REVISED 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.:	**205-8230**
SRP Section:	**11.03 - Gaseous Waste Management System**
Application Section:	**11.3**
Date of RAI Issue:	**09/08/2015**

Question No. 11.03-5

Staff review of DCD section 11.3, “Gaseous Waste Management System” (GWMS) did not identify information to describe the operation of the charcoal delay beds. The review of charcoal delay beds is discussed in BTP 11-5.

The staff is requesting information to support compliance with 10 CFR 20.1301 and 1302 in terms of verifying the integrity of the gaseous effluent charcoal delay beds utilized to control radioactive effluent releases to members of the public. The application does not describe the methods that are in place to monitor conditions concerning a fire within the charcoal delay beds, ensuring integrity given a leak of the chilled water system, and information ensuring the applicant is capable of detecting clogs or blockage in the charcoal delay beds. Identification of figures that describe the flow path and the systems that interact with the charcoal delay beds are not evident during the application review.

The staff is requesting the following information:

1. Provide a description of the processes in place to monitor conditions for a fire in the charcoal delay beds.

2. Describe how potential leaks of the chilled water system are monitored and what measures would be taken to address water inside the charcoal delay beds. This should also include a description for how the applicant anticipates the corrosion inhibiting chemicals added from the chilled water would affect the charcoal delay beds.

3. Provide a description for the use of differential pressure sensors on the charcoal delay bed. What measures are in place for the applicant to detect any potential clogs in the charcoal delay beds?

4. Information is requested defining the flow paths and the chilled water flow path that acts to control temperature.

Please address these items and provide a markup for the proposed DCD changes.

Response - (Rev.1)

1. A fire in the charcoal delay beds can be prevented because the operating and design temperature in the beds is maintained to be sufficiently lower than the self-ignition temperature of the charcoal used in the beds. In addition, the gaseous radwaste system is designed to control oxygen concentration to prevent explosive or flammable conditions with provisions to monitor oxygen/hydrogen in the process radioactive gas and to inject nitrogen gas for the control of oxygen concentration.

   Potential fire conditions in the charcoal delay beds can be monitored or detected with temperature instrumentation located at the inlet of each bed by measuring for an abnormal increase of temperature in the beds. In case of a fire, the system can be isolated and nitrogen gas can be injected into the bed in order to extinguish the fire, cool down activated charcoal, and prevent oxygen inflow from waste gas.

   DCD Tier 2, Section 11.3.2.1.1 will be updated to add the information above.

2. There are two 100 percent capacity dehumidification trains, each comprising one waste gas dryer and one charcoal guard bed, are used designed to reduce remove the gas moisture which could degrade the performance of the charcoal delay beds. The guard bed provides further to protection for the charcoal in the charcoal delay beds by removing any residual moisture. from the moisture entrained in the process radioactive gas. Additionally, moisture instruments are provided upstream and downstream of the guard beds to detect the moisture content in the inlet gas, and to indicate the moisture condition of the sacrificial guard bed. Hence, the inlet gas to be processed in the delay beds is dry and moisture degradation to the delay bed is not expected.

   A potential leakage of chilled water in waste gas dryer can be collected in a condensate pot in the bottom of the dryer and drained to the GRS header drain tank. The level instrumentation is installed at the pot and interlocked with a drain line isolation valve. The water collected in the pot is discharged upon receipt of water level high alarm through the ball drainer which is located in the downstream of isolation valve.

   If the chilled water leakage accidently flows to the process downstream waste gas dryer, the moisture instrumentation installed at the upstream of the charcoal guard bed can detect the high moisture condition and then the train is isolated automatically. The other train starts to operate when the train is isolated. Leaked water in the isolated train is drained to the GRS header drain tank. The charcoal guard bed also prevents the wetting of the charcoal delay bed from the chilled water leakage and the contamination of the delay bed from the corrosion inhibiting chemicals in water.

   Therefore there is no possibility that the water flows to charcoal delay bed and the corrosion inhibiting chemicals would not affect the charcoal delay beds.

   The 10th paragraph in DCD Tier 2, Section 11.3.2 will be revised to clarify the description. And also DCD Tier 2, Section 11.3.2.1.2 and 11.3.2.1.4 will be updated to add the information above.

3. The basic flow diagram for GRS package will be provided in DCD Tier 2, Figure 11.3-1. The flow diagram includes the process and chilled water flow path. Potential clogs or blockages are not expected in the charcoal delay bed because the process gas is transferred from the CVCS equipment processing reactor grade water, as described in Section 9.3.4, and may not contain particulates leading to potential clogs in charcoal delay beds.

   Any particulate, which may be entrained with moisture in the process gas, can be dissolved in water by condensation of moisture in the waste gas dryer and removed with the condensed water by drains. Any of the particulates that passed through the dryer will be captured in the activated charcoal contained in guard bed before processing radioactive gas in charcoal delay bed.

   The differential pressure sensors or provisions are not required to detect any potential clogs in the charcoal delay bed.

   DCD Tier 2, Section 11.3.2.1.2 and 11.3.2.1.4 will be updated to add the information above.

4. The basic flow diagram for GRS package will be provided in DCD Tier 2, Figure 11.3-1.

Impact on DCD

DCD Tier 2, Section 11.3.2, 11.3.2.1.1, 11.3.2.1.2, 11.3.2.1.4 and Figure 11.3-1 will be revised as indicated in 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.

bed further protects the main charcoal delay bed from moisture. Humidity sensors are installed upstream and downstream of the charcoal guard bed to monitor the charcoal wetting condition. Temperature sensors are installed at the guard beds and delay beds. Iodine is held up for decay in the charcoal guard beds.

The four delay beds are normally operating in series. The leading delay beds can be isolated for regeneration or replacement, if needed. This mode of operation is temporary and the delay beds can be switched back in when they are ready. ~~During this mode of operation, the gas velocity remains unchanged, but the adsorption rate of the xenon and krypton gases is temporarily increased to compensate for the beds in maintenance mode.~~ Nitrogen purge is available to dry the charcoal beds in the event of excessive moisture contamination. The four charcoal delay beds, containing a total of 9,525 kg (21,000 lb) of charcoal, are used for xenon and krypton delay. All GRS components are located in a shielded cubicles.

After passing through the charcoal delay beds, the waste gas flows through a HEPA filter where particulates, including charcoal fines, are removed, and then it is vented to the compound building HVAC system.

The GRS operates at pressures slightly above atmospheric to provide the necessary pressure to route the gas flow into the HVAC ventilation exhaust. Operating at this slightly pressurized condition also minimizes the potential for oxygen inleakage. Leakage from the GRS is further limited through the use of welded connections wherever the connections are not restricted for maintenance purposes. Control valves are provided with bellow seals to minimize leakage through the valve stem.

The GRS is designed to prevent the formation or buildup of explosive mixtures of hydrogen and oxygen by monitoring the concentrations of hydrogen and oxygen through one of the two gas analyzers (continuous monitoring). The concentrations are confirmed by periodic sampling and analysis at several routing locations. When the oxygen concentration is detected to be higher than the predetermined setpoint (high-high setpoint), nitrogen is injected to dilute the concentration to below the lower flammable limit of 4 percent. Along the gas flow paths, there are process vessels (VCT, RDT, EDT, gas stripper, GRS header drain tanks, and associated piping) that are designed in accordance with ASME VIII (Reference 25) for pressure vessels. Accordingly, design pressures are assigned to contain significant margins above the normal operating pressure, and relief valves are provided for each vessel to protect against surges in pressure. A loop seal is provided downstream of

11.3.2.1.1 Charcoal Delay Beds

The holdup of radioactive gases for decay is accomplished by the selective adsorption of xenon and krypton gases in the charcoal delay beds. Charcoal has been used in the nuclear industry for adsorption and delay for radioactive decay of noble gases. The charcoal beds are designed with a sufficient amount of charcoal to provide the necessary retention time to facilitate decay of these gases to reduce the radioactivity for release. Analyses using the method described in ANSI/ANS 55.4 (Reference 8), the design basis source terms, and the maximum gas flow rate provides a conservative design and the operating margins for normal operations, including AOOs. The results of the analyses are summarized in Tables 11.3-10 and 11.3-11 for the expected and design basis conditions.

The GRS is designed to operate close to the ambient conditions. The operating pressure is slightly higher than the atmospheric pressure to provide the motive forces for the gas stream to flow through the process components into the compound building exhaust. The gas temperature is controlled by the dryer and chilled water. The charcoal bed performs more efficiently and effectively at lower temperatures through the use of the chilled water system or the standby chiller unit when plant chilled water is not available. The vessels are designed to prevent charcoal carryover by charcoal support screens. The charcoal delay beds are designed to allow the replacement of the charcoal. Piping connections are arranged to make it possible to bypass any charcoal delay bed for maintenance reasons. In addition, nitrogen gas can be introduced to each charcoal delay bed to flush or dry the charcoal.

← Insert 'A' on page 4 in this Attachment.

The charcoal delay bed vessels are pressure vessels designed in accordance with NRC RG 1.143 (Reference 2).

11.3.2.1.2 Waste Gas Dryer

One of two waste gas dryers is normally in service to reduce the moisture content of the gases by cooling with chilled water. The cooling water is supplied from the plant chilled water system or from the standby GRS chiller. The waste gas dryer is designed to take an inlet gas flow of 623 L/min (22 scfm) with an inlet temperature of 48.9 °C (120 °F) and an outlet temperature of 7.8 °C (46 °F).

← Insert 'B' on page 4 in this Attachment.

The waste gas dryer is a condensing shell-and-tube heat exchanger designed in accordance with NRC RG 1.143 (Reference 2).

11.3.2.1.3 GRS Header Drain Tank

All of the condensed liquid in the gas surge header is collected in the GRS header drain tank. The condensed liquid is drained into the compound building normal sump, from which the drains are routed to the LWMS for processing and release. The GRS header drain tank is provided with a level control. Tank water level is interlocked with the drain line isolation valve.

The GRS header drain tank is a pressure vessel designed in accordance with NRC RG 1.143 (Reference 2).

11.3.2.1.4 Charcoal Guard Bed

by removing any residual moisture or particulates, prevent the contamination of the delay bed from the corrosion inhibiting chemicals in water, and reduce the concentration of radioactive iodine in the waste gas.

The charcoal guard beds are provided at the upstream of the charcoal delay beds. The guard beds protect the main charcoal delay bed from moisture ~~and the delay of iodine for decay.~~

The charcoal guard bed vessels are pressure vessels designed in accordance with NRC RG 1.143 (Reference 2).

11.3.2.1.5 HEPA Filter

After passing through charcoal delay beds, the waste gas flows through a HEPA filter where particulates, including charcoal fines, are removed. The waste gas then flows through a check valve to prevent backflow. Efficiency of the HEPA filter is not credited in the PWR-GALE Code calculation. The filter has test ports for in-place testing. Through the check valve, the waste gas flows to the environment after it is diluted with building ventilation air.

The HEPA filter vessel is a vessel designed in accordance with NRC RG 1.143 (Reference 2).

'A'

A fire in the charcoal delay beds can be prevented because the operating and design temperature in the beds is maintained to be sufficiently lower than the self-ignition temperature of the charcoal used in the beds. The potential fire conditions in the charcoal delay beds can also be monitored or detected with temperature instrumentation located at the inlet of each bed by measuring for an abnormal increase of temperature in the beds. In case of a fire, the system can be isolated and nitrogen gas can be injected into the bed in order to extinguish the fire, cool down the activated charcoal, and prevent oxygen inflow from waste gas.

'B'

A potential leakage of chilled water in the waste gas dryer can be collected in a condensate pot in the bottom of the dryer and drained to the GRS header drain tank. The level instrumentation is installed at the pot and interlocked with a drain line isolation valve. The water collected in the pot is discharged upon receipt of water level high alarm through the ball drainer which is located in the downstream of the isolation valve.

If the chilled water leakage accidently flows to the process downstream waste gas dryer, the moisture instrumentation installed at the upstream of the charcoal guard bed can detect the high moisture condition and then the train is isolated. The other train starts to operate when the train is isolated. Leaked water in the isolated train is drained to the GRS header drain tank.

Potential clogs or blockages are not expected in the charcoal delay bed because the process gas is transferred from the CVCS equipment processing by reactor grade water and may not contain particulates leading to potential clogs in the charcoal delay beds.

In addition, any particulate, which may be entrained with moisture in the process gas, can be dissolved in water by condensation of moisture in the waste gas dryer and removed with the condensed water by the drains.

APR1400 DCD TIER 2

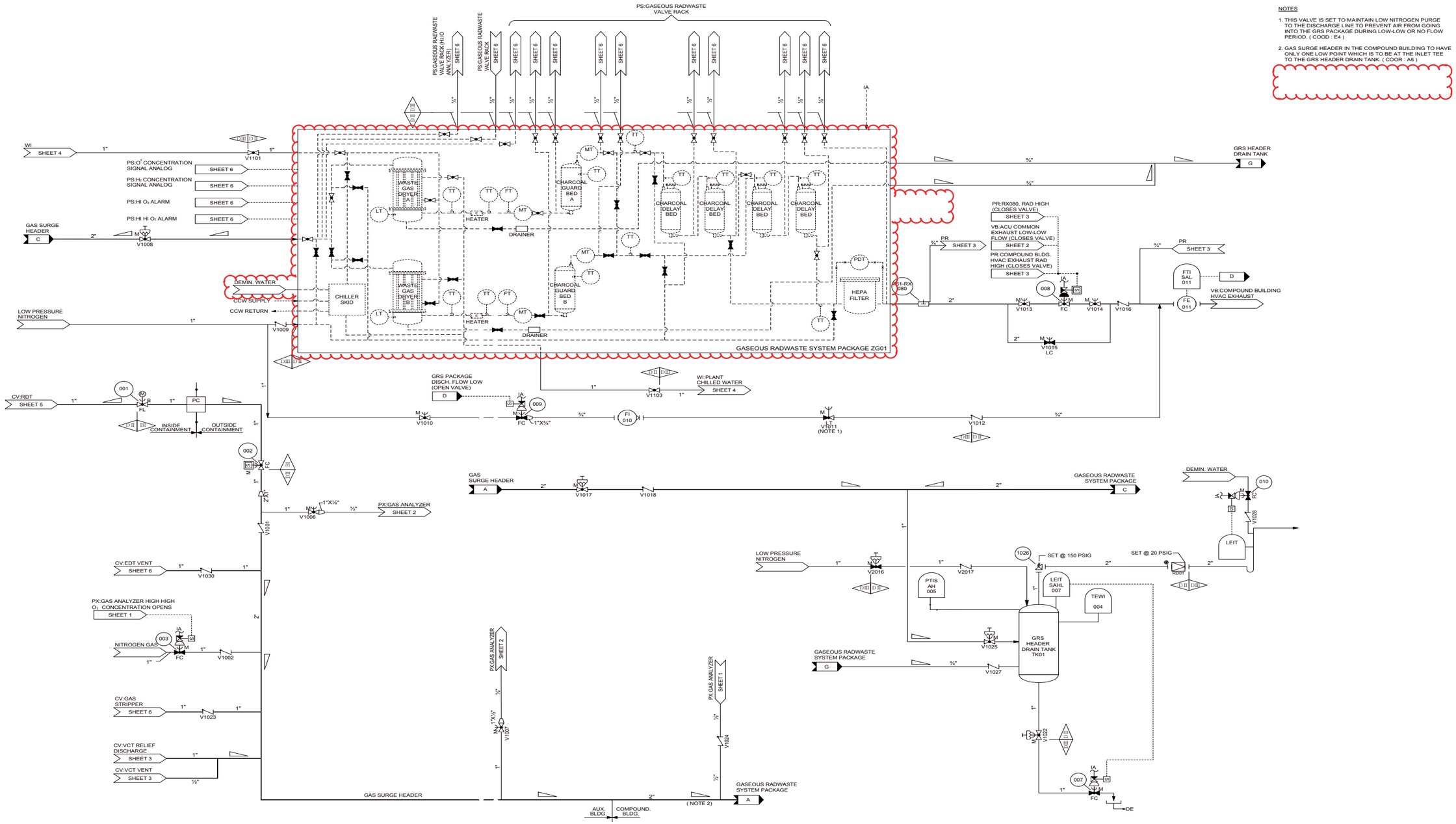

Figure 11.3-1 Gaseous Radwaste System Flow Diagram