ENCLOSURE 2

MFN 14-010 R0

Description of Evaluation

Non-Proprietary Information - Class I (Public)

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1 to MFN 14-010 R0, from which the proprietary information has been removed. Portions of the enclosure that have been removed are indicated by open and closed double square brackets as shown here [[ ]].

Summary

GEH is evaluating the discovery of a Scram Solenoid Pilot Valve (SSPV) with a disengaged valve spring based on information available to date and has determined that insufficient information is available to determine whether the condition is reportable under 10 CFR Part 21. The SSPV manufacturer has issued an Interim Report, in parallel with this GEH Interim Report Notification, providing information currently known, recommendations, and intentions to complete their evaluation. GEH expects the manufacturer's investigation will provide sufficient information to complete the determination of reportability. GEH intends to complete our own evaluation and determine reportability under 10 CFR Part 21 by July 31, 2014.

The GEH evaluation of potential effects, as currently understood and which include slow scram insertion of affected control rods during full-core scram, suggests that compensatory measures and defense in depth provide means to ensure that any affected plants will be able to shutdown in accordance with requirements. A previous GEH evaluation suggests that [[ ]] would not lead to violation of the Technical Specifications safety limit for Minimum Critical Power Ratio (MCPR).

Introduction

On January 15, 2014, GEH was informed of the failure of a control rod to scram (i.e., no control rod motion) during a single rod scram test at a U.S. BWR/5 plant (Plant E). Plant personnel conducted an investigation and determined that the 118 Scram Solenoid Pilot Valve (SSPV) in the Hydraulic Control Unit (HCU) for the affected control rod did not function. They inspected the valve and discovered that the spring normally connected to valve plunger (or core) had become detached. Such a condition would not place the valve into its isolated/vented configuration upon deactivation in response to the Reactor Protection System (RPS) scram signal, and scram performance would be degraded, with a delayed insertion proceeding through function of the backup scram valves (or, if necessary, manual activation of the Alternate Rod Insertion, ARI, system). In the case of a single rod scram test, the backup scram valves do not open and the condition would leave the control rod unmoved in the pre-scram position; this was the behavior observed at Plant E.

The valve was returned for inspection by the SSPV manufacturer (ASCO Valve, Inc.), who initiated their own 10 CFR Part 21 investigation into the apparent condition of the valve and the extent of condition. Details of valve manufacturing can be provided only by the manufacturer, who is also best equipped to assess the failure mechanism and valve behavior in the failed condition. As of this date, the manufacturer's investigation is ongoing,

but the manufacturer has issued an Interim Report (in parallel with this GEH Interim Report Notification) from which information is being incorporated into the GEH evaluation of safety significance under 10 CFR Part 21. Details provided herein present the information available to GEH at this time and support the GEH determination that there is insufficient information to completely evaluate the reportability of the condition under 10 CFR Part 21.

Description of Discovery

A review of available industry operating experience and recent GEH experience indicates that this condition was observed and reported 5 times: 1993, 1994 (two occurrences), 2012, and 2014. The salient information from the review is summarized below in Table 1.

Table 1. Summary of SSPV Spring Disengagement History

Date	Plant	Observations
March 1993	Plant A BWR/3	• Slow scram during full-core scram from operation • Shortly after CRD HCU maintenance
April 1994	Plant B BWR/2	• Slow scram during full-core scram from full-power operation • Had operated successfully on previous occasions after installation (time to failure not provided)
Nov. 1994	Plant C BWR/3	• Failure to scram in low-power Tech Spec testing during post-outage startup • Immediately after installation/refurbishment
October 2012	Plant D BWR/4	• Passed scram-time test during start-up after installation • Cycled 87 times in “half-scram” testing over 2 months • Normal insert from notch 12 during full-core scram 2 months after installation • Cycled 112 additional times in “half-scram” testing over next 3 months • Slow to scram during full-core scram (2.5-sec delay) 5 months after installation (scheduled for testing) • Failure to scram during single-rod test 6 months after installation
Jan. 2014	Plant E BWR/5	• Passed two scram-time tests during start-up after installation • Cycled roughly 60 times in “half-scram” testing over 7 months • Failed to scram (no movement) in single-rod test 7 months after installation

Summary of Observed Behaviors

- In observations from 1993, 1994 (2), 2012, and 2014, the condition was discovered during normal plant operation within months after valve installation but in only one case during pre-operational testing just after installation of the affected valve.
    - The 2012 and 2014 occurrences of the condition were evident within 7 months of valve installation, after cycling roughly 60 to 200 times in "half-scram" tests (during which the condition would not be evident, because only one of the pair of SSPVs is cycled at a time).
    - Two of the three occurrences from 1993 and 1994 also appear to have been discovered within a short time after valve installation (immediately in post-installation testing in one case, and "shortly after" HCU maintenance in another case).

- When the condition is present:
    - During a full-core scram, the rod fully inserts but is delayed, often outside of the insertion time required by Technical Specifications. This is because the backup scram valves depressurize the scram air header, which allows the scram valves to open and the rod to insert, but the rate is slower than insertion triggered with the SSPV function. (If the backup scram function, which is activated by the Reactor Protection System, RPS, were to not function for some reason, the operator could then manually activate the ARI system, which would also depressurize the scram air header to insert affected rods, but at a delayed rate and after the duration needed to trigger the system manually. Note that the backup scram function and the ARI system are not safety related.)
    - During a single-rod scram test, the control rod fails to move upon scram signal.

Extent of Condition

The manufacturer has defined the suspect population as 401 SSPVs assembled during a period extending from 2010, when the assembly operation was moved to a new location, to November 2012, when an assembly inspection step was added to confirm spring engagement. GEH has correlated internal records with those of the manufacturer to identify the serial numbers of SSPVs remaining at receiving plants sites, as provided in Table 2. From the population of 401, a total of 399 SSPVs were shipped from GEH to various plant sites. (Note that these quantities do not include an additional 36 valves from the suspect population that were received but later returned to the manufacturer.)

Table 2. Serial Numbers and Receiving Plants for SSPVs from Suspect Population

Plant Name	Customer PO	S/N Base	S/N Extensions	Ship Date	QTY
Browns Ferry	00073419 140715	A762654	-001, -002, -003	4-Apr-11	3
				Plant Total:	**3**
Columbia	337332	A272718	-008, -012, -021, -027 -028, -031, -034, -035, -036, -045, -046, -048, -049, -050, -052, -053, -057, -060, -062, -065	3-May-13	20
	Note: This quantity for Columbia is for SSPVs remaining at the site, all of which were inspected for the condition and cleared. An additional 36 valves from the suspect population were initially received and then returned by Columbia and are not included in this table.			**Plant Total:**	**20**
Dresden	00000707 13418	A171767	-001, -002	25-Oct-10	2
				Plant Total:	**2**
Fermi	4700381095	A113888	-001 thru -009, -011 thru -014, -016 thru -024, -026 thru -050, -052 thru -067, -069, -070, -072, -073 thru -081, -083 thru -125	8-Feb-12	118
		A171767	-007 thru -009, -014, -025, -031, -034, -037, -045	31-Jan-12	9
			-030	22-Aug-11	1
		A321861	-021 thru -029	22-Aug-11	9
		A321861	-005, -006, -010, -012, -030 thru -037, -041 thru -047, -050	31-Jan-12	20
		A351454	-001 thru -005	28-Sep-12	5
	Note: This quantity for Fermi is for suspect SSPVs remaining at the site, and does not include two suspect valves previously returned to the manufacturer and replaced with two valves not from the suspect population.			**Plant Total:**	**162**
Oyster Creek	80 034650	A171767	-003 thru -006, -010 thru -013, -015, -020, -022, -023, -024, -026, -027 thru -029, -032, -033, -035, -036, -038 thru -044, -046 thru -050	23-Aug-10	33
		A321861	-001 thru -004, -007 thru -009, -011, -013, -014, -017, -018, -038, -039, -040, -048, -049	23-Aug-10	17
	80 045972	A276160	-006 thru -011, -013 thru -033	26-Jun-12	27
	80 048306	A272718	-001 thru -006	5-Nov-12	6
		A276160	-002, -004	11-Sep-12	2
	80 045972	A272718	-022, -023, -024	6-May-13	3
				Plant Total:	**88**
Peach Bottom	90 258497 427	A171767	-016 thru -019	5-Jan-11	4
		A321861	-015, -016, -019, -020	5-Jan-11	4
				Plant Total:	**8**
Quad Cities	00000707 13765	A272718	-066 thru -071	11-Sep-13	6
				Plant Total:	**6**
Non-U.S. Plant	8981120150	A496905	unknown	9-Dec-10	2
	8991120188	A793691	-001 thru -108	26-Sep-11	108
	Note: The A496905 quantity for the Non-US Plant is for suspect SSPVs remaining at the site and does not include 104 SSPVs from that original shipment that were returned to the manufacturer for a different issue and received a spring inspection prior to reshipment under a new S/N.			**Plant Total:**	**110**
				Combined Total:	**399**

Implications for Safety Significance

The limited number of observations of the condition from the current suspect population and the consistency of time to identify the condition for the five occurrences (recent and 1990s) suggest this condition occurs with low frequency and relatively early identification. However, the possibility of other affected SSPVs from the population exhibiting this condition is indeterminate and cannot be quantified until the supplier's investigation is completed. For that reason, the degree to which the suspect population is affected by the condition is uncertain, and the safety significance of the condition, which depends on the number of control rods affected, cannot be assessed. However, some comments on potential effects can be made.

For cases of any affected but undetected SSPVs, the ability to shutdown the plant and maintain shutdown will depend on whether the functioning control rods maintain sufficient shutdown margin. In the U.S., and in other countries with similar regulations and practices, reactor cores and fuel cycles are designed to maintain adequate shutdown margin at all times with the highest-worth control rod fully withdrawn. This ensures that a plant unknowingly affected with a single control rod of this condition (typical of the cases observed thus far), or other conditions with similar effects on scram, will meet shutdown requirements throughout the operating cycle, during cold shutdown, and during refueling. If that provision is not made in core design or if multiple control rods are concurrently impacted, shutdown requirements are likely to be met due to the function of the backup scram valves. The backup scram function is activated by the Reactor Protection System (RPS) and ensures the scram air header is depressurized to allow the scram valves to open and control rods with non-functioning SSPVs to insert. If the backup scram function were to fail, operator action to activate the ARI system would also depressurize the scram air header, allowing affected control rods to insert. Activation of the ARI system must be done in sufficient time to allow the rods to insert before the scram discharge volume fills. Control rod insertion by either of these functions is slower than that triggered through the SSPVs, due partly to the delay in start of motion and also to the slower rate of insertion. Finally, the operator has the option of manual insertion using the normal control rod positioning function. Although the backup scram function, the ARI system, and the normal control rod positioning function are not safety-related, these functions are redundant, independent, and/or diverse to the normal RPS scram function. If those systems were to fail with multiple control rods concurrently affected by this condition, then shutdown requirements might not be met – this would depend on plant-specific details, including the core locations of the affected rods.

For cases in which affected control rods are inserted by the function of the backup scram valves, the scram insertion time could exceed Technical Specifications scram time limits (i.e., > 7 sec.). However, a previous GEH evaluation of control rod performance [[

]] will have negligible effect on Critical Power Ratio for the limiting fuel assembly. [[

]] will not pose a concern for shutdown of the plant and will not lead to violation of the Technical Specifications safety limit for Minimum Critical Power Ratio (MCPR).

Synopsis

What is currently known about the condition can be summarized as follows:

- The condition is a latent tendency for the SSPV spring to disengage from the valve plunger and apparently results from an assembly issue that escaped detection by the manufacturer.
    - The failure mechanism associated with this condition and the frequency at which the condition might be present remains to be determined.
- When the condition manifests, the control rod is observed to insert slowly during a full-core scram or to not move at all during a single-rod scram test.
- A number of BWR plants have received GEH-shipped SSPVs from a population identified by the manufacturer as being associated with valve spring disengagement.
    - Two occurrences of this condition have been discovered from the identified population of 399 potentially susceptible SSPVs.
    - Industry operating experience indicates three other known or likely occurrences of this condition in the 1990s, which are not associated with the currently identified population.
- Of the five known occurrences to date (three in the 1990s and two within the past two years):
    - The condition has been detected in only one occurrence at each of five plants.
    - The frequency at which this condition exists in any of the suspect SSPVs is unknown but apparently is low. The probability that this condition exists in more than one suspect SSPV in a single plant is also unknown, but is lower than the probability of existing in a single suspect SSPV. Finally, the probability of two or more control rods with affected SSPVs concurrently failing to scram is lower yet.

- Known occurrences of the condition were detected within a relatively short time after SSPV replacement installation and specifically within 7 months (or 60 to 200 valve cycles) for the two recent occurrences.
    - The manufacturer's ongoing investigation of the failure mechanism is intended to determine whether the condition would reliably become apparent within a short time or a limited number of valve cycles after installation; i.e., within a single plant operating cycle as observed in at least 4 of the 5 occurrences from 1993, 1994, 2012, and 2014.

- Safety significance of this condition, if present, depends on the number of affected control rods and, if multiple control rods in a plant are concurrently affected, on their location. But some general points can be made:
    - Shutdown margin for the case of a single affected control rod is assured by core designs that maintain shutdown margin with the highest-worth control rod fully withdrawn.
    - Shutdown margin is otherwise assured by the backup scram function and the ARI system, which serve to depressurize the scram air header and allow control rods with SSPV failure to insert. Operators might also choose to insert un-scrammed rods using the normal control positioning function.
    - Scram insertion initiated by backup scram function or ARI could exceed Technical Specification scram times, but in a previous GEH evaluation, a condition [[
      ]] was
      shown to have negligible effect on critical power performance of the limiting fuel assembly.

The manufacturer has not completed their evaluation and has issued a Part 21 Interim Report (in parallel with the GEH Interim Report Notification), which reports on their evaluation of the condition, summarizing plans for and status of their ongoing evaluation.

GEH is not able to evaluate the safety significance of this condition with the limited information available at this time, particularly:

- the uncertainty regarding the number of shipped suspect SSPVs that are actually affected;
- the uncertainty regarding the time needed for the condition to manifest with an impact on scram performance; and
- the specific core locations of control rods and HCUs with potentially affected SSPVs.

ABWR and ESBWR Design Certification Documentation Applicability

The issue described herein has been reviewed for applicability to documentation associated with 10 CFR 52, and determined to have no effect on the technical information contained in either the ABWR certified design or the ESBWR design in certification. This is true because this condition is not a deficiency in design.

Recommendations

GEH suggests the following:

- Customers who received shipments of the suspect SSPVs should consider assisting ASCO Valve, Inc. with their investigation, as practical and appropriate.
- Plant staff can consider whether more-frequent testing of CRDs with suspect SSPVs is beneficial to identify presence of the condition for appropriate action. However, staff should remember that effects are not gradual to allow early identification before SSPV malfunction (i.e., the observable characteristic is scram performance affected by the malfunction).

GEH assistance on this issue can be obtained by contacting Rich Jones (richard2.jones@ge.com; 910-819-6043, or 910-228-4602).

Corrective/Preventive Actions

The manufacturer, ASCO Valve, Inc. issued an Interim Report, ("Interim Report on HVL26600000010J Valve," March 11, 2014) with stated intention to complete their investigation by the end of June 2014. GEH intends to complete the ongoing GEH evaluation by July 31, 2014, after the manufacturer's completed evaluation has been communicated.

Refer to Attachment 2, Item (vii) for corrective actions.