Exelon Generation®

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September 10, 2014
TMI-14-109

10 CFR 50.73

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

THREE MILE ISLAND NUCLEAR STATION, UNIT 1 (TMI-1)
RENEWED FACILITY OPERATING LICENSE NO. DPR-50
DOCKET NO. 50-289

SUBJECT: LICENSEE EVENT REPORT (LER) NO. 2014-002-00
"Through-Wall Leak on High Pressure Injection (HPI) "A" Train Root Valve MU-V-1034 Socket Weld"

This report is submitted in accordance with 10 CFR 50.73(a)(2)(i)(B). For additional information regarding this LER contact Mike Fitzwater, Sr. Regulatory Engineer, TMI Unit 1 Regulatory Assurance at (717) 948-8228.

There are no regulatory commitments contained in this LER.

Sincerely,

Mark Newcomer
Plant Manager, Three Mile Island Unit 1
Exelon Generation Co., LLC

MN/mdf

cc: TMI Senior Resident Inspector
Administrator, Region I
TMI-1 Senior Project Manager

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NRR

NRC FORM 366 (01-2014) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 01/31/2017

LICENSEE EVENT REPORT (LER)

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4. TITLE

Through-Wall Leak on High Pressure Injection (HPI) "A" Train Root Valve MU-V-1034 Socket Weld

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
07	13	2014	2014	- 002	- 00	09	11	2014	FACILITY NAME	DOCKET NUMBER
										05000

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*			
N	☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
10. POWER LEVEL	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
100	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
	☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER *(Include Area Code)*
Michael Fitzwater, TMI Unit 1 Regulatory Assurance Engineer	(717) 948-8228

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO				

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On July 13, 2014 at 17:31 Three Mile Island, Unit 1 exceeded a 72 hour limiting condition for operation (LCO), after being granted a period of enforcement discretion, due to a through-wall leak found on the "A" train of the High Pressure Injection (HPI) system piping at the ½" socket weld coupling to root valve MU-V-1034. The flaw resulted in declaring the "A" train of HPI inoperable. This event was reportable under 10 CFR 50.73(a)(2)(i)(B) as an operation or condition which was prohibited by the plant's technical specifications. A Notification of Enforcement Discretion (NOED) was granted by the NRC at 17:19 on July 13, 2014. The apparent cause leading to the NOED request was inadequate procedure guidance for applying freeze seals which resulted in delays in achieving isolation of the leak in order to establish proper conditions to perform the repair. The through-wall leak most probable cause was determined to be from stress corrosion cracking driven by fatigue. The corrective action was to grind out the weld and repair (re-weld). This event had no adverse effect upon the health and safety of the public.

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A. EVENT DESCRIPTION

Plant Conditions before the event:

Babcock & Wilcox – Pressurized Water Reactor – 2568 MWth Core Power
Date/Time: July 10, 2014 / 17:30 hours
Power Level: 100%
Mode: Power Operation

On July 10, 2014 at approximately 17:30 EDT, a small leak (1 drop every 2 minutes) was identified from a welded connection upstream on the high pressure injection (HPI) line side of instrument root isolation valve MU-V-1034 during a plant walk-through. Valve MU-V-1034 is the high side root isolation valve for the 'B' HPI line flow instrument, but isolation of this leak required that the 'A' train of HPI be isolated and declared inoperable. TMI Unit 1 Technical Specifications 3.3.2 states, "Components shall not be removed from service so that the affected system train is inoperable for more than 72 consecutive hours. If the system is not restored to meet the requirements of Specification 3.3.1 within 72 hours, the reactor shall be placed in a HOT SHUTDOWN condition within six hours." The Limiting Condition for Operation (LCO) was entered at 17:30 EDT on July 10, 2014; therefore the expiration time for restoration of the train or initiation of a plant shutdown to hot standby was at 17:30 EDT on July 13, 2014. The 'B' HPI train was verified and maintained operable throughout the event.

During execution of the repair activity, adequate isolation could not be obtained. Makeup/HPI fluid leaked past closed boundary isolation valves. Maintenance repair of the leaking welded connection was delayed due to inadequate isolation due to intrusion of hot water into the repair area. The water source was identified as through valve seat leakage from an HPI injection path isolation valve. Efforts to eliminate the through valve seat leakage were not successful. The isolation efforts included multiple attempts to increase valve seating torque and the application of freeze seals. The repair method was understood, however due to the delays in achieving isolation to allow performance of the repair, a request for Notice of Enforcement Discretion (NOED) was required.

A request for enforcement discretion to apply a 46.5 hour extension to the current in effect 72 hour LCO was discussed with the NRC at approximately 15:00 on July 13, 2014. At 17:19 on July 13, 2014, TMI Unit 1 was verbally granted a Notice of Enforcement Discretion (NOED) by the US Nuclear Regulatory Commission (NRC) prior to exceeding the 72 hour Limiting Condition for Operation (LCO) for a high pressure injection (HPI) line being removed from service due to a small leak (1 drop every 2 minutes) from a welded connection. This non-conformance to the plant TS requires reporting as an "operation or condition which was prohibited by the plant's Technical Specifications" in accordance with 10 CFR 50.73(a)(2)(i)(B).

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B. CAUSE OF EVENT

Delays in achieving isolation to create the proper conditions to allow leak repair resulted in requesting a NOED that was granted by the NRC.

The apparent cause for the repair delay was due to the inability to achieve an adequate isolation and subsequent freeze seal. The freeze seal procedure did not contain appropriate guidance to attain isolation for the given situation. The procedure lacked direction on expected times to achieve a freeze and relied heavily on vendor experience to determine when the freeze was established. The criteria listed in the procedure to determine the establishment of a freeze seal was not accurate for schedule 80 stainless steel piping. Additional guidance is required for application of freeze seals to ensure they can be established in a timely manner and prevent pre-mature aborting of a freeze.

A contributing cause was determined to be insufficient station freeze seal experience and knowledge which resulted in over-reliance on the vendor and subject matter experts in development of freeze seal plans to effectively drive actions to establish isolation in a timely manner.

An additional contributing cause was lack of readily available freeze seal jackets. TMI Unit 1 does not have liquid nitrogen freeze seal jackets on hand and relies on the vendor to supply. The local vendor only had 6 inch jackets available; this size jacket was not sufficient to establish conditions for the weld repair. A 12 inch jacket with improved heat transfer capability had to be shipped from the Midwestern United States.

An investigation was conducted to determine the cause for the through-wall pipe leak. Several potential causes were developed with the most-probable cause of the weld failure being Stress Corrosion Cracking (SCC). Several damage mechanisms were evaluated based on a review of EPRI Technical Reports related to failures in nuclear piping systems.

The damage mechanisms evaluated were:

- Aging
- Corrosion
- Construction/Fabrication Defect
- Design Error
- Erosion/FAC
- Fatigue
- Stress Corrosion
- Mechanical Damage
- Water Hammer
- Wear

The most-probable cause of the weld flaw was due to Stress Corrosion Cracking (SCC) that was propagated from an existing weld root defect. The fabrication materials are susceptible to stress corrosion cracking. The weld is located in a dead leg and socket welds provide crevices for

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contaminants to be trapped. The additional noted weld root porosity makes trapped contaminants more likely at this location. During filling and venting activities this crevice can trap some oxygen in the location of the socket weld. These conditions are known to be conducive to SCC as evidenced by industry OE. The flaw was most likely driven through wall by fatigue from an existing SCC flaw. The system undergoes both vibration and dynamic transients. NDE technicians indicated that the piping was vibrating during the dye penetrant examination, and it is expected additional vibration exists during HPI flow testing. Additionally plant process computer data shows system pressure spikes during valve and pump In-Service test activities. As evidenced in significant industry OE, fatigue is known to cause through-wall failures. This condition likely contributed to the propagation of the initial SCC flaw.

Extent of condition (weld flaw):

Stress corrosion cracking can occur in a PWR. This is likely to occur in low flow borated systems with pre-existing flaws. The weld flaw growth is exacerbated by piping vibration. The current processes and programs in place allow early detection and repair of a through wall leak prior to a safety significant occurrence.

Additionally, the most-likely contributing cause, fatigue, is not uncommon in the PWR fleet, however is unlikely the sole cause of failure. The relevant locations have low or stagnant flow conditions and would be expected to have low vibrations. However, as discussed in EPRI report TR-107455, even small vibrations can cause cracking if a pre-existing flaw is present. Therefore the same systems susceptible to the apparent cause, SCC, are susceptible to fatigue failure.

It is unlikely that similar through-wall leaking welds currently exist in the plant. This is based on:

- the leak being located while leaking one drop every two minutes
- a strong Boric Acid Corrosion Control (BACC) program that requires periodic examinations for leakage
- the ISI program performs pressure tests and associated VT-2 examinations at least three times every 10 years (many of the susceptible piping segments are examined every cycle)
- system engineers perform periodic walkdowns of their systems
- the plant work force is knowledgeable about BACC and reports findings
- normal operator rounds are performed by personnel that are very aware of the need to identify leaks in the plant

In addition, plant walk downs were completed as a result of this discovery. There were no locations with weld leakage concerns based on the subject programmatic controls and walk downs conducted.

C. ANALYSIS / SAFETY SIGNIFICANCE

This event did not affect the health and safety of the public.

In 2009, a similar weld failure occurred in close proximity to the current weld failure. At that time a Probabilistic Risk Assessment (PRA) sensitivity analysis was performed for the weld failure in order to understand potential impacts on the station. That analysis concluded that the failure represented a negligible impact on the baseline Core Damage Frequency (CDF) and Large Early Release Frequency

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(LERF) models as well as the Risk Informed-Inservice Inspection (RI-ISI) program. The basis for this statement was:

- failures of this nature are slow growing
- the RI-ISI program models SCC, fatigue, and design/construction errors
- the failure is not a new type of failure
- the failure does not indicate TMI is susceptible to a higher than expected number of flaws
- the TMI PRA model accounts for very small LOCAs; and
- leakage that could occur due to similar failure mechanisms is bounded by the TMI Very Small LOCA rate.

The bases for the above six statements were verified to remain valid for this current weld failure and no additional PRA analysis was required as a result.

The TMI ISI Program performs volumetric examinations of >10% of the risk significant butt welds in the Make-up & Purification (MU&P) and similar systems over each 10 year interval. These examinations have not identified stress corrosion cracking in low/stagnant flow risk significant butt welds. The ISI program performs visual examinations of socket welds as there are no reliable volumetric examination techniques available. While no socket welds have been examined, the butt weld examinations support the conclusion that stress corrosion cracking is neither widespread nor significant in the stainless steel borated water systems. Additionally this supports the conclusion that the socket weld configuration is susceptible to SCC that is not present in the stainless steel butt welds of these systems.

There was minimal safety consequence in extending the LCO an additional 46.5 hours. The 'A' train of HPI was returned to service 40 hours and 23 minutes after the 72 hour Technical Specification allowed LCO, within the 46.5 hour extension requested by TMI and granted by the NRC. TMI Unit 1 requested that the U.S. Nuclear Regulatory Commission (NRC) exercise discretion in enforcing compliance with the actions required in Technical Specification (TS) 3.3.2. The NOED request included the results of a risk analysis which demonstrated that the risk associated with allowing TMI Unit 1 to remain at power operation for an additional 46.5 hours to repair the leak remained acceptable. The NRC subsequently verbally approved the NOED request on July 13, 2014. The written NOED documentation was submitted to the NRC on July 15, 2014 (ADAMS Accession Number ML14197A293). The NRC subsequently issued the written NOED approval (NOED No. 14-1-03) on July 17, 2014 (ADAMS Accession Number ML14198A494).

D. CORRECTIVE ACTIONS

The immediate action taken was to grind out and repair the weld. Planned actions include revision of MA-AA-736-610 "Application of Freeze Seal to All Piping" to provide additional guidance to ensure freeze seals can be established in a timely manner and prevent pre-mature aborting of a freeze.

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E. PREVIOUS OCCURENCES

IGSCC was identified at TMI in the spent fuel pool cooling, decay heat removal, and building spray systems in 1979. The cracking was attributed to contamination from the building spray system (sodium thiosulfate). The pipe flaws were repaired, and augmented inspections were conducted for other pipe cracks. Water chemistry controls were established to limit contamination that could lead to IGSCC.

In March 2009, a through wall leak was identified in a stagnant high pressure one-half inch diameter stainless steel socket weld on an instrument reducer in the vicinity of MU-V-1034. The apparent cause report identified transgranular stress corrosion cracking (TGSCC) as the most likely failure mechanism. The weld was repaired through excavation and re-welding. A one-time visual inspection was conducted on similar configurations and operating procedures were reviewed to minimize the introduction of oxygen into the system. The flaw occurred 2 inches from the flaw discussed in this LER and was exposed to the same conditions. Due to this, these flaws are attributed to the same damage mechanism.

In November 2010, a leak of approximately 10 drops per minute at the inlet welded connection for an elbow on the MU pump common recirculation line was identified. The line was low pressure 1 ½" stainless steel piping downstream of MU-V-36/37. The EACE determined the leak was due to TGSCC similar to the 2009 failure. The leak was repaired using a mechanical clamping device and actions were established to perform destructive analysis. Corrective actions included a permanent repair of the weld and a one-time visual examination of similar locations.