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NRC Meeting:
Containment Isolation GDC 57

November 30, 2022

Meeting Agenda

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- Introductions
- Purpose & Outcome
- Overview of SMR-160 Primary and Secondary Heat Removal Systems
- Regulations and Guidance
- NuScale Decay Heat Removal System
- Questions provided to NRC
- Open Forum

Introductions

- NRC staff
- Holtec staff

Purpose & Outcome

PURPOSE: to give a high-level overview of Holtec's design of the SMR-160 Primary Decay Heat Removal (PDHR) and Secondary Decay Heat Removal (SDHR) systems, specifically the containment isolation schemes.

OUTCOME: To obtain feedback from the NRC staff on containment isolation regulations and understand how they apply to the SMR-160 PDHR and SDHR designs.

Overview of SMR-160 PDHR

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- The SMR-160 PDHR consists of two loops to provide safety-related decay heat removal from the RCS.
  - ✓ The primary loop is part of the RCPB and circulates primary coolant through the tube side of a heat exchanger (PDHR HX1).
  - ✓ The secondary loop is a closed system inside and outside containment that contains demineralized water that flows through the shell side of PDHR HX1, exits containment, and flows through the tube side of another heat exchanger (PDHR HX2). The Annular Reservoir (AR) water surrounds the tubes of PDHR HX 2.
  - ✓ The closed system inside containment consists of PDHR HX1, the connected piping, and an expansion tank with a relief valve that relieves to containment atmosphere. The closed loop outside containment consists of PDHR HX2 and connected piping.

Overview of SMR-160 PDHR

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- The PDHR actuates by isolation valves opening in the primary PDHR loop return leg. There are no containment isolation valves in the secondary PDHR loop.
- The primary PDHR loop is designed to Quality Group A and seismic Category I.
- The secondary PDHR loop is designed to Quality Group B seismic Category I and envelops containment temperature and pressure.

Overview of SMR-160 SDHR

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- The SMR-160 SDHR consists of one loop to provide safety related decay heat removal from the RCS.
  - ✓ The loop is a closed system inside and outside containment that circulates secondary side fluid from the steam generator, flows through a heat exchanger outside containment, and returns to the steam generator through the Main Feedwater system. The AR water surrounds the tubes of the SDHR heat exchanger.
  - ✓ The closed system inside containment consists of the steam generator and connected piping, and the closed system outside containment consists of the heat exchanger and connected piping.

Overview of SMR-160 SDHR

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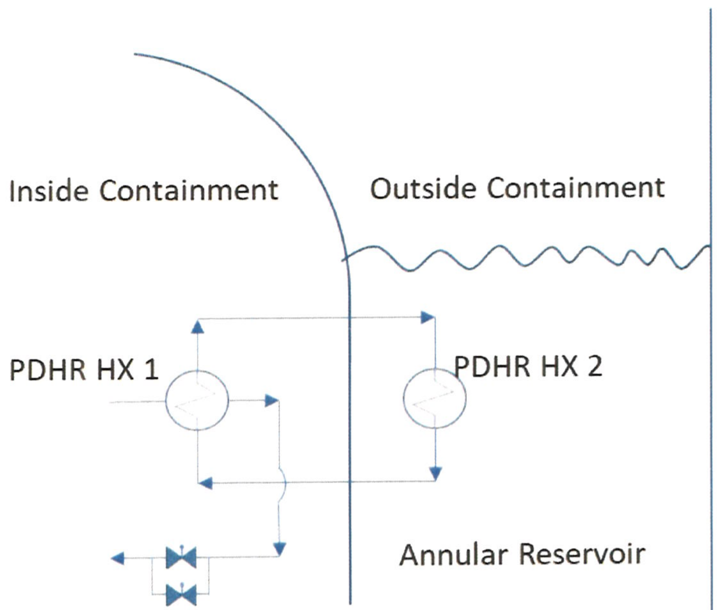
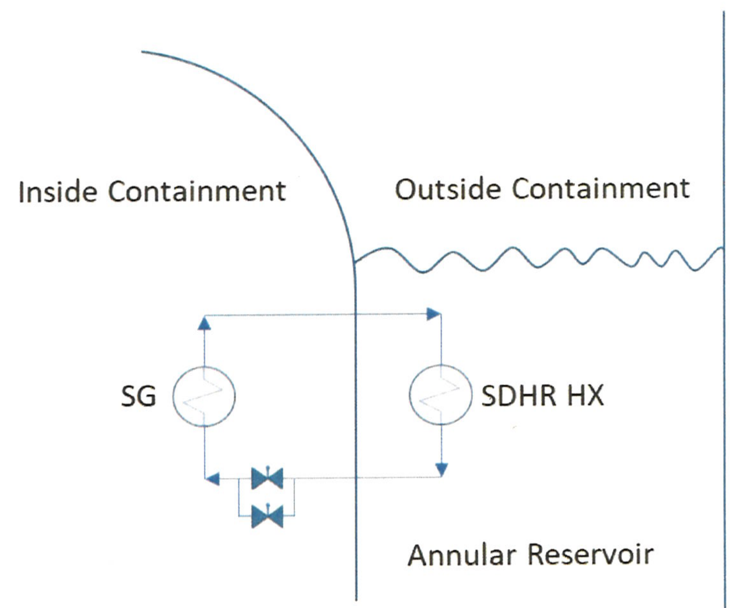
- The SDHR actuates by isolation valves opening in the SDHR loop. There are no containment isolation valves. The SDHR is designed to Quality Group B, seismic Category I, and envelops containment temperature and pressure.

Overview of SMR-160 PDHR and SDHR Systems





Regulations and Guidance

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- GDC 57, *Closed system isolation valves*, states:
  - ✔ Each line that penetrates primary reactor containment and is neither part of the reactor coolant pressure boundary nor connected directly to the containment atmosphere shall have at least one containment isolation valve which shall be either automatic, or locked closed, or capable of remote manual operation. This valve shall be outside containment and located as close to the containment as practical. A simple check valve may not be used as the automatic isolation valve.

Regulations and Guidance

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- SRP 6.2.4, *Containment Isolation System*, Acceptance Criteria 5 states:
  - ✓ Containment isolation provisions for lines in engineered safety feature or engineered safety feature-related systems normally consist of two isolation valves in series. A single isolation valve is acceptable if system reliability can be shown to be greater, the system is closed outside containment, and a single active failure can be accommodated with one isolation valve in the line. The closed system outside containment should be protected from missiles, designed to seismic Category I and Group B quality standards, and have a design temperature and pressure rating at least equal to that for the containment. The closed system outside containment should be leak-tested unless system integrity can be shown to be maintained during normal plant operations. For this type of isolation valve arrangement the valve is located outside containment, and the piping between the containment and the valve should be enclosed in leak-tight or controlled-leakage housing. If, in lieu of housing, piping and valve are designed conservatively to preclude a breach of piping integrity, the design should comply with SRP Section 3.6.2 requirements. Design of the valve or the piping compartment should provide the capability to detect and terminate leakage from the valve shaft or bonnet seals.

Regulations and Guidance

- SRP 6.2.4, *Containment Isolation System*, Acceptance Criteria 15 states:
  - The use of a closed system inside containment as one of the isolation barriers is acceptable id the closed system design satisfies the following requirements:
    - The system does not connect with either the reactor coolant system or the containment atmosphere.
    - The system is protected against missiles and pipe whip.
    - The system is designated seismic Category I.
    - The system is classified Quality Group B.
    - The system is designed to withstand temperatures equal to at least that of the containment design.
    - The system is designed to withstand the external pressure from the containment structure acceptance test.
    - The system is designed to withstand the LOCA transient and environment.
  - As to the structural design of containment internal structures and piping systems, the protection against loss of function from missiles, pipe whip, and earthquakes is acceptable if 1) isolation barriers are located behind missile barriers; 2) pipe whip was considered in the design of pipe restraints and the location of piping penetrating the containment; and 3) the isolation barriers, including the piping between isolation valves, are designated seismic Category I, i.e., designed to withstand the effects of the safe-shutdown earthquake, as recommended by Regulatory Guide 1.29

Regulations and Guidance

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- RG 1.141, *Containment Isolation Provisions for Fluid System*, states:
  - The requirements and recommendations for the containment isolation of fluid systems that penetrate primary containment of light-water-cooled reactors, as specified in ANSI N271-1976, are generally acceptable and provide an adequate basis for use, subject to [additional criteria].

- ANSI N271-1976, revised by ANSI/ANS 56.2-1984, does not address containment isolation schemes that utilize a closed loop inside containment and a closed loop outside containment as containment isolation barriers.

NuScale Decay Heat Removal System

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- The NuScale Decay Heat Removal System has a similar design to the SMR-160 SDHR system. Both consist of a closed loop inside containment that includes primary reactor coolant flowing through the steam generator, and a closed system outside containment that includes secondary fluid flowing through a heat exchanger outside containment.
- NuScale requested, and was granted, an exemption to GDC 57 for the Decay Heat Removal System containment penetrations.
  - ✔ "The use of closed systems inside and outside containment as an alternative isolation provision for the NuScale DHRS is not addressed by the GDC or by other regulatory guidance. However, although not directly applicable to a GDC 57, the DHRS outside containment otherwise meets the criteria for a closed system outside containment ... Therefore, the alternative isolation provisions used for the DHRS penetrations meet the underlying purpose of GDC 57 by ensuring reliable containment isolation through the use of redundant isolation barriers."

Questions

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- Does GDC 57 govern the containment isolation scheme for the SMR-160 PDHR and SDHR systems?

- Context:
  - ✓ No existing regulations address designs where a closed system inside containment and a closed system outside containment serve as containment isolation barriers, similar to the SMR-160 PDHR and SDHR design. However, GDC 57 discusses the use of a closed system as a containment isolation barrier.
  - ✓ The PDHR and SDHR design meets the intent of GDC 57 by providing two containment isolation barriers (a closed loop inside containment and a closed loop outside containment) while increasing the reliability of each system. Each containment isolation barrier meets guidance and criteria provided in SRP 6.2.4 and RG 1.141.

Open Forum

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