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NRC Meeting:
SRP 3.9.4 CRDS Operability
QA Program

September 13, 2022

Meeting Agenda

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- Introductions
- Purpose & Outcome
- Overview of SMR-160 CRDS
- CRDS White Paper
- Questions provided to NRC
- Open Forum

Introductions

- NRC staff
- Holtec staff

Purpose & Outcome

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PURPOSE: To give a high-level overview of the SMR-160 control drive system design and the associated SRP 3.9.4 testing requirements. Additional topics for discussion include acceptable analytical methods that can be used in lieu of prototype testing, industry experience and plant referenced designs that preclude use of analytical methods, and Holtec's white paper on CRDM testing.

OUTCOME: To obtain feedback and clarification from the NRC staff on the testing requirements in SRP 3.9.4, 'Control Rod Drive Systems' as they pertain to the SMR-160's control drive system.

Overview of SMR-160 CRDS

- The control rod assembly of the SMR-160 is based on proven designs that have been in operation in various PWRs.
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Figure 9-3: Overall Schematic

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CRDS QA Program

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- An aggregate review of five different reactor designs and associated CRDS quality assurance programs was conducted to determine compliance with SRP 3.9.4 for the SMR-160 design.

- The SMR-160 design is subject to a CRDS quality assurance program and Holtec will need to implement a program in accordance with the requirements in SRP 3.9.4.

- The existing quality assurance programs that were reviewed provide design verification through previous like-for-like designs using operating experience, analysis, or through the creation of a prototype program.

NuScale

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- NuScale CRDS is similar in design to the CRDSs of current operating fleet PWRs however, it has some unique features that include a longer control rod drive shaft (due to the presence of an integral steam generator and a pressurizer volume between the top of the core and the top of the RPV), and a remote disconnect mechanism.

- The design also uses a CRA (control rod assembly) and fuel-assembly design similar but shorter than traditional operating reactors.

- The arrangement of a shorter fuel assembly and CRA coupled to a longer control rod drive shaft creates a unique configuration of these components with no operational or testing experience

- The CRA drop and control rod drive shaft alignment prototype test program was developed to confirm the operability of this unique design. This prototype testing program integrates the CRDM, the control rod drive shaft, the CRA, and the fuel assembly to demonstrate the acceptable mechanical functioning

AP1000 (Westinghouse)

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- The AP1000 control rod drive mechanism is based on a proven Westinghouse design that has been used in many operating nuclear power plants.

- The control rod cluster and fuel assembly thimble tube mechanical designs are also based on a proven design; therefore, no prototype testing was conducted.

- The units are production tested prior to shipment to confirm the capability of the control rod drive mechanism to meet design specifications and operating requirements.

APR 1400 CEDM (KEPCO/KHPN

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- The APR1400 CEDM is essentially identical to the System 80 CEDM, which is presently operating at the Palo Verde Nuclear Generating Station, except for the material of the motor housing lower end fitting and thickness of the upper shroud tube.

- The tests performed during development of System 80 CEDM along with operating experience provide design verification for the APR1400 CEDM.

- The operating experience has demonstrated that the APR1400 CEDM operates without malfunction and meets design criteria.

What is the NRC's definition of "new design"?

Background – SRP 3.9.4 states the following – *"The design stress limits, including fatigue limits and deformation limits appropriate to the components of the CRDM, are compared to the limits of specified codes, previously designed, and successfully operating systems, or the results of scale model and prototype testing programs. The CRDM of a new design or configuration should be subjected to a life cycle test program to determine the ability of the drive components to function during and after normal operation, anticipated operational occurrences, seismic events, and postulated accident conditions over the full range of temperatures, pressures, loadings, and misalignment expected in service."* The SMR-160 CRDM design being developed by Framatome is based off previous operating PWR designs such as Westinghouse, Combustion Engineering, and Babcock Wilcox.

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What is the NRC's definition of "new and unique features"?

(Background – SRP 3.9.4 states the following – *"The design criteria presented should be evaluated for the internal pressure-containing portions and other portions of the CRDS, including the CRDM housing, the hydraulic control unit, the condensate supply system and scram discharge volume, and portions such as the cylinder, tube, piston, and collet assembly. Of particular interest are any new and unique features that have not been used in the past."*)

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What is the NRC's definition of operability assurance as it relates to the overall CRDM and CRDS function?

Background – SRP 3.9.4 states the following – *"In the DC or construction permit (CP) review, it should be determined that the design criteria utilize proper load combinations, stress and deformation limits, and that operability assurance is provided by reference to a previously accepted testing program, or provisions are specified to perform a testing program that includes the essential elements listed below. In the operating license (OL) review, the results of any testing program not previously reviewed should be evaluated."*

- For a new a testing program, what can be evaluated empirically vs analytically when evaluating design stress limits including fatigues limits and deformation limits in support of performance testing, stability testing, endurance testing?

Open Forum