From:	Carolyn Lauron
To:	Justin Hawkins
Cc:	Greg Cranston; Andrew Brenner
Subject:	NRC Staff Response to Clarification Question re: RHR System Classification (99902049)
Date:	Friday, May 26, 2023 11:16:00 AM
Attachments:	image001.png

Hi Justin –

Please see the NRC staff response below to the subject question.
Please let me know if you have additional questions or need more information.

Thanks,
Carolyn

Question:
Is SMR-160 appropriately classifying the RHR system, specifically the portions of the RHR system outside of the containment boundary as Quality Group D, based on the information and context provided below?

Context: SMR-160 Residual Heat Removal System Classification - The SMR-160 RHR system performs two safety functions: maintaining the RCPB integrity through use of isolation valves at the RHR and RCS interface, and maintaining the containment boundary integrity through use of isolation valves inside and outside of containment. In addition, the RHR system performs non-safety functions, including providing normal shutdown heat removal and low temperature overpressure protection, among others. The RHR system designed to comply with GDC 1 as it is classified in accordance with Regulatory Guide 1.26 [1], see Figure 1. As such, the portions of the RHR system that form the RCPB are Quality Group A, and the portions of the RHR system that form the containment boundary are at least Quality Group B (some Quality Group A RCPB isolation valves are also credited as part of the containment boundary). For the remaining portions of the RHR system, the guidance associated with Quality Group C, reproduced in part below, was considered:

The Quality Group C standards […] should be applied to water-, steam-, and radioactive-waste-containing [specific components] that are not part of the reactor coolant pressure boundary or included in Quality Group B but are part of the following:

a. cooling water and auxiliary feedwater systems or portions of those systems important to safety that are design for […] (4) residual heat removal from the reactor […]

c. systems or portions of systems that are connected to the reactor coolant pressure boundary and are capable of being isolated from the boundary during all modes of normal operation reactor operation by two valves, each of which is either normally closed or capable of automatic closure[5]

[5] Components in influent lines may be classified as Quality Group D if they are capable of being isolated from the reactor coolant pressure boundary by an additional valve that has high leaktight integrity.

Criterion a. for Quality Group C does not apply to the remaining portions of the RHR system outside of the containment boundary as they do not serve any safety related or, based on preliminary SMR-160 PRA results, important to safety residual heat removal functions.

The RHR system is connected to the RCPB and is isolated with either normally closed or capable of

automatic closure isolation valves. However, criterion c. for Quality Group C similarly does not apply to the remaining portions of the RHR system outside of the containment boundary due to note 5. The RHR system containment isolation valves serve as the additional valve that has high leaktight integrity. While the RHR system circulates coolant outside the RCPB and could be considered more than just an influent line, such a consideration is not applied to the Quality Group D portions of the AP1000 chemical and volume control system, which also circulates RCS coolant outside the RCPB during coolant purification [2]. The NRC specifically states that the AP1000 chemical and volume control system meets "GDC 1 and RG 1.26 by assigning quality group classifications to system components in accordance with the important to safety function to be performed" [3]. **Therefore, the portions of the RHR system outside of the containment boundary are also justified as Quality Group D.**

It is noted that the AP1000 normal residual heat removal system, which has similar safety related functions (i.e., maintaining the RCPB integrity and maintaining the containment boundary), and nonsafety related functions (e.g., normal shutdown heat removal) as the SMR-160 RHR system, is classified as Quality Group C for portions outside of containment. The rationale provided by Westinghouse is that "this classification recognizes the importance of pressure boundary integrity even though these components have no safety-related functions" [4]. Maintaining the pressure boundary integrity is particularly important to meet ISLOCA guidance in SECY-90-016 [5] and SECY-93-087 [6], specifically that low pressure systems are to be designed such that their ultimate rupture strength is at least equal to the full RCS pressure. In WCAP-15993, Westinghouse states "design features are provided that exceed the ISLOCA criteria. The design features of the [normal residual heat removal system] contribute to the low core damage frequency attributed to ISLOCA calculated in the AP1000 PRA" [7]. Among the design features listed in this evaluation is the Quality Group C classification. The SMR-160 RHR system meets the ISLOCA guidance by designing the portions of the system beyond the RCPB isolation valves (beyond Quality Group A portions) such that the ultimate rupture strength is at least equal to the full RCS pressure. A low temperature overpressure relief valve is also provided in the Quality Group B portion of the system inside containment.

In the AP1000 FSER, the NRC states "The design of classifications of the [AP1000 normal residual heat removal system] components discussed above comply with GDC 1 which specifies that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. […] The staff finds that the [normal residual hear removal system] design will perform its safety-related functions of containment isolation and preservation of the RCPB integrity and, therefore, is acceptable" [8].

It is not clear that the Quality Group C portions of the AP1000 normal residual heat removal system were needed for the NRC to come to this conclusion regarding GDC 1. However, the AP1000 normal residual heat removal system classification and the evaluation by the NRC does not invalidate the acceptability of designing portions of the SMR-160 RHR system outside of the containment boundary as Quality Group D.

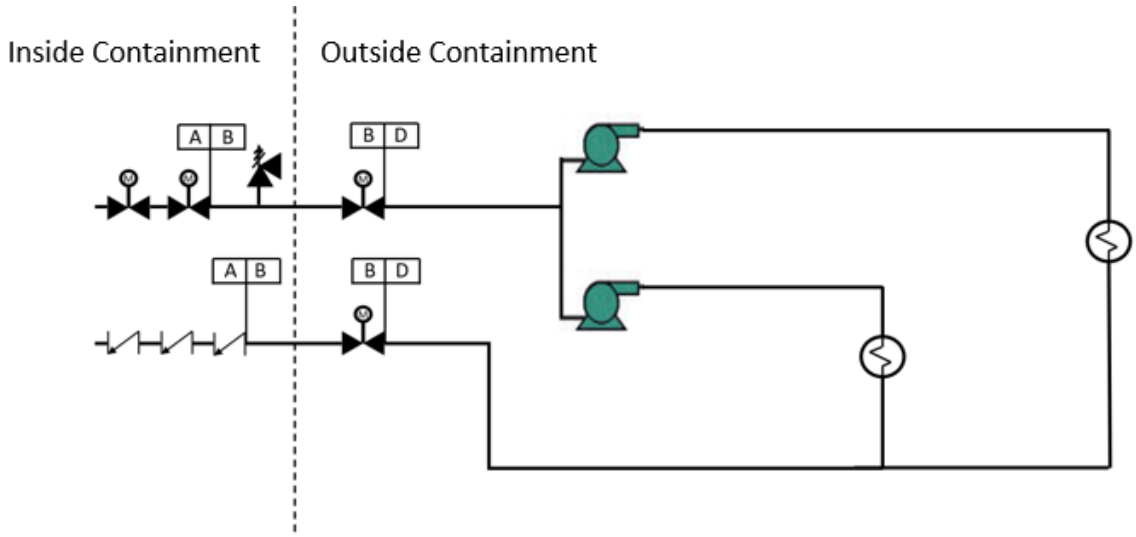

Figure 1: SMR-160 RHR RG 1.26 Quality Group Classification

Note:
Quality Group A portions of the system are designed to 2485 psig and 650°F
Quality Group B and D portions of the system are designed to 885 psig and 400°F

REFERENCES

[1] U. S. NRC, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," RG 1.26, Revision 6, ML21232A142, December 2021.

[2] Westinghouse, "AP1000 Design Control Document, Chapter 9 Auxiliary Systems, Section 9.3 Process Auxiliaries," Revision 19, June 2011.

[3] U. S. NRC, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design, Chapter 9 Auxiliary Systems," NUREG-1793, Initial Report, September 2004.

[4] Westinghouse, "AP1000 Design Control Document, Chapter 5 Reactor Coolant and Connected Systems, Section 5.4 Component and Subsystem Design," Revision 19, June 2011.

[5] U. S. NRC, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," SECY-90-016, January 12, 1990.

[6] U. S. NRC, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water-Reactor (LWR) Designs," SECY-93-087, April 2, 1993.

[7] Westinghouse, "Evaluation of the AP1000 Conformance to Inter-System Loss-of-Coolant Accident Acceptance Criteria," WCAP-15993, Revision 0, November 2002.

[8] U. S. NRC, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design, Chapter 5 Reactor Coolant System and Connected Systems," NUREG-1739, Initial Report, September 2004.

NRC Staff Response:

SMR, LLC (Holtec) requests NRC staff feedback on whether SMR-160 is appropriately classifying the portions of the residual heat removal (RHR) system outside of the containment boundary as Quality Group D to satisfy NRC Regulatory Guide (RG) 1.26. In support of its classification of the RHR system for the SMR-160 outside containment, SMR, LLC (Holtec) refers to the separate quality group classifications of the normal residual heat removal system (RNS) and chemical and volume control system (CVS) for the AP1000 reactor. The NRC staff discusses the RNS and CVS quality group classifications accepted by the NRC staff in the AP1000 Final Safety Evaluation Report (FSER) in the following paragraphs.

AP1000 Design Control Document (DCD), Section 5.4.7, “Normal Residual Heat Removal System,” states that the RNS for the AP1000 performs the following major functions:

- Reactor Coolant System (RCS) Shutdown Heat Removal - Remove heat from the core and the RCS during shutdown operations.
- Shutdown Purification - Provide RCS and refueling cavity purification flow to the CVS during refueling operations.
- In-containment Refueling Water Storage Tank Cooling - Provide cooling for the in-containment refueling water storage tank.
- RCS Makeup - Provide low pressure makeup to the RCS.
- Post-Accident Recovery - Remove heat from the core and the RCS following successful mitigation of an accident by the passive core cooling system.
- Low Temperature Overpressure Protection - Provide low temperature overpressure protection (LTOP) for the RCS during refueling, startup, and shutdown operations.
- Long-Term, Post-Accident Containment Inventory Makeup Flowpath - Provide long-term, post-accident makeup flowpath to the containment inventory.
- Spent Fuel Pool Cooling - Provide backup for cooling the spent fuel pool.

AP1000 DCD, Section 5.4.7.1, “Design Basis,” includes several subsections that outline the safety design bases and nonsafety design bases for the AP1000 RNS. Subsection 5.4.7.1.1, “Safety Design Bases,” states the following:

> The safety-related functions provided by the normal residual heat removal system include containment isolation of normal residual heat removal system lines penetrating containment, preservation of the reactor coolant system pressure boundary and a flow path for long term post-accident makeup to the containment inventory. The containment isolation valves perform the containment isolation function according to the criteria specified in subsection 6.2.3. The system preserves the reactor coolant system pressure boundary according to the criteria specified in subsection 5.4.8.
>
> The normal residual heat removal system piping and components outside containment are an AP1000 Class C, Seismic Category I pressure boundary. This classification recognizes the importance of pressure boundary integrity even though these components have no safety-related functions.

AP1000 DCD, Section 3.2, Table 3.2-3, “AP1000 Classification of Mechanical and Fluid Systems, Components, and Equipment,” lists specific classifications for various RNS components.

AP1000 DCD, Section 9.3.6, “Chemical and Volume Control System,” states that the CVS performs the following major functions:

- Purification - maintain RCS fluid purity and activity level within acceptable limits.
- RCS inventory control and makeup - maintain the required coolant inventory in the RCS; maintain the programmed pressurizer water level during normal plant operations.
- Chemical shim and chemical control - maintain the reactor coolant chemistry conditions by controlling the concentration of boron in the coolant for plant startups, normal dilution to compensate for fuel depletion and shutdown boration, and provide the means for controlling the RCS pH by maintaining the proper level of lithium hydroxide.

- Oxygen control - provide the means for maintaining the proper level of dissolved hydrogen in the reactor coolant during power operation and for achieving the proper oxygen level prior to startup after each shutdown.
- Filling and pressure testing the RCS - provide the means for filling and pressure testing the RCS. The CVS does not perform hydrostatic testing of the RCS, which is only required prior to initial startup and after major, nonroutine maintenance, but provides connections for a temporary hydrostatic test pump.
- Borated makeup to auxiliary equipment - provide makeup water to the primary side systems that require borated reactor grade water.
- Pressurizer Auxiliary Spray - provide pressurizer auxiliary spray water for depressurization.

AP1000 DCD, Section 9.3.6.1, "Design Bases," describes the various functions of the AP1000 CVS. Subsection 9.3.6.1.1, "Safety Design Basis," states the following:

> The safety functions provided by the chemical and volume control system are limited to containment isolation of chemical and volume control system lines penetrating containment, termination of inadvertent reactor coolant system boron dilution, isolation of makeup on a steam generator or pressurizer high level signal, and preservation of the reactor coolant system pressure boundary, including isolation of normal chemical and volume control system letdown from the reactor coolant system.

Subsection 9.3.6.1.2, "Power Generation Design Basis," states the following:

> The principal functions of the chemical and volume control system are outlined above and include controlling reactor coolant system chemistry, purity, and inventory. The system provides some functions necessary for the continued normal operation of the plant. Reliability is achieved by the use of redundant equipment (pumps, filters, and demineralizers). The equipment classification for the chemical and volume control system is contained in Section 3.2.

AP1000 DCD, Section 3.2, Table 3.2-3, lists the classification of CVS components, including Quality Group D for pumps, heat exchangers, and certain valves.

Based on a comparison of the AP1000 DCD sections, RNS and CVS in the AP1000 nuclear power plant perform significantly different functions related to the safe operation of the AP1000 reactor. For example, the RNS provides core cooling functions to provide assurance of the safe shutdown condition of the AP1000 reactor. However, the AP1000 DCD does not specify similar core cooling safety functions for the CVS, which may be isolated in the event of a leakage condition. Therefore, the NRC concluded in the AP1000 FSER that the RNS is appropriately classified as a Quality Group C system outside of containment, and that portions of the CVS may be classified as Quality Group D outside of containment.

In reviewing the discussion provided by SMR, LLC (Holtec), the staff noted the following statement:

> Criterion a. for Quality Group C does not apply to the remaining portions of the RHR system outside of the containment boundary as they do not serve any safety related or, based on preliminary SMR-160 PRA results, important to safety residual heat removal functions.

In the *Federal Register* notice dated March 3, 2022, "Determining which Structures, Systems, and Components and Functions are Important to Safety," (87 FR 11986, 11987), the Commission stated the following in response to a petition for rulemaking:

> Specifically, the 1981 Denton memorandum states that '' 'important to safety' encompasses the

broad class of plant features, covered (not necessarily explicitly) in the General Design Criteria, that contribute in [an] important way to safe operation and protection of the public in all phases and aspects of facility operation (*i.e.,* normal operation and transient control as well as accident mitigation).''

Based on the NRC evaluation of the term "important to safety" as described in the *Federal Register* notice, probabilistic risk assessment (PRA) results may not be used to remove a component from the classification of important to safety in a nuclear power plant. PRA results may be used to determine that a component has low safety significance compared to other components for a particular nuclear power plant design. For components in a nuclear power plant, the applicant must satisfy the NRC regulations applicable to the safety functions of each component.

In response to the specific question from SMR, LLC (Holtec), the NRC staff does not consider it appropriate to rely on the quality group classification of the CVS in the AP1000 design to justify the quality group classification of the RHR system in the SMR-160 design. SMR, LLC (Holtec) will need to justify its proposed quality group classification of the RHR system for the SMR-160 based on its specific functions and safety significance as part of an application submitted for review by the NRC staff. SMR, LLC (Holtec) might request a meeting with the NRC staff in the reactor systems, mechanical engineering, and PRA branches to discuss the specific functions and safety significance of the RHR system for the SMR-160 in determining its appropriate quality group classification.

References:

1. Westinghouse AP1000 Design Control Document Revision 19. https://www.nrc.gov/docs/ML1117/ML11171A500.html

2. U.S. NRC, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design, Docket No. 52-006," NUREG-1793, Supplement 2, September 2011. https://www.nrc.gov/docs/ML1120/ML112061231.pdf