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.:	**153-8070**
SRP Section:	**10.04.03 – Turbine Gland Sealing System**
Application Section:	**10.4.3**
Date of RAI Issue:	**08/13/2015**

Question No. 10.04.03-1

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Tier 2, Section 10.4.3 indicates the turbine gland sealing system (TGSS) is designed to provide a source of sealing steam to the annulus space where the turbine and large steam valve shafts penetrate their casings to prevent air leakage into and steam leakage out of these components. This includes the equipment to collect and route the system effluents to the appropriate destination.

The staff finds the applicant using two terms: turbine gland sealing system (TGSS) and turbine steamseal system (TSSS) throughout DCD Chapter 10. It appears these two names are for the same system.

The applicant is requested to clarify the differences between turbine gland sealing steam, TGSS, and turbine steam-seal system, TSSS. The DCD should be modified accordingly.

Response

Turbine gland sealing system and turbine steal seal system are the same system. “Turbine gland sealing system” described on DCD Tier 2 will be revised to “turbine steam seal system” as indicated on the attached markups.

Impact on DCD

DCD Tier 2, descriptions, tables and figures will be revised as indicated on the attached markups.

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.

TCS	turbine control system
TDAFWP	turbine-driven auxiliary feedwater pump
TDH	total dynamic head
TDR	time domain reflectometry
TEDE	total effective dose equivalent
TEMA	Tubular Exchanger Manufacturers Association
TEPCO	Tokyo Electric Power Company
TG	turbine generator
TGB	turbine generator building
TGBCCW	turbine generator building closed cooling water
TGBOCWS	turbine generator building open cooling water system
TGCS	turbine generator control system
~~TGSS~~ TSSS	turbine ~~gland sealing~~ Steam Seal system
THD	total harmonic distortion
THERP	technique for human error rate prediction
TI	temperature indicator
TI-SGTR	temperature-induced steam generator tube rupture
TID	1) technical information document 2) total integrated dose
TIHA	treatment of important human action
TIV	temperature isolation valve
TLOCCW	total loss of component cooling water
TLOESW	total loss of essential service water
TLOFW	total loss of feedwater
TMI	Three Mile Island
T_{NDT}	nil-ductility transition temperature
TO	turbine operator
TRAN	transient
T_{REF}	reference temperature
TRS	test response spectrum
TS	technical specification

Table 1.7-2 (2 of 3)

Figure No.	Title	DCD Tier 2 Section
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9.3.3-1	Radioactive Drain System Flow Diagram	9.3
9.3.4-1	Chemical and Volume Control System Flow Diagram	9.3
9.4.1-1	Control Room HVAC System Flow Diagram	9.4
9.4.2-1	Fuel Handling Area HVAC System Flow Diagram	9.4
9.4.3-1	Auxiliary Building Clean Area HVAC System Flow Diagram	9.4
9.4.4-1	Turbine Generator Building HVAC System Flow Diagram	9.4
9.4.5-1	Emergency Diesel Generator Area HVAC System Flow Diagram	9.4
9.4.5-2	Electrical and I&C Equipment Areas HVAC System Flow Diagram	9.4
9.4.5-3	Auxiliary Building Controlled Area HVAC System Flow Diagram	9.4
9.4.6-1	Reactor Containment Building HVAC System Flow Diagram	9.4
9.4.6-2	Reactor Containment Building Purge System Flow Diagram	9.4
9.4.7-1	Compound Building HVAC System Flow Diagram	9.4
9.5.1-1	Fire Protection System Flow Diagram	9.5
9.5.4-1	Diesel Fuel Oil Transfer System Flow Diagram	9.5
9.5.5-1	Emergency Diesel Engine Cooling Water System Flow Diagram	9.5
9.5.6-1	Emergency Diesel Engine Starting Air System Flow Diagram	9.5
9.5.7-1	Emergency Diesel Engine Lube Oil System Flow Diagram	9.5
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9.5.9-1	Gas Turbine Generator Facility Flow Diagram	9.5
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10.1-2	Overall System Flow Diagram	10.1
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10.3.2-2	Turbine System Flow Diagram	10.3
10.4.2-1	Condenser Vacuum System Flow Diagram	10.4
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10.4.6-1	Condensate Polishing System Flow Diagram	10.4
10.4.7-1	Condensate and Feedwater System Flow Diagram	10.4
10.4.8-1	Steam Generator Blowdown System Flow Diagram	10.4

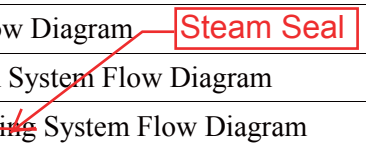

Table 1.9-2 (22 of 33)

SRP Section/Title	Revision / Issue Date	Conformance or Summary Description of Deviation	DCD Tier 2 Section
10.3 – Main Steam Supply System	Rev. 4 03/2007	The APR1400 conforms with this SRP.	10.3
10.3.6 – Steam and Feedwater System Materials	Rev. 3 03/2007	The APR1400 conforms with this SRP.	10.3.6
10.4.1 – Main Condensers	Rev. 3 03/2007	The APR1400 conforms with this SRP.	10.4.1
10.4.2 – Main Condenser Evacuation System	Rev. 3 03/2007	The APR1400 conformance with exceptions. Criterion 1 refers to a potential for explosive mixtures and the APR1400 has no potential for explosive mixtures.	10.4.2
10.4.3 – Turbine ~~Gland Sealing~~ System	Rev. 3 03/2007	The APR1400 conforms with this SRP.	10.4.3
10.4.4 – Turbine Bypass System	Rev. 3 03/2007	The APR1400 conforms with this SRP.	10.4.4
10.4.5 – Circulating Water System	Rev. 3 03/2007	System is site-specific and is addressed with interface requirements.	10.4.5
10.4.6 – Condensate Cleanup System	Rev. 3 03/2007	The APR1400 conforms with this SRP.	10.4.6
10.4.7 – Condensate and Feedwater System	Rev. 4 03/2007	The APR1400 conformance with exceptions. Criterion 3 refers to shared systems and the APR1400 is a single unit design. Criterion 7 is defined as COL item in DCD subsection 10.3.6. Criterion 8 is for BWR.	10.4.7
10.4.8 – Steam Generator Blowdown System (PWR)	Rev. 3 03/2007	The APR1400 conforms with this SRP.	10.4.8

Steam Seal

LIST OF FIGURES

Steam Seal

NRV	non-return check valve
NSSS	nuclear steam supply system
POSRV	pilot-operated safety relief valve
QA	quality assurance
RCS	reactor coolant system
RG	Regulatory Guide
RPCS	reactor power cutback system
RRS	reactor regulating system
RSR	remote shutdown room
SBCS	steam bypass control system
SBLOCA	small-break loss-of-coolant accident
SBO	station blackout
SG	steam generator
SGBDS	steam generator blowdown system
SGMSR	steam generator's maximum steaming rate
SGTR	steam generator tube rupture
SSC	structure, system, or component
SSE	safe shutdown earthquake
TB	turbine building
TBS	turbine bypass system
TBV	turbine bypass valve
T/G	turbine generator
TGBCCW	turbine generator building closed cooling water
TGBOCWS	turbine generator building open cooling water system
TGCS TSSS	turbine generator control system
~~TGSS~~	turbine ~~gland sealing~~ system
VWO	valve wide open Steam Seal
WLS	wet lay-up subsystem
WWTS	wastewater treatment system

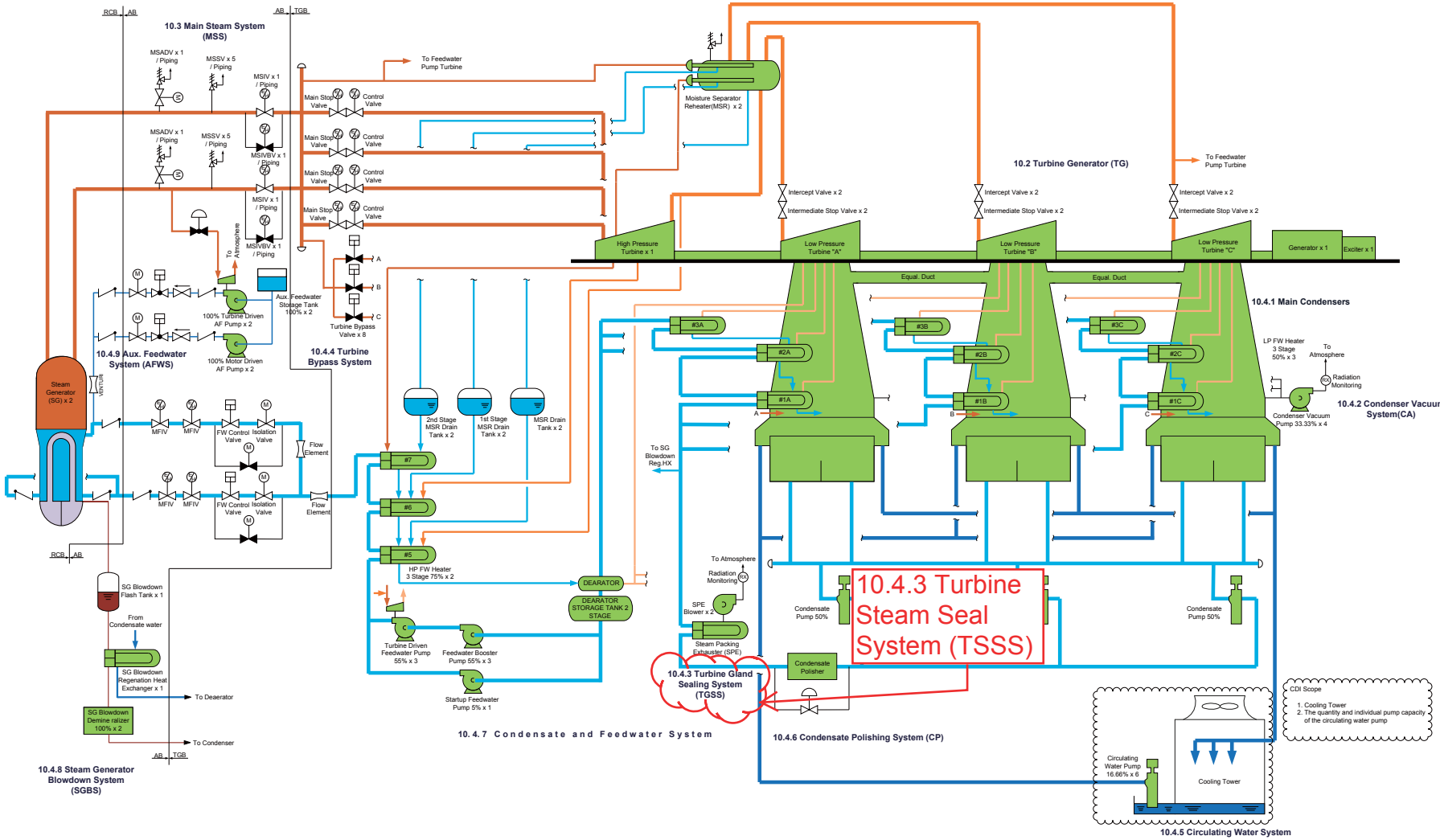

Figure 10.1-2 Overall System Flow Diagram

10.4.3 Turbine Gland Sealing System

10.4.3.1 Design Basis

Steam Seal

The turbine ~~gland sealing~~ system (~~TGSS~~) is designed to seal the annular openings where the turbine shaft penetrates the turbine casings to prevent steam outleakage and air inleakage along the turbine shaft. The ~~TGSS~~ also returns the air-steam mixture to the turbine gland steam-packing exhauster, condenses the steam, returns the drains to the main condenser, and exhausts the non-condensable gases to the atmosphere through blowers. The ~~TGSS~~ is designed to prevent uncontrolled release of radioactive material to the environment in accordance with GDC 60 and 64.

TSSS

All system components are non-seismic and designed in accordance with NRC RG 1.26 (Reference 2), Quality Group D, as described in Section 3.2.

10.4.3.2 System Description

The ~~TGSS~~ consists of a steam-seal supply and exhaust header, a gland steam-seal feed valve, turbine steam seal control panel, a gland steam-packing exhauster with two motor-driven blowers, and the associated piping and valves. The ~~TGSS~~ serves both the main turbine and the feedwater pump turbines. For the system to function satisfactorily from startup to full load, a fixed positive pressure in the steam seal supply header and a fixed vacuum in the outer ends of all turbine glands are maintained at all loads. Steam is provided by the main, auxiliary, and extraction steam systems. The ~~TGSS~~ also receives steam-seal leak-off from turbine control valves and main turbine stop valves. The ~~TGSS~~ is shown in Figure 10.4.3-1.

The steam discharge ends of all glands are routed to the gland steam packing exhauster, which is maintained at a slight vacuum by the redundant motor-driven blowers. The gland steam packing exhauster is a shell-and-tube heat exchanger. Condensate from the condensate system is used to condense the steam from the mixture of air and steam drawn from the shaft packing. Drains from the gland steam packing exhauster are returned to the condenser, and the non-condensable gases are vented to the atmosphere through the condenser vacuum system discharge line. The non-condensable gases discharged from the blowers are monitored for radioactivity as addressed in Section 11.5. The non-

condensable gases are not radioactively contaminated in normal operation. The radioactive materials are processed in this system only if there is a primary-to-secondary SG tube leak due to an SGTR. If radioactivity in the exhaust flow exceeds an acceptable level, the condenser vacuum pump vent effluent monitor actuates an alarm in the MCR, and then adequate operating procedures are implemented to preclude significant release to the environment. Design and configuration for the effluent monitor, and the associated parameters, are provided in Subsections 11.5.2.1 and 11.5.2.2, respectively. The location of radiation detector is shown in Figure 11.5-1.

During cold startup of the T/G, sealing steam is provided by the auxiliary steam system. When the SG is brought up to full pressure, the auxiliary steam source is closed, and the main steam provides sealing. As the turbine is brought up to about 50 percent load, steam leakage from the high-pressure packing and the extraction steam system enters the steam-seal header. When this leakage is sufficient to maintain steam-seal header pressure, the main steam source valve is closed, and sealing steam to all turbine seals is supplied from the high-pressure packing and the extraction steam system. When the leakage from the high-pressure packing is more than required by vacuum packing, the excess steam is discharged through the unloading valve to the main condenser.

10.4.3.3 Safety Evaluation

The ~~TGSS~~ has no safety function. The ~~TGSS~~ valves are arranged for fail-safe operation to protect the turbine.

10.4.3.4 Inspection and Testing Requirements

Tests and inspection of ~~TGSS~~ equipment are performed in accordance with applicable codes and standards. Hydrostatic tests for piping and valves are performed in accordance with ASME B31.1 (Reference 5) and ASME B16.34 (Reference 10), respectively. Nondestructive inspections are performed in accordance with ASME Section V (Reference 11). The ~~TGSS~~ is functionally tested during unit startup. Normal operating system performance monitoring detects any deterioration in the performance of system components.

10.4.3.5 Instrumentation Requirements

The indicating and alarm devices for steam-seal header pressure in local locations and the MCR are provided to monitor the system. A pressure controller is provided to maintain the steam-seal header pressure by signaling to the steam-seal header pressure control valves to discharge the excess steam into the main condenser by providing the signal to the unloading valve. All instrumentation of the ~~TGSS~~ TSSS is for the normal power operation, and not required for safe shutdown of the reactor.

10.4.4 Turbine Bypass System

The TBS is a part of the MSS. The TBS provides the capability to flow main steam from the SGs to the main condenser, bypassing the main turbine to dissipate heat and to minimize transient effects on the RCS during startup, hot standby, cooldown, and generator step-load reduction.

10.4.4.1 Design Bases

The TBS performs no safety-related functions and therefore has no nuclear safety-related design basis. The TBS is located in the T/G building. The TBS takes steam from the main steam line upstream of the turbine stop valves and discharges steam to the condenser. The TBS is designed to accomplish the following functions:

a. Regulate steam flow to dissipate excess energy from the nuclear steam supply system (NSSS) following load rejections of any magnitude without tripping the reactor or opening the pressurizer pilot-operated safety relief valves (POSRVs) and/or MSSVs in conjunction with steam bypass control system (SBCS) and reactor power cutback system (RPCS) and reactor regulating system (RRS).

b. The TBS has the capacity to bypass 55 percent of the total saturated steam flow at normal full-power SG pressure to the main condenser.

c. Maintain the NSSS thermal conditions at no-load conditions

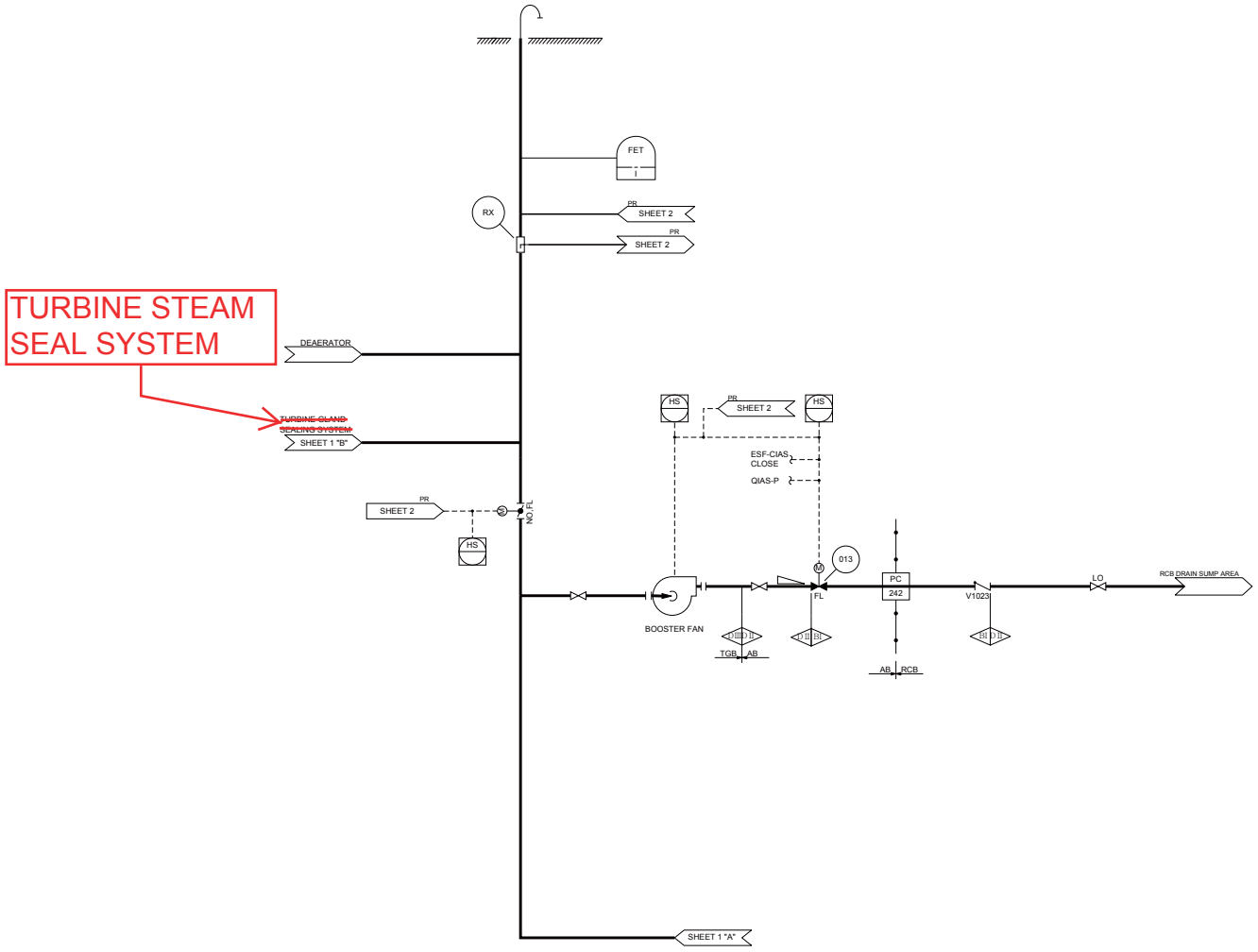

Figure 10.4.2-1 Condenser Vacuum System Flow Diagram (2 of 2)

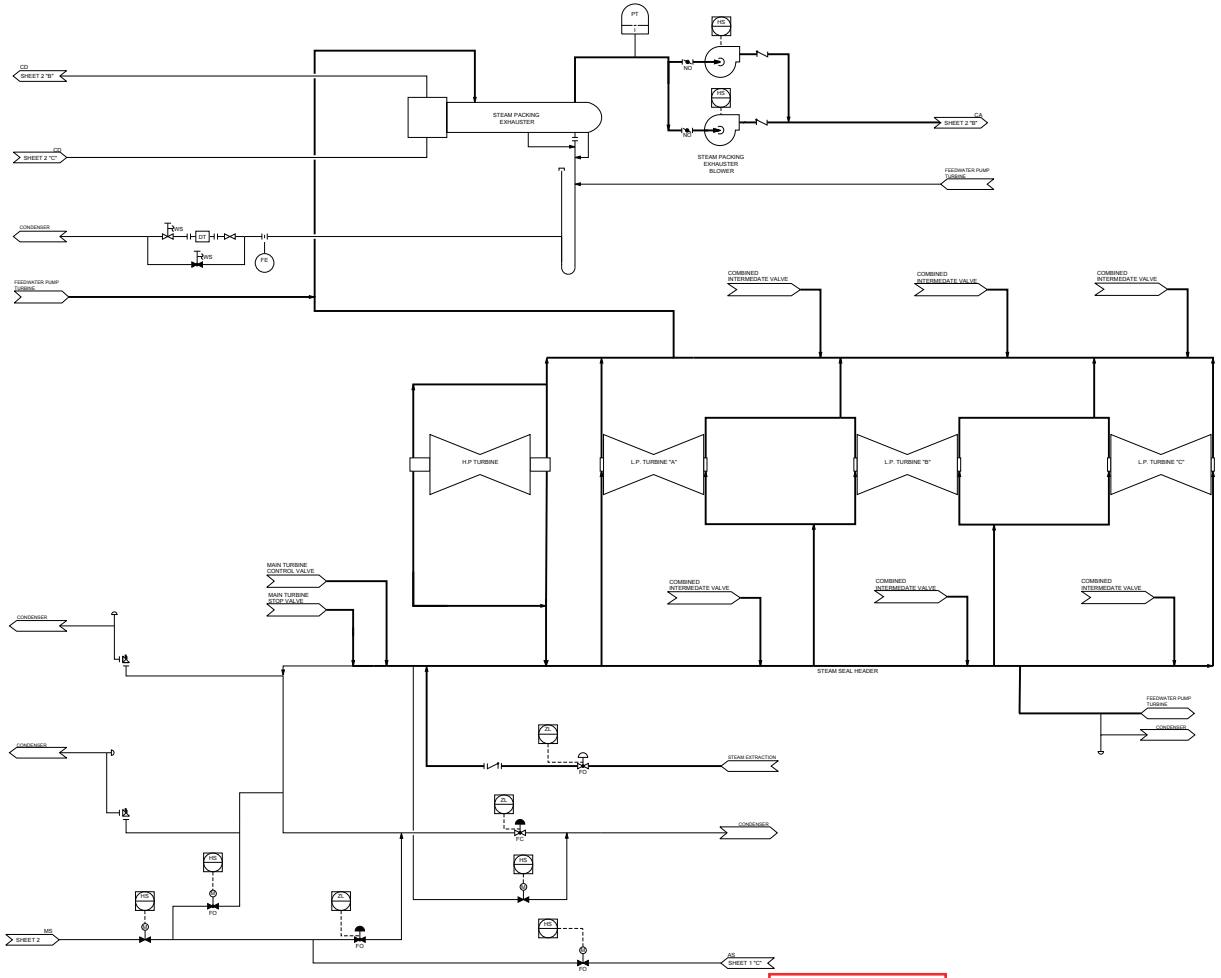

Figure 10.4.3-1 Turbine ~~Gland Sealing~~ System Flow Diagram

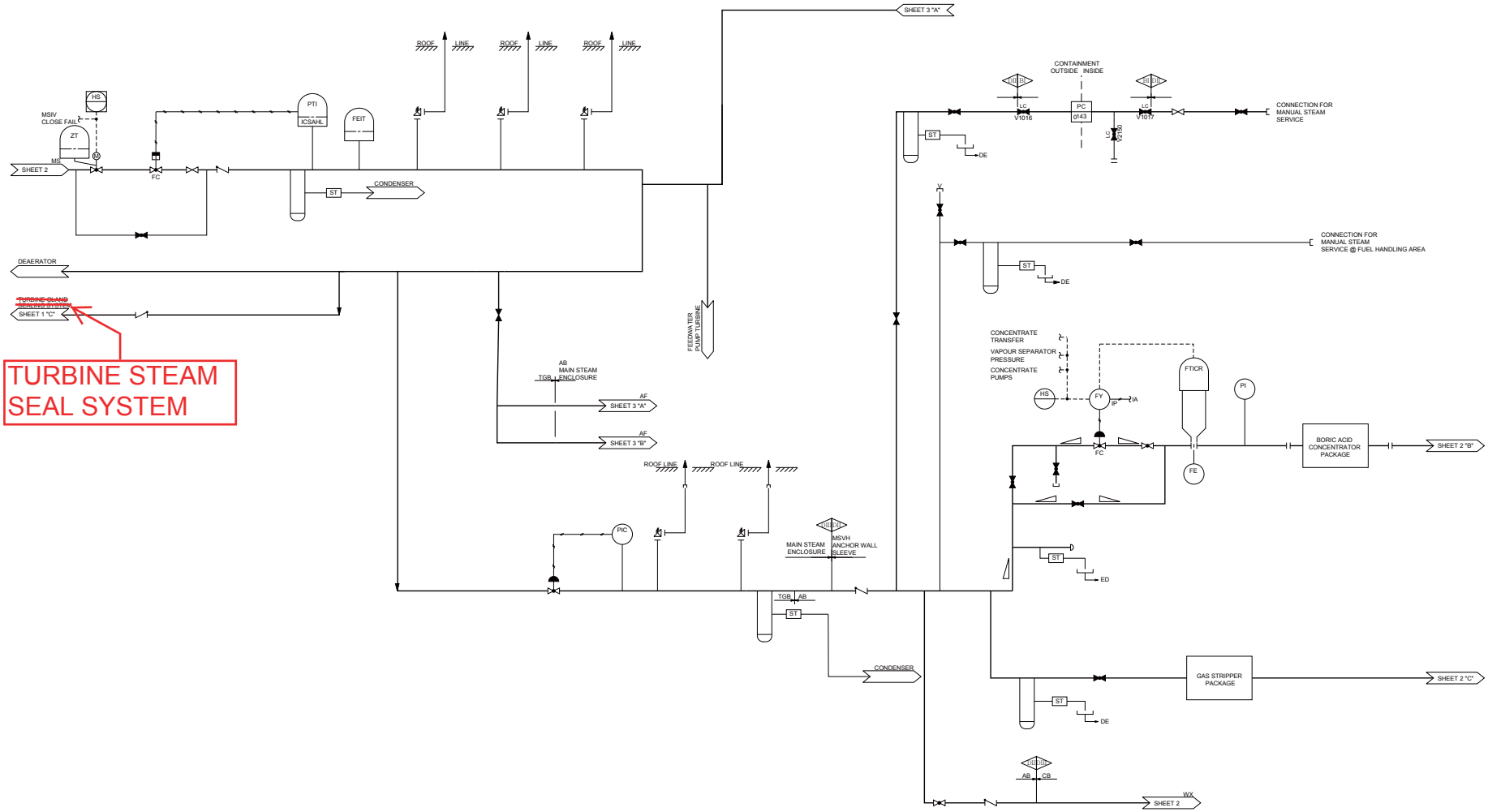

Figure 10.4.10-1 Auxiliary Steam System Flow Diagram (1 of 3)

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.:	**153-8070**
SRP Section:	**10.04.03 – Turbine Gland Sealing System**
Application Section:	**10.4.3**
Date of RAI Issue:	**08/13/2015**

Question No. 10.04.03-2

Conformance to GDC 60 requires the turbine gland sealing system (TGSS) design to include means to control the releases of radioactive materials to the environment.

DCD Tier 2, Section 10.4.3.2 states that if radioactivity in the exhaust flow exceeds an acceptable level, the condenser vacuum pump vent effluent monitor actuates an alarm in the main control room (MCR), and then adequate operating procedures are implemented to preclude significant release to the environment.

The staff notes that the DCD does not contain any discussion on the key elements to be included in the procedure, nor does it require the COL applicant to create a procedure that will instruct operators to perform needed actions if the alarm level is reached.

The applicant is requested to provide further information regarding the key elements that are to be included in the before mentioned procedures, and to create a COL item in the DCD that will direct the COL applicant to create such procedures.

Response

The air and non-condensable gases are discharged from the steam packing exhauster blower to the atmosphere. The non-condensable gases are monitored by a radiation monitor installed on the steam packing exhauster blower discharge line.

If radioactivity in the exhaust flow exceeds a predetermined setpoint , an alarm activates in the MCR for operator actions. The operating procedures are implemented in accordance with “Radioactive effluents controls program” described in Technical Specification 5.5.4.

Technical Specification 5.5.4 “The radioactive effluents controls program” states that “The program shall be contained in the ODCM, shall be implemented by procedures, and shall include remedial actions to be taken whenever the program limits are exceeded.”

DCD Tier 2, Subsection 11.3.3.3 “Offside Dose Calculation Manual” states that “The COL applicant is to prepare an ODCM following the guidance in NEI 07-09A(Reference 34) (COL 11.3(9)).

Therefore, DCD Tier 2, Subsection 10.4.3.2 will be revised as indicated on the attached markup.

Impact on DCD

DCD Tier 2, Subsection 10.4.3.2 will be revised as indicated on the attached markup.

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.

condensable gases are not radioactively contaminated in normal operation. The radioactive materials are processed in this system only if there is a primary-to-secondary SG tube leak due to an SGTR. If radioactivity in the exhaust flow exceeds an acceptable level, the condenser vacuum pump vent effluent monitor actuates an alarm in the MCR, and then adequate operating procedures are implemented to preclude significant release to the environment. Design and configuration for the effluent monitor, and the associated parameters, are provided in Subsections 11.5.2.1 and 11.5.2.2, respectively. The location of radiation detector is shown in Figure 11.5-1.

During cold startup of the T/G, sealing steam is provided by the auxiliary steam system. When the SG is brought up to full pressure, the auxiliary steam source is closed, and the main steam provides sealing. As the turbine is brought up to about 50 percent load, steam leakage from the high-pressure packing and the extraction steam system enters the steam-seal header. When this leakage is sufficient to maintain steam-seal header pressure, the main steam source valve is closed, and sealing steam to all turbine seals is supplied from the high-pressure packing and the extraction steam system. When the leakage from the high-pressure packing is more than required by vacuum packing, the excess steam is discharged through the unloading valve to the main condenser.

10.4.3.3 Safety Evaluation

The TGSS has no safety function. The TGSS valves are arranged for fail-safe operation to protect the turbine.

10.4.3.4 Inspection and Testing Requirements

Tests and inspection of TGSS equipment are performed in accordance with applicable codes and standards. Hydrostatic tests for piping and valves are performed in accordance with ASME B31.1 (Reference 5) and ASME B16.34 (Reference 10), respectively. Nondestructive inspections are performed in accordance with ASME Section V (Reference 11). The TGSS is functionally tested during unit startup. Normal operating system performance monitoring detects any deterioration in the performance of system components.

The non-condensable gases are discharged from the steam packing exhauster blower to the atmosphere. The non-condensable gases are monitored by a radiation monitor installed on the steam packing exhauster blower discharge line.
If radioactivity in the exhaust flow exceeds a predetermined setpoint, an alarm activates in the MCR for operator actions. The operating procedures are implemented in accordance with "Radioactive effluents controls program" described in Technical Specification 5.5.4.

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SRP Section:	**10.04.03 – Turbine Gland Sealing System**
Application Section:	**10.4.3**
Date of RAI Issue:	**08/13/2015**

Question No. 10.04.03-3

10 CFR 52.47(b)(1) requires the application to contain the proposed inspections, tests, analyses, and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Act, and the Commission's rules and regulations.

In Tier 2, Section 10.4.3.4, "Inspection and Testing Requirements," the DCD states that the testing and the inspection will be performed in accordance with applicable codes and standards and further lists ASME B31.1 and ASME B16.34 as references for the hydrostatic tests of piping and valves. Additional nondestructive inspections are performed in accordance with ASME Section V.

The staff finds that DCD Tier 2, Subsection 10.4.3.2, "Inspection and Testing Requirements," lacks information on how the TGSS will be functionally tested during unit startup.

The staff requests the applicant to describe the procedures by which the functional test of the TGSS will be performed during unit startup.

Response

The functional test of the TGSS will be performed in accordance with requirements of DCD Tier 2, Subsection 14.2.

Impact on DCD

There is no impact on the DCD

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.