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.:	**99-7836**
SRP Section:	**10.04.01 – Main Condensers**
Application Section:	**10.04.01**
Date of RAI Issue:	**07/22/2015**

Question No. 10.04.01-1

GDC 60 requires, in part, a power unit design to "include means to control suitably the release of radioactive materials in gaseous and liquid effluents … produced during normal reactor operation, including anticipated operating occurrences." As stipulated in SRP Section 10.4.1, Section II, "Acceptance Criteria", Item 1, the design of the main condenser (MC) is acceptable if the integrated design of the system meets the requirements of GDC 60 as related to failures in the design of the system which do not result in excessive releases of radioactivity to the environment.

DCD Tier 2, Section 10.4.1.3, "Safety Evaluation," provides an evaluation of the APR1400 MC system. The DCD states that non-condensable gases are removed by the mechanical vacuum pumps, as addressed in DCD Tier 2, Section 10.4.2, and there is no hydrogen buildup in non-condensable gas constituents in the MC.

While reviewing DCD Tier 2, Section 10.4.1, the staff could not find adequate details to justify the requirements of GDC 60, as it relates to the detection and main control room annunciation of a potential explosive environment due to hydrogen buildup.

The applicant is requested to provide additional information in the DCD, with full justification, to conform to the GDC 60 criteria as described above.

Response

DCD Tier 2, Subsections 10.4.2.2.2 describes as following;

> "Thermal decomposition of hydrazine can be considered as a source of hydrogen within condenser shells. However, a potential for hydrogen buildup within condenser shells does not exist because three vacuum pumps operate continuously during normal operation, and a standby vacuum pump starts when one vacuum pump fails. Condenser shells are considered to maintain the water vapor content above 58 percent by volume in non-

condensable gases in conformance with SRP Subsection 10.4.2. The trace amounts of oxygen dissolved in the condensate and condenser hotwell inventory are considered negligible compared to the amounts of air evacuated by the vacuum pumps. Therefore, a potential for explosive mixtures within the condenser shells does not exist."

Therefore, the detection and main control room annunciation of a potential explosive environment due to hydrogen buildup is not needed.

DCD Tier 2, Subsection 10.4.1.3 will be revised as indicated on the attached markup.

Impact on DCD

The DCD Subsection 10.4.1.3 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 Reports.

the condenser through the turbine bypass system. The condenser is also used to condense the main steam bypassed to the condenser in the event of sudden load rejection by the turbine generator or a turbine trip.

In the event of load rejection, the condenser condenses 55 percent of full-load main steam flow from the turbine bypass system without tripping the reactor. If the main condenser is not available during normal plant shutdown, sudden load rejection, or turbine trip, the spring-loaded main steam safety valves (MSSVs) can discharge full main steam flow to the atmosphere to protect the main steam system (MSS) from overpressure. Safe reactor shutdown can then be achieved by use of the main steam atmospheric dump valves (MSADVs). Non-availability of the main condenser considered here includes failure of the circulating water pumps to supply cooling water or loss of condenser vacuum for any reason.

condenser, which are addressed in Subsection 10.4.2

During normal operation and shutdown, the main condenser does not have radioactive contaminants. Radioactive contaminants are only through primary-to-secondary system leakage due to steam generator (SG) tube leaks. The radiological aspects of primary-to-secondary leakage, including operating concentrations of radioactive contaminants, are addressed in Subsection 11.1.1.3. If high radiation is detected in the condenser vacuum system discharge, the off-gases are automatically diverted to containment drain sump area for removing the contaminants based on GDC 60. Detailed methods to preclude the accidental release of radioactive materials to the environment in excess of established limits are addressed in Subsection 10.4.2. There is no hydrogen buildup in non-condensable gas constituents in the main ~~condenser.~~ The noncondensable gases are removed by the mechanical vacuum pumps, which is addressed in Subsection 10.4.2. ~~If there is a failure in one of the three vacuum pumps, a standby pump starts. The standby pump further decreases the buildup of hydrogen and explosive mixture in the main condenser shells.~~

Delete

Flooding due to failure of a condenser hotwell does not prevent safe shutdown of the reactor. Flooding from turbine generator building does not enter the safety-related building because the opening or access door between the turbine building and auxiliary building is located at a higher level than the basic grade of turbine building. Because the turbine generator building contains non-safety-related equipment and other buildings are not affected by turbine generator building flooding, the impact of internal flooding from the turbine generator building is limited to non-safety-related equipment in the turbine

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Question No. 10.04.01-2

GDC 4 requires, in part, that SSCs important to safety be "appropriately protected against dynamic effects, including…the effects of discharging fluids …" According to Section III, "SRP Review Procedures," Item III.2.A of SRP Section 10.4.1, "Main Condensers," the requirements of GDC 4 are met by providing a means for controlling and correcting cooling water leakage into the condensate.

DCD Tier 2, Section 10.4.1.2, "System Description," describes that the main condenser (MC) interfaces with the tube leak detection system to permit sampling of the condensate in the condenser hotwell. The DCD further states that, if circulating water in-leakage occurs, this system permits identification of which tube bundle has sustained leakage. The waterbox is then drained to permit access for repairs by isolating the circulating water system from the affected waterbox of the MC. The tube leak detection system is further described in DCD Tier 2, Section 9.3.2.

While reviewing DCD Tier 2, Section 10.4.1, the staff could not find further details on the controlled collection of the waterbox drainage which may contain radioactive contaminants.

The applicant is requested to provide additional information in the DCD as related to the provisions to determine which MC tube bundle is affected with the leakage.

Response

The condensate water is sampled and analyzed continuously by the secondary sampling system (SSS). In case that a MC tube bundle is affected by inleakage, alarms will be annunciated in the MCR and RSR.

The condenser hotwell affected by inleakage can be identified through sampling from condenser tube tray sampling lines in the SSS.

Therefore, APR1400 has provisions to determine which MC tube bundle is affected by the inleakage.

DCD Tier 2, Subsection 10.4.1.2 will be revised as indicated on the attached markup

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Impact on DCD

The DCD Subsection 10.4.1.2 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 Reports.

a. The main condenser hotwells serve as storage reservoirs for the condensate and feedwater systems with sufficient volume to supply maximum condensate flow for 5 minutes.

b. The condenser vacuum system in the main condenser is designed to remove leaked air and non-condensable gases from condensing steam. The condenser vacuum system is described in Subsection 10.4.2.

c. The circulating water system is routed to each of three condenser shells in parallel configuration. Heat is removed from the main condenser by the circulating water system.

d. The condenser tube material is titanium and tube sheets are titanium-clad carbon steel, or equivalent material as specified in Table 10.4.1-1. The titanium material provides good corrosion and erosion resisting properties.

e. Condenser design precludes or minimizes steam impingement forces on the condenser tubes for normal operation and turbine bypass valve quick opening events. Tube support plates are designed to minimize tube vibrations.

f. Tube leak detection system is provided to permit sampling of the condensate in the condenser hotwell as discussed in Subsection 9.3.2. The tube leak detection system identifies which tube bundle has sustained the leakage if circulating water in-leakage occurs. The affected condenser hotwell is manually isolated by closing the motor-operated hotwell discharge valve when condenser tube leakage exceeds the design value for the condensate polishing system. Plant power is reduced as necessary. The water box is then drained and the affected tubes are either repaired or plugged.

using sampling from condenser tube tray

g. The condenser is designed to deaerate the condensate during startup and normal operation. The design also deaerates any drains that enter the condenser.

h. In the event that the condenser tube leakage is beyond the design limit of the condensate polishing (CP) system, the condenser and circulating water system (CWS) are designed to permit isolation of a portion of the tubes (segmented

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Question No. 10.04.01-4

Conformance to GDC 64 requires that effluent discharge paths shall be provided with a means to monitor for radioactivity that may be released during anticipated operational occurrences, such as steam generator tube leakage.

DCD Tier 2, Section 10.4.1 states that during normal operation and shutdown, the main condenser (MC) does not have radioactive contaminants. Typically, main condensers would only be expected to receive radioactive contaminants through a steam generator tube leak. A discussion of the radiological aspects of these leaks is included in DCD Tier 2, Subsection 11.1.1.3.

While reviewing the DCD, the staff could not find adequate details to justify the requirements of GDC 64, as it relates to the detection and main control room annunciation of radioactive contaminants found in the MC.

The applicant is requested to provide additional information in the DCD, with full justification, to conform to the GDC 64 criteria as described above.

Response

DCD Tier 2, Subsections 10.4.2.2.2 describes as following;

"The non-condensable gases in Main Condenser are not radioactively contaminated in normal operation. The radioactive materials are processed in Condenser Vacuum System only if there is a primary-to-secondary SG tube leak due to a steam generator tube rupture (SGTR). If radioactivity in the exhaust flow exceeds acceptable level, the condenser vacuum pump vent effluent monitor actuates an alarm in the MCR and automatically diverts the exhaust flow from vacuum pumps to the containment drain sump area in reactor containment building, and then adequate operating procedures are implemented to preclude significant release to the environment. The effluent monitor design, configuration, and its associated parameters are addressed in Subsections 11.5.2.1 and 11.5.2.2, respectively. The location of radiation detector is shown in Figure 11.5-1. The accumulated gas in the reactor containment building is exhausted to the atmosphere by the low-volume purge air cleaning unit of the reactor containment building purge system addressed in Subsection 9.4.6.2.2."

"The exhausted non-condensable gases from the condenser vacuum pumps are controlled and monitored alarm setpoints in accordance with GDC 60 and 64. Conformance with GDC 60 and 64 is addressed in Subsections 3.1.51 and 3.1.55, respectively. The gaseous effluent radiological evaluation is provided in Section 11.3."

Therefore, the APR1400 conforms to the GDC 64 criteria.

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 Reports.