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Revision Log

Revision	Description of Changes
0	Initial Issue.

Executive Summary

This white paper is intended to convey to the NRC the design of the SMR-160 Passive Containment Heat Removal system and demonstrate SMR-160 compliance with GDC 40.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this white paper is to give a high-level overview of Holtec's design of the SMR-160 Passive Containment Heat Removal (PCHR) system as part of the Holtec and NRC pre-application Regulatory Engagement Plan.

1.2 Objective

The objective of this whitepaper is to document Holtec's position that SMR-160 and the PCHR system is compliant with GDC 40 Testing of containment heat removal system.

1.3 Abbreviations

AR	Annular Reservoir
CES	Containment Enclosure Structure
CS	Containment Structure
PCHR	Passive Containment Heat Removal system

2.0 SMR-160 PCHR DESIGN

The SMR-160 PCHR is a passive system that maintains containment pressure and temperature below its design limits. The PCHR reduces containment pressure by rejecting heat from the containment atmosphere to the Containment Structure (CS), then to the Annular Reservoir (AR), and finally to the environment (the ultimate heat sink).

The PCHR consists of the AR water and its associated instrumentation, the AR water recirculation loop, and containment pressure and temperature instrumentation. The AR is the volume formed in the annulus above grade between the outside surface of the CS and the inside surface of the Containment Enclosure Structure (CES) filled with water. The CS contains sufficient heat transfer area for PCHR to transfer heat from the containment atmosphere to the CS, then to the AR, and finally to the environment. The CES has a vent open to the atmosphere. The AR recirculation loop, which is not important to safety, provides chemistry control, freeze protection, and makeup water connection for the AR. Class 1E pressure, level, and temperature instrumentation are provided for monitoring containment pressure and temperature, and AR water level and temperature, but these instruments are not relied upon to perform safety-related containment heat removal. Additional non-Class 1E instruments measure parameters in the recirculation loop.

In the event of a Design Basis Accident where the containment pressure and temperature increase from the combined decay heat of the reactor core and the spent fuel pool, the CS wall heats up as a result. The large heat transfer area and high conductance of the CS wall result in instantaneous heat rejection from the CS to the AR water. The AR then rejects heat to the environment by convective heat transfer to the CES vent. The PCHR is the safety system that removes heat from the containment atmosphere for at least 72 hours without any operator action or relying upon actuation signals or active components. A preliminary analysis shows

that the water in the AR is sufficient to extract heat from the containment atmosphere indefinitely without replenishment.

3.0 COMPLIANCE WITH GDC 40

10 CFR 50 Appendix A [1] General Design Criteria 40, Testing of containment heat removal system, states:

The containment heat removal system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole, and under conditions as close to the design as practical the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated water cooling system.

The following characterizes the SMR-160 PCHR design as it relates to GDC 40:

1. The AR structural and leaktight integrity is assured by leakage rate testing of containment penetrations and hydrostatic pressure testing of the CS, in compliance with GDC 16, Containment design, GDC 50, Containment design basis, GDC 51, Fracture prevention of containment pressure boundary, GDC 52, Capability for containment leakage rate testing, and GDC 53, Provisions for containment testing and inspection. Visual inspections of the CES will also be performed, in addition to monitoring the makeup required to the AR for unexplained increases indicative of leaks causing inventory loss beyond evaporation through the vent in the CES.

2. The PCHR has no active components needed to perform its containment heat removal function; therefore, assurance of active component operability and performance is not applicable.

3. The operability of the PCHR relies on the inherent heat transfer characteristics of the CS and the AR water. Maintaining the heat transfer characteristics of the CS is also verified through periodic inspections of the CS heat transfer surfaces in compliance with GDC 39, Inspection of containment heat removal system. Such inspections assure surface fouling or degradation that could potentially impede heat transfer from the CS is not in excess of the design basis.

   Since the PCHR does not rely on any actuation signal or active components, there is no operational sequence that brings the system into operation. The PCHR is always available to perform containment heat removal except when the AR is drained for maintenance.

4.0 CONCLUSION

The SMR-160 PCHR passively removes containment heat without use of actuation signals or active components to ensure containment pressure is below design limits. SMR-160 is compliant with GDC 40 as the PCHR is designed to permit appropriate periodic testing including

pressure testing of the CS and visual inspections of the CS and CES. Functional testing of the PCHR is not applicable to verify system operability and functionality.

5.0 REFERENCES

[1] 10 CFR 50 Appendix A, "General Design Criteria for Nuclear Power Plants".