Entergy

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Lawrence Coyle
Site Vice President

NL-15-115

September 8, 2015

U.S. Nuclear Regulatory Commission
Document Control Desk
11545 Rockville Pike, TWFN-2 F1
Rockville, MD 20852-2738

SUBJECT: Licensee Event Report # 2015-007-00, "Manual Reactor Trip Due to Decreasing Steam Generator Water Level Caused by a Miss-Wired Circuit Board in the Main Feedwater Pump Speed Control System"
Indian Point Unit No. 3
Docket No. 50-286
DPR-64

Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc. (ENO) hereby provides Licensee Event Report (LER) 2015-007-00. The attached LER identifies an event where the reactor was manually tripped, which is reportable under 10 CFR 50.73(a)(2)(iv)(A). As a result of the reactor trip, the Auxiliary Feedwater System was actuated, which is also reportable under 10 CFR 50.73(a)(2)(iv)(A). This condition was recorded in the Entergy Corrective Action Program as Condition Report CR-IP3-2015-03795.

There are no new commitments identified in this letter. Should you have any questions regarding this submittal, please contact Mr. Robert Walpole, Manager, Regulatory Assurance at (914) 254-6710.

Sincerely,

LC/cbr

cc: Mr. Daniel H. Dorman, Regional Administrator, NRC Region I
NRC Resident Inspector's Office, Indian Point Energy Center
Ms. Bridget Frymire, New York State Public Service Commission

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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

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-I0202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME:	2. DOCKET NUMBER	3. PAGE
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4. TITLE: Manual Reactor Trip Due to Decreasing Steam Generator Water Levels Caused by a Miss-Wired Circuit Board in the Main Feedwater Pump Speed Control System

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
7	8	2015	2015	007 -	00	9	8	2015	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE

1

10. POWER LEVEL

100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

- ☐ 20.2201(b)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☐ 50.73(a)(2)(i)(A)
- ☐ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☒ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER *(Include Area Code)*
James Timone, Engineering Systems E-FIN	(914) 254-6733

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	SJ	ECBD	L253	Y	X	SD	MO	W120	Y

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

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

On July 8,2015, during surveillance testing, the Control Room received a 6.9kV motor trip alarm due to 31 Condensate Pump (CP) Motor circuit breaker trip on overcurrent. Operators entered Alarm Operating Procedure 3-AOP-FW-1 due to loss of the 31 CP and initiated a load reduction. During this time the Main Boiler Feedwater Pump (MBFP) suction pressure decreased to its suction pressure cutback controller pressure range and its output decreased MBFP speed control to a minimum. The 31 MBFP speed control signal locked in at this minimum speed signal due to actuation of the MBFP Lovejoy speed control system Track and Hold feature. Due to this minimum 31 MBFP condition, the 31 MBFP recirculation valve opened causing the 31 MBFP check valve to close. With the 31 MBFP unloaded, Steam Generator (SG) water levels decreased and at 15 percent operators manually tripped the reactor. The Auxiliary Feedwater System automatically started as expected due to SG low level from shrink effect. Direct cause was the 31 MBFP entered a Hold condition erroneously due to a miss-wired Track and Hold board in the speed control system. The root cause was inadequate verification/testing process by the vendor that resulted in miss-wiring and manufacturing of the track and hold circuit board in the MBFP speed control system. Corrective actions included replacement of MBFP track and hold board and 31 CP motor. A new replacement Track and Hold circuit board for both the 31 and 32 MBFP speed control system with the miss-wiring corrected will be installed. MBFP Lovejoy speed control maintenance procedures and site vendor manuals will be revised to include more detail. The event had no effect on public health and safety.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

Note: The Energy Industry Identification System Codes are identified within the brackets {}.

DESCRIPTION OF EVENT

On July 8,2015, while at 100 percent reactor power, during performance of surveillance test 3-PT-Q100B (Turbine First Stage Analog Channel B Calibration), the Control Room {NA} received a 6.9kV motor trip alarm {ALM} due to 31 Condensate Pump (CP) {KA} Motor circuit breaker {BKR} trip on overcurrent. Operators entered Alarm Operating Procedure 3-AOP-FW-1 due to loss of the 31 CP and initiated a load reduction to 900 MWe. During this time the Main Boiler Feedwater Pump (MBFP) {SJ} suction pressure decreased to its suction pressure cutback controller PC-409A pressure range (265 psig to 230 psig) and its output decreased MBFP speed control to a minimum. The 31 MBFP speed control signal locked in at this minimum speed signal due to actuation of the MBFP Lovejoy speed control system {JB} Track and Hold feature. Due to this minimum 31 MBFP condition, the 31 MBFP recirculation valve BFD-FCV-1115 opened causing the 31 MBFP check valve to close. With the 31 MBFP unloaded, Steam Generator (SG) {AB} water levels decreased and at 15 percent operators manually tripped the reactor {JC}. All control rods {AA} fully inserted and all required safety systems functioned properly. After the RT the 32 Component Cooling Water (CCW) pump auto started while adjusting temperature control valve TCV-130.. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. The Auxiliary Feedwater System {BA} automatically started as expected due to SG low level from shrink effect. The Emergency Diesel Generators {EK} did not start as offsite power remained available and stable. The RT event was recorded in the Indian Point Energy Center corrective action program (CAP) as CR-IP3-2015-03795. A post trip evaluation was initiated and completed on July 8, 2015.

The main feedwater (FW) system consists of two steam turbine driven pumps which receives condensate and heater drains in its suction and provides the final boost in pressure and temperature to provide FW to the SGs. The MBFPs speed is controlled automatically to provide FW header pressure greater than SG pressure. Low suction pressure protection is needed to prevent cavitation in the MBFP. There are two low suction pressure protection circuits, 1) PS-521 provides suction pressure protection by automatically starting the standby Condensate Booster Pumps, 2) PT-408B provides a signal to controller PC-409A to initiate the low suction pressure MBFP turbine speed cutback. This cutback starts at approximately 265 psig and automatically reduces MBFP turbine speed as a function of suction pressure to a minimum (approximately 3,000 rpm). There is a MBFP Turbine (MBFPT) control oil system whose purpose is to adjust the position of the high and low pressure stop valves and high and low pressure governor valves based on the signal from the MBFP speed control system. The speed of the MBFP turbine is controlled with a combination of electric, pneumatic, and hydraulic controls. The Lovejoy Control System which converts the electrical output of the Foxboro Control System into an equivalent control oil pressure signal to control the Westinghouse Boiler Feed Pump's turbine speed control system.

For normal operations MBFP speed is controlled automatically by an auto-manual speed controller. Each MBFP (2) has its own speed controller (SC-408 and SC-409). Each MBFP speed signal is compared to a MBFP suction pressure signal by low current detectors (SM-408B and SM-409B). The low current selectors choose the lower of the two signals to pass on to the MBFP speed changers as follows: 1) Pressure Transmitter PT-408B senses pump suction pressure and sends a signal to suction pressure cutback controller PC-409A.

Pressure controller PC-409A is programmed to generate a full output signal for any suction pressure above 265 PSI and ramp down to minimum output for a suction pressure of 230 PSI. During normal operation of the MBFP, suction pressure is 370 PSI, well above 265 PSI and the FW signal will be selected by the low current selector and passed on to the speed changers. 2) If the pump suction pressure falls below 265 PSI, the pressure signal will begin decreasing until it falls below the value of the FW signal. At this point the low current selector will pass the suction pressure signal to the Lovejoy signal processor thereby limiting MBFP speed to maintain suction pressure.

The Lovejoy Control System has a Track and Hold circuity (card or circuit board) whose function is to protect the system against a loss of FW demand signal from the Foxboro Loop. There are three permissives that allow the system to go into HOLD mode: rate change of the signal, signal being at low or high setpoints, and signal remaining at this value for more than a ½ second. The Track and Hold cards contain a potentiometer that is used to adjust rate of change setting that will trigger first permissive for a HOLD condition. The second permissive is met by having FW demand signal be at either the low or high setpoints. The third permissive is made up if the signal remains at the high or low setpoint value for more than ½ second.

The Lovejoy System receives a 2 year preventive maintenance (PM) calibration every refueling outage (RO) per procedure 3-IC-PC-I-31MBFP. Instrument and Control personnel perform this PM under the guidance of a Lovejoy technical representative every RO. The 2 year PM does not have steps to test the Track and Hold functions that are controlled by a microprocessor. Testing is not performed to ensure erroneous hold conditions are not entered.

On July 13 2015, a troubleshooting team was assembled including Lovejoy representatives to determine the cause of the false Hold conditions. On July 14, 2015, the refurbished Track and Hold card installed after the RT was Lab tested. During testing it was identified that the potentiometer used to set rate of change permissive was wired incorrectly. This resulted in Rate of Change permissive being constantly armed. Thus, with the rate of change permissive satisfied, the Track and Hold card would actuate HOLD mode once the FW signal went to minimum for greater than ½ second. The faulty Track and Hold card was miss-wired during manufacturing at the Lovejoy Controls Facility. Entergy reviewed the Track and Hold card testing performed at Lovejoy Controls on new cards and the calibration performed by I&C during a 2 year PM. Neither of these testing procedures contained sufficient details to detect the incorrectly wired rate of change potentiometer. A performance analysis worksheet was completed to analyze the knowledge and skills of applicable site personnel. The assessment concluded that site personnel over rely on the vendor (Lovejoy) for troubleshooting and maintenance of the MBFP speed control system and that refresher training is recommended. The MBFP speed control system Track and Hold circuit board (CAT ID 0018475019) {ECBD} is manufactured by Lovejoy {L253}.

After the RT the 31 Condensate Pump motor was tested and a winding short was detected. A spare motor was installed. The 31 Condensate Pump motor was rewound at Schulz Electric in 2003 and installed in the 31 Condensate Pump position in 2005. During RO 3R17 in 2013, the motor was removed for its 8 year PM overhaul then reinstalled at the end of the RO. During the 2013 overhaul of this motor, a hot spot in the stator core was identified by the vendor during the extended core loss test which was accepted by the vendor. The vendor recommended performing a restack of the core during the next scheduled overhaul in 2019.

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To address the identified hot spot, the stator was dipped in varnish, underwent a vacuum pressure impregnation process which pulls the varnish into voids including the suspect inter-laminar insulation between steel sheets and the stator placed in an oven to bake and cure the varnish. During 3R18 in 2015, the motor was lifted and the 2 year offline electrical testing performed satisfactorily and the motor was returned to service.

An extent of condition investigation determined that Unit 3 remains susceptible to a manual or automatic RT due to low SG levels on decrease in FW suction pressure, which would occur with a loss of Condensate Pump or Heater Drain Pumps. A critical decision paper was prepared to return Unit 3 to service with this condition.

The Cause of Event

The direct cause of the RT was lowering SG levels and the inability to maintain SG levels. The decrease in FW flow was due to the 31 MBFP Lovejoy speed control system entering a Hold condition erroneously due to a miss-wired speed control Track and Hold circuit board. The miss-wired Track and Hold board resulted in the rate of change permissive continuously being made up. The Track and Hold cards contain a potentiometer that is used to adjust rate of change setting that will trigger first permissive for a Hold condition. The potentiometer used to set rate of change permissive was wired incorrectly so that it satisfied the rate of change permissive. This condition resulted in the Rate of Change permissive being constantly armed. With the Rate of Change permissive satisfied, the Track and Hold card would actuate Hold mode once the FW signal went to minimum for greater than ½ second.

The direct cause of the 31 Condensate Pump motor fault was a localized hot spot in the stator core that caused a winding fault in the 31 Condensate Pump motor. There is no set industry criterion for restacking stator core laminations when hot spots are identified during extended core loss testing of motors.

The root cause was an inadequate verification/testing process by the vendor resulting in failing to identify a miss-wiring and the malfunctioning of the track hold board in the MBFP speed control system. The vendor failed to functionally test the Tack and Hold board to verify that all functions operated as intended. The vendor also failed to adequately review and verify wiring on the Track and Hold circuit board. This malfunction would not block a hold condition from occurring which is the primary design function of the board upon loss of input FW demand signal but instead would result in an erroneous track and hold when minimum FW demand signal is obtained. This is what occurred during the plant event when the MBFP speed cutback was initiated following the MBFP suction pressure decreasing below 265 psig when the 31 Condensate Pump motor tripped

Corrective Actions

The following are some of the corrective actions that have been or will be performed under the Corrective Action Program (CAP) to address the causes of this event.

- The 31 MBFP speed control Track and Hold circuit board was replaced.
- The 31 Condensate Pump was replaced with a spare.
- A TEAR will be prepared and submitted for refresher Lovejoy training for I&C Technicians.

- The I&C MBFP Lovejoy speed control procedures (2-IC-PC-N-P-408B, 2-IC-PC-I-E-21MBFP, 3-IC-PC-I-E-31MBFP, 3-IC-PC-N-P-408B) will be revised to include more detail to functionally check all mission critical board functions. Additionally, the Track and Hold rate adjustment potentiometer setting will be documented with a range in the procedure.
- The site vendor manuals will be revised to provide sufficient details to adequately troubleshoot and understand the functionality of the Lovejoy speed control system.
- A Supplier Quality Performance Data Tracking (SQPDTP) will be issued for the Lovejoy miss-wiring of the Track and Hold circuit board.
- The Track and Hold circuit board for the 31 MBFP Lovejoy speed control system will be replaced with a new board with the miss-wiring corrected.
- The Track and Hold circuit board for the 32 MBFP Lovejoy speed control system will be replaced with a new board with the miss-wiring corrected.
- The CAT ID descriptions will be revised to require Lovejoy to test all functions and perform independent wiring verification for all mission critical Lovejoy circuit boards for Unit 2 and 3.

Event Analysis

The event is reportable under 10CFR50.73(a)(2)(iv)(A). The licensee shall report any event or condition that resulted in manual or automatic actuation of any of the systems listed under 10CFR50.73(a)(2)(iv)(B). Systems to which the requirements of 10CFR50.73(a)(2)(iv)(A) apply for this event include the Reactor Protection System (RPS) including RT and AFWS actuation. This event meets the reporting criteria because a manual RT was initiated at 14:27 hours, on July 8, 2015, and the AFWS actuated as a result of the RT. On July 8, 2015, a 4-hour non-emergency notification was made to the NRC at 15:37 hours, for an actuation of the reactor protection system {JC} while critical and included an 8-hour notification under 10CFR50.72(b)(3)(iv)(A) for a valid actuation of the AFW System (Event Log #51211). As all primary safety systems functioned properly there was no safety system functional failure reportable under 10CFR50.73(a)(2)(v). The Track and Hold circuit board is a non-safety related part and does not perform a safety function therefore not applicable to reporting under 10CFR21.

Past Similar Events

A review was performed of the past three years for Licensee Event Reports (LERs) reporting a RT as a result of main FW reduction. One LERs was identified that reported a RT due to a FW event, LER-2014-001 reported an automatic RT as a result of a steam flow/feedwater flow mismatch with low 33 SG water level due to the failure of the 33 SG FW flow controller. The decreasing SG level was due to reduced FW flow from closure of the 33 FW regulating clave as a result of the failure of its flow controller. This event was similar but concerned the failure of the FW regulating valve not the speed control system of the MBFP. Corrective actions for that event would not have prevented this event.

Safety Significance

This event had no effect on the health and safety of the public.
There were no actual safety consequences for the event because the event was an uncomplicated reactor trip with no other transients or accidents. Required primary safety systems performed as designed when the RT was initiated. The AFWS actuation was an expected reaction as a result of low SG water level due to SG void fraction (shrink), which occurs after a RT and main steam back pressure as a result of the rapid reduction of steam flow due to turbine control valve closure.

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There were no significant potential safety consequences of this event. The Reactor Protection System (RPS) is designed to actuate a RT for any anticipated combination of plant conditions to include low SG level. The reduction in SG level and RT is a condition for which the plant is analyzed. A low water level in the SGs initiates actuation of the AFWS. Redundant safety SG level instrumentation was available for a low SG level actuation which automatically initiates a RT and AFWS start providing an alternate source of FW. The AFW System has adequate redundancy to provide the minimum required flow assuming a single failure. The analysis of a loss of normal FW (UFSAR Section 14.1.9) shows that following a loss of normal FW, the AFWS is capable of removing the stored and residual heat plus reactor coolant pump waste heat thereby preventing either over pressurization of the RCS or loss of water from the reactor. In addition, Operators for this event anticipated a possible low SG level and initiated a manual RT. The manual actuating devices are independent of the automatic trip circuitry and are not subject to failures which make the automatic circuitry inoperable. There are two manual trip buttons in the control room. Either one of these buttons will directly energize the trip coils of the reactor trip and bypass breakers in addition to de-energizing the undervoltage coils of the reactor trip and bypass breakers. For this event, rod control was in manual and all rods inserted upon initiation of a RT. The AFWS actuated and provided required FW flow to the SGs. RCS pressure remained below the set point for pressurizer PORV or code safety valve operation and above the set point for automatic safety injection actuation. Following the RT, the plant was stabilized in hot standby.