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Subject: Submittal of "Successful Post-Operational Testing of the Generation III SHIELD[®] Passive Thermal Shutdown Seal" (Non-Proprietary)

Reference:

1. TR-FSE-14-1-P, Revision 1, "Use of Westinghouse SHIELD[®] Passive Shutdown Seal for FLEX Strategies," March 2014. (Proprietary)

Enclosed is a report titled "Successful Post-Operational Testing of the Generation III SHIELD[®] Passive Thermal Shutdown Seal." The design basis, operating experience, analysis, and qualification testing of the Westinghouse Generation III SHIELD^{®1} Passive Thermal Shutdown Seal are documented in Reference 1.

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Enclosure

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Successful Post-Operational Testing of the Generation III SHIELD[®] Passive Thermal Shutdown Seal

BACKGROUND

The design basis, operating experience, analysis, and qualification testing of the Westinghouse Generation III SHIELD^{®2} Passive Thermal Shutdown Seal are documented in Reference 1. The Reference 1 document was created to provide relevant information to the U.S. Nuclear Regulatory Commission in order to support endorsement of the shutdown seal for use in plants' FLEX applications.

Part of the original test plan for the Generation III Shutdown Seal was to conduct a post-operational test after some period of operation in an operating plant. This letter provides notification that such testing has been successfully completed.

DISCUSSION

Reference 1 provides a comprehensive summary of the testing that Westinghouse committed to perform in order to demonstrate successful operation of the Generation III shutdown seal. Part of that document describes Westinghouse's intention to perform post-operational testing of the Generation III shutdown seal to confirm reliable actuation after being installed in a reactor coolant pump in an operating plant. The purpose of such a test is to demonstrate that the Generation III shutdown seal would have reliably actuated in an extended loss of AC power or other such event during which the shutdown seal is designed to limit leakage from the reactor coolant pump seals.

Review of Test Requirements

A description of the Generation III shutdown seal test program was provided to the industry and the Nuclear Regulatory Commission in Reference 1. Section 7.3 of Reference 1 provides a matrix outlining the various tests performed on the shutdown seal. The test matrix shown in Figure 7.3-1 of Reference 1 establishes the requirement that a shutdown seal will be removed from operation after one cycle and tested as part of "Extended Qualification Testing." "Extended Qualification Testing" was a term used to draw the distinction that completion of this test was not required prior to installation and crediting of the shutdown seal. This is clarified on page D-15 of Reference 1 which states:

"Post-Operational Test: This is not required for qualification, but indicates intent to verify successful product rollout."

Section 7.3.6 of Reference 1 further defines the post-operational static test, stating:

"The final step in the qualification program will be to conduct a static actuation test on an SDS after one cycle of full-power operation in an RCP. Static testing will be performed at the Westinghouse Science and Technology Center using suitable facilities and equipment for handling and testing contaminated components."

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The post-operational test will be a static actuation test in which the acceptance criteria will be for the SDS to actuate at the design temperature and limit leakage to less than 1.0 gpm."

Reference 1 further defines the static actuation test in Section 7.3.2.8:

"The purpose of the static actuation test is to demonstrate that...the SDS remains capable of properly actuating and reducing seal leak-off flow to below 1 gpm. Static actuation testing is performed on a test mockup that subjects the seal to normal leak-off temperature and pressure. The SDS is installed in a fixture that has a simulated shaft with the same dimensions as the RCP shaft or shaft sleeve, depending on the model of RCP."

No further discussion of the post-operational test is provided in Reference 1, except in Section 7.4.6 which states that the testing will occur following removal of the first Generation III shutdown seal from service.

The above excerpts represent the extent of Westinghouse's comments to the Nuclear Regulatory Commission regarding post-operational testing of the Generation III shutdown seal. These comments are entirely captured in Reference 1, which was reviewed and endorsed by the Nuclear Regulatory Commission in Reference 2.

Based on this review of Reference 1, it was concluded that post-operational testing of the Generation III SHIELD® Passive Thermal Shutdown Seal should meet the following requirements:

- (1) Testing shall be conducted on a Generation III shutdown seal after one cycle of operation in a plant,
- (2) The testing shall be performed in the static tester at the Westinghouse Science and Technology Center in a configuration comparable to what was used for the qualification testing, and
- (3) The test shall have the following acceptance criteria:
 - a. Actuation shall be passively initiated by rising seal leak-off temperature,
 - b. Actuation shall occur between 260°F and 320°F,
 - c. After actuation, leakage shall be reduced to below 1 gallon per minute.

Test Results

This testing was completed at the Westinghouse Science and Technology Center in Churchill, Pennsylvania on October 4, 2015. The shutdown seal was removed from a reactor coolant pump in Beaver Valley Unit 2 after operating from April 2014 to October 2015. The seal was installed in a special test machine designed to replicate the configuration and operating conditions inside the seal package of the reactor coolant pump.

During the test, the temperature was programmed to increase until actuation of the shutdown seal was achieved. When the water temperature reached 297°F, the shutdown seal actuated and the leakage rate immediately dropped to below 0.01 gallons per minute while the inlet pressure immediately rose to approximately 2280 psig. After actuation, the sealed condition was maintained for 10 minutes to demonstrate that a consistent, stable, and low level of leakage was maintained. The test was then ended in accordance with the test procedure. Temperature and leak rate profiles from the test are provided in Figure 1.

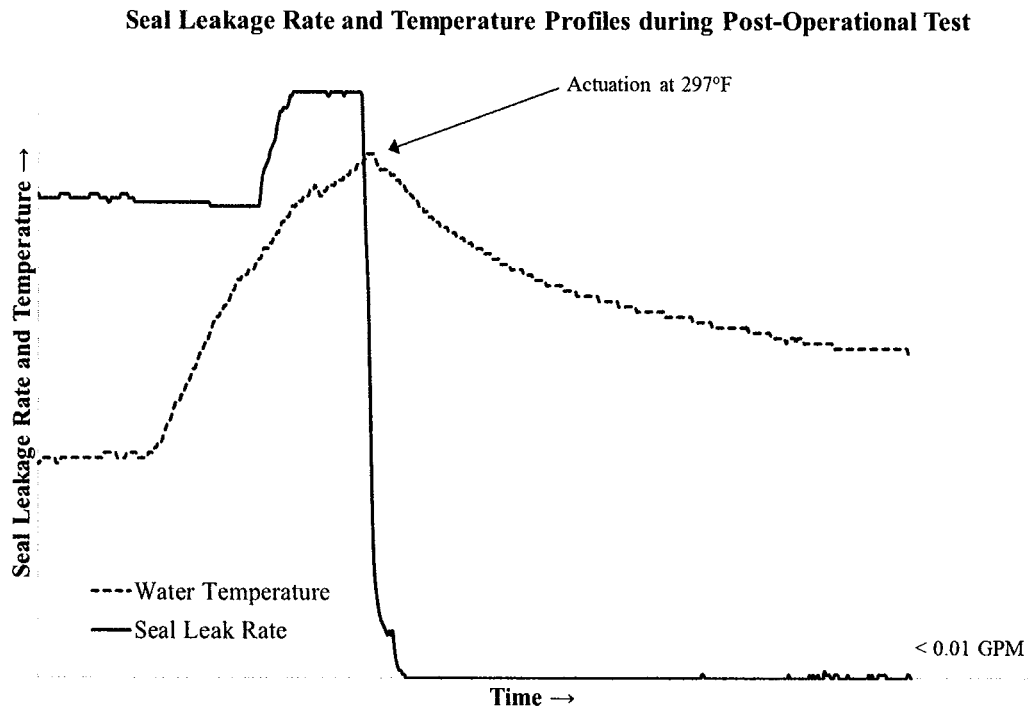


Figure 1. Temperature and Leak Rate Profiles during Post-Operational Test

Shutdown seal performance in the post-operational test was consistent with its designed function and met all relevant acceptance criteria: (1) actuation was passively initiated by rising leak-off water temperature, (2) the actuation temperature of 297°F falls acceptably within the design temperature range of 260°F to 320°F, and (3) post-actuation leakage of <0.01 gallons per minute is far below the maximum allowable leakage of 1.0 gallons per minute. The post-operational test is therefore concluded to have been successful.

References:

1. TR-FSE-14-1-P, Revision 1, "Use of Westinghouse SHIELD® Passive Shutdown Seal for FLEX Strategies," March 2014.
2. U.S. NRC Letter, Accession No. ML14132A128.