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.:	**63-7983**
SRP Section:	**06.02.02 - Containment Heat Removal Systems**
Application Section:	**6.2.2**
Date of RAI Issue:	**07/07/2015**

Question No. 06.02.02-24

Review procedure #9 of SRP 6.2.2, “Containment Heat Removal Systems,” addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.2, “Wear Rate Evaluation for Valves, Orifices and Pipes,” describes the wear rate evaluation for valves, orifices, and pipes during operation with post-LOCA fluids. Technical Report APR1400-E-N-NR-14001-P, Table 4.2-7 contains a summary of the piping and orifice wear calculation. Based upon the results of wear evaluation for piping and orifice, the report concludes that the system piping and component flow resistances will change minimally during the course of the LOCA. Therefore, flow balances and system performance are not affected in an appreciable manner. The resulting flows and pressures are consistent or conservative with respect to the accident analysis. The minor resistance changes do not affect the system flow calculations and design basis analysis. An analysis will be provided to confirm that the overall system resistance/pressure drop across the ECCS is consistent with the safety analysis results for the 30 day mission time. The NRC staff requests that the applicant describe the analysis in the technical report to confirm that the overall system resistance/pressure drop across the SIS and CSS is consistent with the safety analysis results for the 30-day mission time. Also, the applicant is requested to describe in the technical report the analysis documentation that will provide verification of acceptable SIS and CSS operation.

Response – (Rev. 1)

As described in Subsection 4.2.3.3.2 of Technical Report APR1400-E-N-NR-14001-P/NP, the wear rate evaluation for piping, spray nozzle, and orifices was performed and its results are summarized in Table 4.2-7. The wear rate of emergency core cooling system (ECCS) and containment spray system (CSS) valves are not listed since the wear rates will be provided by the supplying vendor. The potential increase in flowrates in the ECCS and CSS due to component wear will be evaluated using the vendor supplied data and verified and reconciled by

the COL applicant to ensure that any increased flow rates are within the maximum allowable flowrates for at least 30 days of post-LOCA operation.

Impact on DCD

DCD Tier 2, Section 6.8.4.5.9, Section 6.8.6 and Table 1.8-2 will be revised as indicated in Attachment 1.

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

Technical Report APR1400-E-N-NR-14001-P/NP, Section 4.2.3.3.2 will be revised as indicated in Attachment 2.

Table 1.8-2 (9 of 29)

Item No.	Description
COL 6.1(1)	The COL applicant is to identify the implementation milestones for the coatings program.
COL 6.2(1)	The COL applicant is to identify the implementation milestone for the CILRT program.
COL 6.3(1)	The COL applicant is to prepare operational procedures and maintenance programs as related to leak detection and contamination control.
COL 6.3(2)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.
COL 6.4(1)	The COL applicant is to provide automatic and manual operating procedures for the control room HVAC system, which are required in the event of a postulated toxic gas release.
COL 6.4(2)	The COL applicant is to provide the details of specific toxic chemicals of mobile and stationary sources and evaluate the MCR habitability based on the recommendations in NRC RG 1.78 to meet the requirements of TMI Action Plan Item III.D.3.4 and GDC 19.
COL 6.4(3)	The COL applicant is to identify and develop toxic gas detection requirements to protect the operators and provide reasonable assurance of the MCR habitability. The number, locations, sensitivity, range, type, and design of the toxic gas detectors are to be developed by the COL applicant.
COL 6.5(1)	The COL applicant is to provide the operational procedures and maintenance program as related to leak detection and contamination control.
COL 6.5(2)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.
COL 6.6(1)	The COL applicant is to identify the implementation milestones for ASME Section Xl inservice inspection program for ASME Code Section III Class 2 and 3 components.
COL 6.6(2)	The COL applicant is to identify the implementation milestone for the augmented inservice inspection program.
COL 6.8(1)	The COL applicant is to provide the operational procedures and maintenance program for leak detection and contamination control.
COL 6.8(2)	The COL applicant is to provide the preparation of cleanliness, housekeeping, and foreign materials exclusion program.
COL 6.8(3)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.
COL 6.8(4)	The COL applicant is responsible for the establishment and implementation of the Maintenance Rule program in accordance with 10 CFR 50.65.
COL 7.5(1)	The COL applicant is to provide a description of the site-specific AMI variables such as wind speed, and atmosphere stability temperature difference.
COL 7.5(2)	The COL applicant is to provide a description of the site-specific EOF.

(COL 6.8(6))
The COL applicant is to evaluate the potential increase of flowrates in ECCS and CSS due to component wear and to verify that any increased flowrates in ECCS and CSS are within the maximum allowable flowrates for at least 30 days of post-LOCA operation.

This result also verifies that inadequate core or containment cooling does not occur because of debris blockage at flow restrictions, plugging or excessive wear of close-tolerance component (e.g., pumps, heat exchangers, piping, valves, spray nozzles) in the flow path. The component design parameter used in the evaluation of ex-vessel downstream effect is listed in ~~Table~~ Tables 6.2.2-2, 6.3.2-1, and 6.8-4.

As a result of strainer bypass test, the amount of bypass fiber per fuel assembly (FA) is less than the 15 gram limit. Based on this information, the evaluation result of in-vessel downstream effect is that the maximum total deposit thickness and the peak cladding temperature are maintained within the WCAP-16793-NP (Reference 10) LTCC criteria with enough margin, and the LTCC can be maintained.

The COL applicant is to evaluate the potential increase of flowrates in ECCS and CSS due to component wear and to verify that any increased flowrates in ECCS and CSS are within the maximum allowable flowrates for at least 30 days of post-LOCA operation (COL 6.8(6)).

6.8.4.5.10 Potential Debris Source Control

Programmatic controls are established to ensure that potential sources of debris introduced into containment (e.g., insulation, coatings, foreign material, aluminum), and plant modifications do not adversely impact the SI and CS/SC recirculation function.

Programmatic controls are established consistent with the guidance in NRC RG 1.82, Rev. 4 (Reference 3), which provides reasonable assurance that (1) potential quantities of post-accident debris are maintained within the bounds of the analyses and design bases that support the safety injection (SI), containment spray (CS), and shutdown cooling (SC) recirculation functions and (2) the long-term core cooling requirements of 10 CFR 50.46 (Reference 11) are met.

The following is a summary of the programmatic controls that are implemented to provide reasonable assurance of the proper operation of IRWST sump strainer and limits the quantities of latent debris (e,g., unintended dirt, dust, paint chips, fibers) and miscellaneous debris (e.g., tape, tags, stickers) are limited inside containment:

a. Preparation of a cleanliness, housekeeping, and foreign materials exclusion program. This program addresses latent and miscellaneous debris inside containment. An acceptance criterion below the conservative assumption of 90.72 kg (200 lb) for latent debris inside containment is consistent with Reference 4. The programs also ensure that the quantity of miscellaneous debris, such as signs, placards, tags or stickers in the containment is limited so that the 9.29 m^3

The COL applicant is responsible for the establishment and implementation of the Maintenance Rule program in accordance with 10 CFR 50.65 (COL 6.8(4)).

d. A containment coating monitoring program is implemented in accordance with the requirements of NRC RG 1.54, Rev. 2 (Reference 15). The coatings program is described in Subsection 6.1.2.

6.8.5 Testing and Inspection

Inservice inspection and testing of ASME Section III Class 2 and 3 components are conducted in accordance with the programs described in Subsection 3.9.6 and Section 6.6.

6.8.6 Combined License Information

COL 6.8(1) The COL applicant is to provide the operational procedures and maintenance program for leak detection and contamination control.

COL 6.8(2) The COL applicant is to provide the preparation of cleanliness, housekeeping, and foreign materials exclusion program.

COL 6.8(3) The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.

COL 6.8(4) The COL applicant is responsible for the establishment and implementation of the Maintenance Rule program in accordance with 10 CFR 50.65.

6.8.7 References

1. 10 CFR 20.1406, “Radiological Criteria for Unrestricted Use,” U.S. Nuclear Regulatory Commission.

2. Regulatory Guide 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," Rev. 0, U.S. Nuclear Regulatory Commission, June 2008.

(COL 6.8(6))
The COL applicant is to evaluate the potential increase of flowrates in ECCS and CSS due to component wear and to verify that any increased flowrates in ECCS and CSS are within the maximum allowable flowrates for at least 30 days of post-LOCA operation.

through the sump strainer. Therefore the valves do not clog due to post-LOCA insulation debris.

4) Orifice

ECCS and CSS flow is controlled though a combination of orifices and throttled valves. Orifices are used for throttling system flow. ECCS and CSS pressure and flow are monitored in the MCR. The orifice sizes are above 20.3 mm (0.8 inch). Flow velocities in all cases are above the settling velocities of the post-LOCA fluid (Table 4.2-6). Therefore, the potential of orifice plugging is very low.

5) Spray Nozzles

The containment main spray nozzles and auxiliary spray nozzles has an orifice of 13.1 mm (0.516 inch) and 5.6 mm (0.22 inch) diameter, respectively. This orifice is the smallest portion of spray nozzle. The strainer hole size is 2.38 mm (0.094 inch). Containment spray nozzles are significantly larger than the strainer hole size. Their one-piece design provides a large, unobstructed flow passage that resists clogging by particles. Therefore, the potential of spray nozzle plugging is very low.

~~Vendor(s) will qualify the ECCS and CSS piping, nozzles, and orifices to support wear rates of piping, nozzles, and orifices in accordance with QME-1-2007 endorsed by RG 1.100 Revision 3.~~

4.2.3.3.2 Wear Rate Evaluation for Valves, Orifices and Pipes

Erosive wear is caused by particles that impinge on a component surface and remove material from the surface because of momentum effects. The wear rate of a material depends on the debris type, debris concentration, material hardness, flow velocity, and valve position.

Flow rates of 6,057 L/min (1,600 gpm) and 26,963 L/min (7,123 gpm)) for SIS and CSS, respectively, are conservatively assumed for the wear rate evaluation of the components listed in Table 4.2-1. The ECCS design flow rates listed in Table 4.2-1 include the maximum flow rate of the SI pump, CS pump, and the sum of the SIS and CSS flows based on system configuration.

Table 4.2-7 contains a summary of the piping and orifice wear calculation. Based upon the results of wear evaluation for piping and orifice, it is concluded that the system piping and component flow resistances will change minimally during the course of the LOCA. Therefore, flow balances and system performance are not affected in an appreciable manner. The resulting flows and pressures are consistent or conservative with respect to the accident analysis. The minor resistance changes do not affect the system flow calculations and design basis analysis.

The wear rate of ECCS valves will be provided by the vendor. The vendor will qualify the ECCS valves to operate with the post-LOCA fluids for at least 30 days, using the qualification guidance of ASME QME-1-2007 endorsed by RG1.100 Revision 3. As part of the qualification process, the vendor will provide data and/or analyses to support acceptable wear rates during operation in post-LOCA fluids (Table 4.2-5) at the associated flow velocities listed in Table 4.2-6.

~~Vendor(s) will also provide tests and/or analyses to support acceptable wear rates of pipes and orifices. In addition, an analysis will be provided to confirm that the overall system resistance/pressure drop across the ECCS is consistent with the safety analysis results for the 30 day mission time.~~

For conservatism, vendors will perform component wear evaluations at the assumed flow rates/velocities.

The potential increase of flowrates in ECCS and CSS due to component wear will be evaluated and any increased flow rates are within the maximum allowable flowrates for at least 30 days of post-LOCA operation will be verified.