstream lines of the SG blowdown filters and demineralizers are stainless steel. This description does not identify how far the stainless steel portion extends upstream; therefore, the response is unclear about the materials used between the flash tank and pre-filter, and how FAC is addressed in that portion of the system.

c. The staff does not understand the meaning of "chemical corrosion" and how it relates to use of stainless steel for the wet lay-up piping. The staff recognizes the use of stainless steel as a way to prevent FAC, but if this subsection of the FSAR provides another reason for using stainless steel in the wet lay-up piping, that reason needs to be clarified.

d. If there are carbon steel portions of the SGBS that can be excluded from the FAC program, that should be justified by identifying the applicable criteria in EPRI Report NSAC-202L, "Recommendations for an Effective Flow-Accelerated Corrosion

Program," Rev. 3 or later. The response references B31.1, the ASME Code for Power Piping, but NRC guidance does not recognize B31.1 as a basis for FAC programs.

Response

a. Stainless steel is used to prevent both FAC and corrosion. "Corrosion" or "chemical corrosion" refers to the condition when the system has no flow.

b. Downstream of the flash tank, stainless steel is installed between pre-filter isolation valves (V1028/1026 and V1029/1027), the demineralizer isolation valves (1030/1032, V1049/1033, V1050/1035, V1031/1034, and V1307/1308), and post-filter isolation valves (V1036 and V1037). The other portion of piping is carbon steel. To prevent FAC, the additional thickness of 1.524 mm (0.06 in) in design is applied in consideration of the 40 years of design life. In addition, water and steam with the same chemical conditions that are utilized in the steam and feedwater system in DCD Tier 2, Subsections 10.3.5 and 10.3.6 are supplied from the steam generators to the flash tank, and to the downstream. The chemical injection line is utilized upstream of the steam generator in the main feedwater system. During the blowdown subsystem operation, the corrosion inhibitor (example: hydrazine) and ethanolamine is continuously injected through the chemical injection line to eliminate oxygen in the feedwater and controls pH in the feedwater for the suitable corrosion resistance environment, respectively.

c. Since the wet lay-up subsystem is only operated during plant shutdown, chemical corrosion is also concerned. The wet lay-up subsystem is made of stainless steel to prevent FAC.

d. DCD Tier 2 Subsection 10.4.8.2.2.f will be deleted and a new section 10.4.8.2.2.1 will be added.

Additionally, the editorial errors in Tier 2 Table 10.4.8-1 (2 of 4) will be revised as indicated in the Attachment.

Impact on DCD

DCD Tier 2 Subsection 10.4.8.2.2.1 will be added and DCD Tier 2 Table 10.4.8-1 will be revised as indicated in Attachment to address FAC considerations for the SGBS and to correct the editorial errors, respectively.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

RAI 381-8467 - Question 10.04.08-3
RAI 475-8596- Question 10.04.08-7

e. Wet lay-up recirculation pump

The centrifugal wet lay-up recirculation pump recirculates the SG secondary side water through filters and demineralizers during wet lay-up of the SG. The pumps are also used to drain and fill the SG secondary side.

insert A (Next page)

10.4.8.2.3 System Operation

10.4.8.2.3.1 Plant Startup

The SGs are maintained in wet lay-up by the WLS when the plant is expected to be shut down for a long period. After the WLS operation is ceased, the water in the SG is transferred to either the [[wastewater treatment facility]] or the liquid radwaste system. If the SG water is nonradioactive, it is drained to the [[wastewater treatment facility]] by gravity or by using the wet lay-up recirculation pump until the required water quality is met and the desired water level is achieved. If the SG water is radioactive, it is drained to the liquid radwaste system by gravity or by using the wet lay-up recirculation pump until the required water quality is met and the desired water level is achieved.

The abnormal blowdown (ABD) is started following feedwater pump startup operation.

The ABD of 1 percent of SG's maximum steaming rate (SGMSR) is maintained until the water quality is within the normal limits.

10.4.8.2.3.2 Normal Operation

During normal power operation, the CBD that flows from each SG is maintained to keep the SG secondary side water chemistry within the specified limits. The CBD flow rate is 0.2 percent in normal blowdown or 1 percent in ABD.

The blowdown system cools the blowdown water with regenerative heat exchanger to a temperature that is acceptable for processing filters and demineralizers.

RAI 381-8467 - Question 10.04.08-3

RAI 475-8596- Question 10.04.08-7

A

f. SG blowdown piping

The SGBS piping is designed to address flow accelerated corrosion (FAC) as follows:

1) SGBS piping from the SGs to the blowdown flash tank is made of chrome-moly materials, which is resistant to flow accelerated corrosion (FAC).

2) The piping in the up and down stream lines of the SG blowdown filters and demineralizers is made of stainless steel. These segments of the piping are not applied for preventing FAC, but for corrosion.

3) The wet lay-up piping is made of stainless steel for consideration of chemical corrosion. The piping is not used during normal operation.

4) Other SGBS piping is made of carbon steel but not susceptible to FAC, since one of operating conditions in the piping is less than the ranges for FAC specified in ASME B31.1 (Reference 5).

10.4.8.2.2.1 Flow-Accelerated Corrosion

The SGBS is designed to avoid FAC and erosion/corrosion damage. The same water chemistry conditions of the secondary system that are controlled to minimize corrosion is applied to the SGBS. The following portion of SGBS is designed to address FAC:

a) SGBS piping from the SGs to the blowdown flash tank is made of chrome-moly materials.

b) Stainless steel is installed between pre-filter isolation valves, the demineralizer isolation valves, and post-filter isolation.

c) The wet lay-up piping is made of stainless steel.

d) Other SG blowdown piping is made of carbon steel with 1.524 mm (0.06 in) additional margin in the design.

e) The carbon steel portions of SGBS are managed by the FAC program during plant operations (COL 10.3(3)).

Table 10.4.8-1 (2 of 4)

Wet Lay-Up Recirculation Pump	
Number of ~~demineralizers~~ pumps	2~~/unit~~
Type	Horizontal, centrifugal
Design flow rate	1,627 lpm (430 gpm)
Total discharge head	112.7 m (370 ft)
Radwaste safety class	RW-IIc
Pre-filter	
Type	Cartridge
Number of ~~coolers~~ filters	2
Design flow rate	3,255 lpm (860 gpm)
Operating pressure	1.72 MPa (250 psig)
Operating temperature	57.2 °C (135 °F)
Design pressure	2.06 MPa (300 psig)
Design temperature	121.1 °C (250 °F)
Rating	98 removal efficiency for the particles greater than 0.5 micron
Material of construction	
Filter Body	Stainless steel Stainless steel
Radwaste safety class	RW-IIc