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.:	**235-8275**
SRP Section:	**12.03 – 12.04 Radiation Protection Design Features**
Application Section:	**12.3 – 12.4**
Date of RAI Issue:	**10/07/2015**

Question No. 12.03-27

10 CFR 20.1101(b) requires licensees to control external occupational exposure, and to ensure that engineering controls are used to keep occupational doses ALARA. In 10 CFR 20, the definition for ALARA includes guidance to make every reasonable effort to maintain exposures below regulatory limits, taking into account the state of technology. 10 CFR 50 GDC 61 requires licensees to ensure that there is adequate shielding for routine activities in the area of the equipment.

While FSAR Section 12.2 provides source term information for areas around the reactor vessel, the application is unclear regarding design features to limit worker dose from refueling outage activities in the vicinity of reactor pressure vessel. For example, it is unclear if radiation streaming through the reactor coolant penetrations in the primary shield wall are considered and how the design will ensure that worker dose will be ALARA and in accordance with 10 CFR 20.

Please discuss work activities that could occur during an outage in the area around the reactor vessel and discuss how the design ensures that workers will not be exposed to radiation streaming paths during fuel movement. Update the FSAR as appropriate.

Response

The shielding design for the APR1400 as well as operational procedures and administrative controls are conjunctively used to ensure that occupational radiation exposures are maintained ALARA and below the limits of 10 CFR 20 during all modes of operation.

The shielding design takes into consideration all anticipated operational occurrences, including refueling. The APR1400 shielding design provides reasonable assurance that the areas adjacent to the spent fuel transfer tube, which require operator occupancy during refueling operations, are accessible at safe radiation levels. The radiation zone map for the fuel transfer area during refueling is shown in DCD Figure 12.3-52. Penetrations through the primary shield follow the same design methodology as for all plant shielding as described in DCD Subsection 12.3.1.2, Item f, which states that penetrations are located as high above the floor as possible and not in a direct line between a radiation source and an area which may require operator occupancy, wherever practicable. The plant layout and shielding design are the primary and most important level of defense in minimizing the occupational radiation exposure (ORE) received by workers performing maintenance and inspection activities in the plant.

The expected ORE during refueling activities are described in DCD Subsection 12.4.1.1.2.6 and listed in Table 12.4-6 along with the anticipated work times and average dose rates. DCD Subsection 12.4.1.1.2.3 and Table 12.4-3 describe the in-service inspection activities, which are generally performed during refueling outages and will result in ORE to workers. In addition, DCD Subsection 12.4.1.1.2.4 and Table 12.4-4 describe the special maintenance activities, which are also performed exclusively during refueling periods.

As described above, there are design features as well as operational programs and procedures for work in the vicinity of the reactor pressure vessel in order to reduce the ORE during refueling and maintenance activities and to maintain dose rates to workers ALARA. These design features include the use of equipment and components with improved reliability and features for the ease of maintenance and part replacement. Additional operational practices implemented to maintain the worker dose ALARA in the vicinity of the reactor pressure vessel during refueling activities and special maintenance activities include the use of remote cameras for inspections wherever possible and the use of temporary shielding to protect workers while performing required tasks. From an operational standpoint, the maintenance and inspection procedures will be carefully developed and executed in order to ensure that these activities and tasks are performed efficiently resulting in the minimum amount of exposure time.

In order to maintain radiation doses to plant personnel ALARA, the areas which are high and very high radiation areas during refueling operations will have restricted access. To prevent personnel from inadvertently receiving a high radiation dose while occupying this area during refueling operations the door to the area is locked and administrative controls are enforced to prevent personnel access.

Therefore, through the combined use of access control to high radiation areas and the implementation of temporary shielding and remotely operated equipment, the radiation dose to workers performing maintenance and inspection activities during refueling outages is maintained ALARA and below the exposure limits of 10 CFR 20.

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.

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APR1400 Design Certification

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Docket No. 52-046

RAI No.:	**235-8275**
SRP Section:	**12.03-12.04 – Radiation Protection Design Features**
Application Section:	**12.03-12.04**
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Question No. 12.03-39

10 CFR 20.1406(b) requires that applicants for standard design certifications describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

While COL 12.4(2) indicates that the COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program, to implement a minimization of contamination approach, it does not specify if the COL applicant will ensure that site specific equipment or design features will meet the requirements of 10 CFR 20.1406 or the guidance of Regulatory Guide 4.21. Please update COL 12.4(2) or provide a new COL item with this information, or justify why it is not needed.

Response

DCD Tier 2 Section 12.4.2.2 and COL 12.4(2) will be revised to include the requirements of 10 CFR 20.1406 and the guidance of RG 4.21.

Impact on DCD

DCD Tier 2 Table 1.8-2, Section 12.4.2.2 and COL 12.4(2) will be updated 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.

in accordance with 10 CFR 20.1406 and the guidance of RG 4.21, to implement the minimization of contamination approach.

Table 1.8-2 (21 of 29)

Item No.	Description
COL 12.4(1)	The COL applicant is to estimate construction worker doses based on site-specific number of operating units, distances, meteorological conditions, and construction schedule.
COL 12.4(2)	The COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program~~, to implement the minimization of contamination approach.~~
COL 12.4(3)	The COL applicant is to implement concrete tunnels for piping of the systems that may include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping.
COL 12.5(1)	The COL applicant is to provide the operational radiation protection program, including the items described in Section 12.5.
COL 13.1(1)	The COL applicant is to provide a description of the corporate or home office organization, its functions and responsibilities, and the number and the qualifications of personnel. The COL applicant is to be directed to activities such as the facility design, design review, design approval, construction management, testing, and operation of the plant.
COL 13.1(2)	The COL applicant is to develop a description of experience in the design, construction, and operation of nuclear power plants and experience in activities of similar scope and complexity.
COL 13.1(3)	The COL applicant is to describe its management, engineering, and technical support organizations. The description includes organizational charts for the current headquarters and engineering structure and any planned modifications and additions to those organizations to reflect the added functional responsibilities with the nuclear power plant.
COL 13.1(4)	The COL applicant is to develop a description of the organizational arrangement. The description is to include organizational charts reflecting the current headquarters and engineering structure and any planned modifications and additions to reflect the added functional responsibilities associated with the addition of the nuclear plant to the applicant's power generation capacity. The description shows how these responsibilities are delegated and assigned or expected to be assigned to each of the working or performance-level organizational units identified to implement these responsibilities. The description includes organizational charts reflecting the current corporate structure and the working- or performance-level organizational units that provide technical support for the operation.
COL 13.1(5)	The COL applicant is to develop the description of the general qualifications in terms of educational background and experience for positions or classes of positions described in the organizational arrangement.
COL 13.1(6)	The COL applicant is to develop a description of the structure, functions, and responsibilities of the onsite organization established to operate and maintain the plant.
COL 13.1(7)	The COL applicant is to provide an organizational chart showing the title of each position, minimum number of persons to be assigned to duplicate positions, number of operating shift crews, and positions that require reactor operator and senior reactor operator licenses.

Objective 6 – Site Radiological Environmental Monitoring

Objective 6 is met by developing a conceptual site model (COL 12.4 (2)) that:

a. Includes site-specific hydrogeology, potential migration, and groundwater transport pathways

b. Assesses the effects of construction on hydrogeological characteristics of the site

c. Establishes a site-specific contamination monitoring program for potential groundwater pathways from release source to receptor point

, in accordance with 10 CFR 20.1406 and the guidance of RG 4.21

12.4.2.3 Summary of Design Features

The APR1400 design features that minimize facility and environmental contamination are described in the relevant sections of this DCD. Table 12.4-10 summarizes how these features meet the design objectives in accordance with the requirements of 10 CFR 20.1206 and NRC RG 4.21 and provides cross-references to the relevant DCD subsections.

Many of the features are designed to work together to support the defense-in-depth strategy for the prevention and minimization of the contamination of the facility and the environment.

12.4.2.4 Design Details to Address Minimization of Contamination

12.4.2.4.1 Early Leak Detection Drain Pipe

The early leak detection design for plant areas containing radioactive components consists of a drain pipe with a level switch and a manual valve installed on the exposed pipe portion in the valve pit or corresponding location of the trench. The drain pipe collects drainage from cubicles that may contain radioactive liquid from leakage or overflow. The drain pipe is a 5.08 cm (2 in) stainless steel pipe embedded in the basemat and is sloped to facilitate drainage. The embedded portion of the drain pipe is encased in an outer pipe. The inner pipe is open to drainage into the trench, which directs the collected liquid to the normal sump for collection. Because the drain pipe is relatively small, a small leak can be

COL 12.4(2) The COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program~~, to implement the minimization of contamination approach.~~

COL 12.4(3) The COL applicant is to implement concrete tunnels for piping of the systems that may include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping.

in accordance with 10 CFR 20.1406 and the guidance of RG 4.21, to implement the minimization of contamination approach."

12.4.4 References

1. Regulatory Guide 8.8, "Information Relevant to Ensuring the Occupational Radiation Exposures at Nuclear Power Stations will be ALARA," Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

2. Regulatory Guide 8.19, "Occupational Radiation Dose Assessment in Light Water Reactor Power Plants Design Stage Man-Rem Estimates," Rev. 1, U.S. Nuclear Regulatory Commission, June 1979.

3. NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities," U.S. Nuclear Regulatory Commission.

4. ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2007.

5. NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980.

6. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," U.S. Nuclear Regulatory Commission, July 2000.

7. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," U.S. Nuclear Regulatory Commission, June 2008.

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APR1400 Design Certification

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

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RAI No.:	**235-8275**
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Application Section:	**12.3 – 12.4**
Date of RAI Issue:	**10/07/2015**

Question No. 12.03-42

10 CFR 20.1406(b) requires that applicants for standard design certifications describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

FSAR Section 12.4.2.4.4 indicates that when embedded piping segments cannot be avoided, double-walled piping is used to the extent practicable and that the outside piping of the double wall pipe is designed to drain to a local sump or onto the floor for drainage into a nearby sump.

1. In accordance with 10 CFR 20.1406, please justify why it is appropriate for the pipe to drain to the floor instead of to the sump or modify the FSAR, as appropriate.
2. In addition, describe how leaks within these double-walled pipes will be identified.

Response

1. KHNP agrees with staff's comment and will remove the wording "or onto the floor for drainage to a nearby sump for collection". Leakage from the outer pipe is to be routed to the nearby sump.
2. Embedded piping above the basemat level and carrying contaminated radioactive fluid is to be routed in double-walled piping. The leakage from the inner piping is collected in the outer walled pipe. When the piping emerges from the wall or floor, the leakage is drained to a nearby collection point, such as a drain collection drain pipe equipped with a water trap and a level switch. When liquid is accumulated to a predetermined level, the level switch initiates an alarm in the MCR for operator actions, which include

investigative inspection, and obtaining samples for analysis to determine the leakage source.

It should be noted that embedded piping is to be minimized by routing pipes in pipe chases to the maximum extent practicable. In the event that pipe embedment cannot be avoided, the embedded pipes are to be grouped at the point where the piping emerges from embedment and that outer pipe leakage is to be collected for the groups of piping in a drain header in order to minimize drain pipe routing to the nearby sump.

Embedded piping at the basemat level consists of (1) specific leak detection piping for tank cubicles containing contaminated fluid, and (2) area drainage piping that carries floor washing and general area drainages. The leak detection piping (e.g., from LRS floor drain tanks, equipment waste tanks, etc.) is routed from the cubicle to the nearby drain header or sump. This category of leak detection piping is generally short in order to facilitate the maximum slope for leakage collection for early detection, which will facilitate timely operator actions to assess the situation and perform any remediation. The leak detection piping is provided with double-wall piping, with any leakage from the inner pipe draining into the concrete trenches. Since the risk for the spread of contamination is low, the outer piping drain is not provided with leak detection instrumentation.

Some of the area drain piping (e.g., access area drains, drains from LRS seal water heat exchanger room, etc.) embedded at the basemat is likely to carry runoff from floor washing and component drains. This category of piping is not expected to contain or carry significant radioactive fluid. Hence double-walled piping is not generally provided. For cubicles that are anticipated to contain significant levels of contamination (such as CTS vacuum skid room, CTS dryer room, etc.), the drain pipes are to be provided with double-wall piping. The outer piping is designed to collect leakage from inner piping and route the drains to the sump for the prevention of contamination to the facility and the environment due to leakage from the inner piping. This category of outer drain piping is not provided with leak detection. This design approach minimizes complexity of floor drainage design, requirements for operator actions, decommissioning waste generation, and meets the risk-based intension of RG 4.21.

Impact on DCD

DCD Tier 2 Subsections 12.4.2.4.3 and 12.4.2.4.4 will be updated 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.

detected, thus achieving early detection. The level switch is designed to initiate an alarm in the MCR for operator action. Early leak detection capability is built into each cubicle that may contain radioactive or potentially radioactive fluid for quick assessment. The typical design of the leak detection configuration is presented in Figure 12.4-1. The leak detection instrumentation is shown in Figure 12.4-2.

12.4.2.4.2 Leak Collection Trench

Concrete trenches are provided within the basemat of the auxiliary and compound buildings to facilitate leak drainage to liquid collection sumps. The trench has an epoxy coating and is significantly sloped to facilitate flow and prevent the accumulation of fluid along the flow path. The trench has removable steel grated covers to facilitate access for inspection and calibration of leak detection instruments; trench cleaning; and inspection, repair, and maintenance of the epoxy coating. Where area drainage is expected to contain significant debris, the trench is equipped with screens or a drain pipe to facilitate liquid flow without entraining solids or debris in the sumps. The typical design of the compound building trench design is presented in Figure 12.4-3.

12.4.2.4.3 Penetration Design between Buildings

Piping that extends from one building to another with a separation gap between the buildings is equipped with sleeves or double-walled concentric piping to prevent direct, unintended leakage to the environment. The use of either piping sleeves or double-walled concentric piping depends on the separation distances, with piping sleeves generally used for smaller separation gaps and double-walled piping used for larger separation gaps.

Piping sleeves and the outer wall piping for the double-walled piping are equipped with seals to maintain building pressure differentials and to prevent the infiltration of outside water and air into the buildings. Piping sleeves and outer piping are also equipped with sleeve joints to accommodate some degree of building movement. Piping sleeves and outer wall piping are installed with a mild slope to facilitate drainage of liquid in the event of inner pipe leakage. The leakage is drained directly into a nearby sump~~ or onto the floor for collection in a nearby sump~~. The typical designs for piping penetrations between buildings and building sleeves are presented in Figure 12.4-4.

12.4.2.4.4 Minimization of Embedded and/or Buried Piping

Embedded or buried piping is minimized using the following approach:

a. Piping is routed inside pipe chases to the extent possible to minimize embedded piping. Drain pipes on the floors above the basemat level are allowed to penetrate the floor and are routed inside pipe chases below the floor level as required.

b. To the extent practicable, double-walled piping is used when embedded piping segments cannot be avoided. The outside piping of the double wall pipe is designed to drain to a local sump~~ or onto the floor for drainage to a nearby sump for collection~~.

c. For the basemat level, drain pipes are routed in concrete trenches that are sloped toward the local sump. The trenches are coated with epoxy to facilitate drainage and cleaning.

d. For piping that carries contaminated or potentially contaminated fluid and is located outside the plant structures, the piping is routed in underground concrete tunnels to the maximum extent practicable. Systems that contain yard piping routed through underground concrete tunnels may include CCWS, ESWS, CVCS, condensate systems, etc., which are determined based upon site-specific plant layout conditions. The COL applicant is to implement concrete tunnels for those systems that include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping (COL 12.4(3)). The tunnels are coated with epoxy and are equipped with sumps with liquid detection level switches. If liquid is accumulated to the detectable level, an alarm is initiated in the MCR for operator actions.

12.4.3 Combined License Information

COL 12.4(1) The COL applicant is to estimate construction worker doses based on the site-specific number of operating units, distances, meteorological conditions, and construction schedule.

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Application Section:	**12.3 – 12.4**
Date of RAI Issue:	**10/07/2015**

Question No. 12.03-43

10 CFR 20.1101(b) requires that the licensee use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

10 CFR 20.1406(b) requires that applicants for standard design certifications describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

FSAR Section 11.3.2 discusses the use of the gas stripper to remove dissolved gases from the reactor coolant. However, the application does not appear to discuss the process for removing gasses from the pressurizer to facilitate reactor shutdown. Some nuclear power plants have been known to degas the pressurizer directly using the primary sampling system, which could potentially cause equipment degradation issues, which could potentially result in the unexpected release of radioactive material or unnecessary worker dose due to the event or system repair.

Please indicate if the processes of degassing the pressurizer directly will be used in the APR 1400 design and update the FSAR to specify if this process will be used. If this process will be used please provide justification ensuring that the primary sampling line heat exchangers, valves, and other components are designed to handle this process.

Response

The APR1400 does not use the sampling system directly to degas the pressurizer. Instead, the APR1400 design provides gas removal from the pressurizer to facilitate reactor shutdown using the connections before the pressurizer pilot-operated safety relief valves (POSRVs) (Please refer to DCD Figure 5.1.2-3). The connections are joined together to form a header which is routed to the reactor coolant gas vent system (RG) (Please refer to DCD Figure 5.4.12-1). The

RG vent is routed to the reactor drain tank (RDT) for moisture separation in the CVCS. The RDT vent is then sent to the gaseous radwaste system (GRS) for processing. The GRS provides further moisture separation, gas drying, and charcoal adsorber to delay release of halogens and noble gases. The gas is then mixed with the compound building vent and is released to the plant vent for discharge.

This design approach minimizes contamination of the facility and the environment, and unnecessary radiation exposure to the worker.

A paragraph is inserted to the end of DCD Subsection 5.4.12.2.2 Pressurizer Vent, and a reference is added to the end of DCD Subsection 5.4.10.2.3 for pressurizer gas removal during shutdown operation

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Impact on DCD

DCD Tier 2 Section Subsection 5.4.10.2.3 and 5.4.12.2.2 will be updated 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

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the desired steam pressure in the pressurizer. The remaining heaters are connected to on-off controllers. These heaters are normally de-energized but are automatically turned on by a low pressurizer pressure signal or a high level error signal. This latter feature is provided because load increases result in an in-surge of relatively cold coolant into the pressurizer, thereby decreasing the bulk water temperature. The CVCS acts to restore level, resulting in a transient pressure below normal operating pressure. To minimize the extent of this transient, the on-off controlled backup heaters are energized, contributing more heat to the water. A low-low pressurizer water level signal de-energizes all heaters to prevent heater damage before they are uncovered. The pressure control program is shown in Figure 5.4.10-5.

The pressurizer is provided with gas removal for shutdown operation as discussed in DCD Subsection 5.4.12.2.2.

5.4.10.3 Design Evaluation

It is demonstrated by analysis in accordance with requirements for ASME Section III, Class 1 vessels that the pressurizer is adequate for all normal operating and transient conditions expected during the life of the facility. Following completion of fabrication, the pressurizer is subjected to the required ASME Section III hydrostatic test and post-hydrostatic test nondestructive testing.

During hot functional testing, the transient performance of the pressurizer is checked by determining its normal heat losses and maximum depressurization rate. This information is used in setting the pressure controllers. Reasonable assurance of the structural integrity of the pressurizer is further obtained from the inservice inspections performed in accordance with ASME Section XI and described in Section 5.2.

Overpressure protection of the RCS is provided by four pilot-operated safety-relief valves. See Subsection 5.4.14.

5.4.10.4 Test and Inspection

Prior to and during fabrication of the pressurizer, nondestructive testing is performed in accordance with the requirements of ASME Section III. Table 5.4.10-2 summarizes the pressurizer inspection program, which also includes tests not required by the Code. See Subsection 5.2.4 for inservice inspections of the pressurizer.

5.4.12.2.2 Pressurizer Vent

The RCGV piping allows the operator to direct the RCGV discharge, through parallel valve divisions, to the IRWST, which is designed as seismic Category I.

The solenoid-operated valves of the parallel valve divisions are controlled from the MCR or RSR. Open and closed indications of the valves are provided and monitored from the MCR or RSR. Each valve is powered by the independent Class 1E power supply, and the valves are supplied power by alternate alternating current power during an SBO. The valves are qualified using the ANSI/IEEE Std. 344 as endorsed by NRC RG.1.100.

The following information is available to the operator for initiating and terminating the pressurizer venting operation during post-accident conditions:

a. For initiating system operation: pressurizer pressure and cold leg temperatures

b. For terminating system operation: pressurizer pressure and cold leg temperatures

The operator may use the RCGV function to cool down and depressurize the plant in the event the pressurizer main spray and auxiliary spray systems are not operable. The operator manually opens the RCGV valves (RG-410, RG-411, RG-412, and RG-413) on the top of the pressurizer, releasing steam to the IRWST through valve RG-0419/RG-0420. This pressurizer vent has the capacity of 14,023 kg/hr (30,915 lb/hr) at the pressurizer condition of 175.8 kg/cm^{2}A (2,500 psia). The RCGV flow and the depressurization rate are controlled by valves RG-410, RG-411, RG-412, and RG-413 in the vent lines from the top of the pressurizer, and by opening and closing the RCGV valves (RG-414, RG-415, RG-416, and RG-417) from the top of the reactor vessel closure head.

The noncondensable gases accumulating in the U-tubes of the steam generators are transferred to the pressurizer by using a procedure in which one or more RCPs per loop operate for short periods to force noncondensable gases out of the U-tubes.

The pressurizer is provided with gas removal for shutdown operation using the connections before the pressurizer pilot operated safety relief valves (POSRVs) (DCD Figure 5.1.2-3). The connections are joined together to form a header which is routed to the reactor coolant gas vent system (RG) (DCD Figure 5.4.12-1). The RG vent is routed to the reactor drain tank (RDT) for moisture separation in the CVCS. The RDT vent is then routed to the gaseous radwaste system (GRS) for processing.