Background
Westinghouse developed the SHIELD® passive thermal shutdown seal (patent pending) as a passive means of protecting the reactor core. It prevents a loss of reactor coolant system (RCS) water inventory should an event occur that causes a loss of all seal cooling. The SHIELD passive thermal shutdown seal is a fail-safe protection that will significantly reduce or eliminate leakage from the reactor coolant pump (RCP) seal, and no operator action, power or control logic is required.

Why Westinghouse?
The SHIELD passive thermal shutdown seal is a passive system that does not rely on operator action, power, control logic or cooling support systems. When the SHIELD passive thermal shutdown seal has been installed, operators do not need to implement an immediate cooldown to address RCP seal leakage at the onset of a station blackout event and, thus, are able to focus their efforts on such critical tasks as power recovery and maintaining a heat sink.

The SHIELD passive thermal shutdown seal offers a lead time from “decision to make improvement” to “implementation of solution” that is a fraction of the time (and effort) of alternate seal cooling systems, and it permits changes to deterministically derived station blackout and fire-coping strategies.

The SHIELD passive thermal shutdown seal improves mitigating system performance index (MSPI) margin by reducing RCP seal cooling vulnerabilities and decreasing core damage frequency by up to 50 percent.

Description
In the event of a loss of all seal cooling in the RCP, the cool water between the pump impeller and the seal package will be displaced by hot RCS water. A loss of all RCP seal cooling requires the loss of both the thermal barrier heat exchanger (component cooling water) and RCP seal injection (charging pump, which sometimes is cooled by component cooling water). As the RCS fluid temperature rises, the seal leak-off is expected to increase to 21 gpm (79.5 L/min). The SHIELD passive thermal shutdown seal mitigation of RCS inventory loss protects the core by maintaining fluid for a natural recirculation cooldown.
Regulatory applications impacted by the loss of all RCP seal cooling may be improved by installation of the SHIELD passive thermal shutdown seal, including the following:

- Loss of All AC Power (10CFR50.63)
- Fire Protection (10CFR50.48 Appendix R), (NFPA 805)
- Maintenance Rule (10CFR50.65)
- Mitigating System Performance Index (MSPI) margins
- Significance Determination Process (SDP) assessments for as-found deviations from the licensing basis
- Flexibility in technical specifications limiting conditions for operations and associated completion times

The SHIELD passive thermal shutdown seal is located above the RCP #1 seal, recessed in the flange of the #1 insert.

Currently, the U.S. Nuclear Regulatory Commission (NRC) has approved 24-hour survivability of the SHIELD passive thermal shutdown seal under station blackout (SBO) conditions for regulatory applications. Testing is in progress to significantly extend the survivability of the seal. The SHIELD passive thermal shutdown seal flow limit of less than 1 gpm (3.8 L/min) also addresses the need for supplemental makeup for compliance with the NRC’s 10CFR50 Appendix R – Fire Protection regulation.

Additionally, the SHIELD passive thermal shutdown seal response time supports easy-to-implement fire protection strategies for National Fire Protection Association Standard NFPA 805 requirements.

**Benefits**

- 24-hour survivability – SBO conditions
- Easy to install, with no additional cost, when done with routine seal maintenance
- Westinghouse working with the NRC to provide proper credit in risk-informed applications
- No additional operating or maintenance costs beyond replacing a worn part during normal seal inspection
- Permits relaxation of regulatory barriers for many risk-informed applications
- Not susceptible to common causes of failure
- Maximizes equipment diversity
- Does not introduce adverse interactions with current systems
- No additional floor space requirements or plant modifications versus alternate seal cooling systems

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