Entergy

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John A. Ventosa
Site Vice President

NL-12-103

August 2, 2012

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Stop O-P1-17
Washington, D.C. 20555-0001

SUBJECT: Licensee Event Report # 2012-006-00, "Automatic Reactor Trip as a Result of a Turbine-Generator Trip Due to a Loss of Generator Field Excitation Caused by a Failed Exciter Trigger Generation Card"
Indian Point Unit No. 2
Docket No. 50-247
DPR-26

Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc. (ENO) hereby provides Licensee Event Report (LER) 2012-006-00. The attached LER identifies an event where the reactor was automatically 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-IP2-2012-03812.

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

Sincerely,

JAV/cbr

cc: Mr. William Dean, Regional Administrator, NRC Region I
NRC Resident Inspector's Office, Indian Point 2
Mrs. Bridget Frymire, New York State Public Service Commission
LEREvents@inpo.org

IE22

NRC FORM 366 (9-2007) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES: 10/31/2013

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME: INDIAN POINT 2

2. DOCKET NUMBER 05000-247

4. TITLE: Automatic Reactor Trip as a Result of a Turbine-Generator Trip Due to a Loss of Generator Field Excitation Caused by a Failed Exciter Trigger Generation Card

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
06	06	2012	2012-	006 -	00	08	02	2012	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)	☐ 20.2203(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)
☐ 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)
☐ 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

NAME Robin Daley, System Engineer

TELEPHONE NUMBER *(Include Area Code)* (914) 254-6817

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
X	TL	AMP	G080	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 June 6, 2012, an automatic reactor trip (RT) was initiated as a result of a main Turbine-Generator trip due to a trip of the Generator backup lockout relay 86 BU on loss of main generator field excitation. All control rods fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser. The Auxiliary Feedwater System automatically started as expected due to SG low level from shrink effect. Investigations determined the 86 BU relay actuation was triggered by relay 62BU1/AUX which serves as a time delay for the KLF-40 loss of field relay. The actuation of the loss of field relay was in response to a loss of generator excitation field from the Generrex voltage regulator system. The direct cause of the RT was loss of generator field excitation due to failure of the Generrex C-Phase Trigger Generation Card. The root cause was indeterminate but most likely due to premature failure of the U5 operational amplifier on the C-Phase Trigger Generation Card causing the U3 and U6 operational amplifiers to also degrade. Corrective actions included replacement of the C-Phase Trigger Generator and AC/DC Gate cards with new cards which were then calibrated and monitored for proper operation, and shipped failed card to a vendor for an equipment failure analysis. The event had no effect on public health and safety.

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

DESCRIPTION OF EVENT

On June 6, 2012, at approximately 06:12 hours, while at 100% steady state reactor power, an automatic reactor trip (RT) {JC} was initiated as a result of a Main Turbine {TA} Generator {TB} trip (TT) due to a trip of the Generator Backup Lockout Relay {86BU} on loss of main generator field excitation {TL}. All control rods {AA} fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. There was no radiation release. The Emergency Diesel Generators {EK} did not start as offsite power remained available. The Auxiliary Feedwater System {BA} automatically started as expected due to SG low level from shrink effect. The event was recorded in the Indian Point Energy Center corrective action program (CAP) as CR-IP2-2012-03812. A post trip evaluation was initiated and completed on June 6, 2012.

Investigations determined the 86BU relay actuation was triggered by relay 62BU1/AUX which serves as a time delay for the KLF-40 Loss of Field relay. The actuation of the loss of field relay was in response to a loss of generator excitation field from the Generrex voltage regulator system. The KLF-40 relay is connected to the Main Generator CTs and PTs to monitor generator output current and terminal voltage, respectively. To initiate a trip signal the following three conditions must exist: 1) The relay must sense lagging VAR flow into the generator, 2) As excitation drops, the relay must sense that the impedance of the generator has fallen below pre-set values, and 3) The relay must sense that an under voltage condition has occurred at the generator output. Inspections did not identify any locked-in alarms or abnormal conditions on the generator control system. Testing of relay KLF-40 and the generator CTs, PTs and associated wiring did not discover any non-conforming conditions. Monitoring traces showed that the generator did experience lagging VAR flow and the generator terminal voltage dropped due to a loss of field voltage. Subsequent inspection of the Generrex Exciter Cabinet identified that the AC/DC Gate Card was not fully seated in its slot. Troubleshooting checks determined the C-Phase Trigger Generator Card was not displaying the expected output but the A and B Phase Trigger Generator Cards were satisfactory. Failure analysis of the AC/DC Gate Card determined it was not the cause of the event.

Unit 2 has a General Electric Exciter-Generator coupled to a Westinghouse Turbine. The Generrex is a main generator exciter regulating device for producing the main generator field and is manufactured by General Electric Company {G080}. The Generrex system is a compound potential source exciter that utilizes three transformers {XFMR} housed above the main generator to obtain excitation power from additional stator bars (P-Bars) in the generator. AC power flows from the P-Bars into the transformers which, when the generator is excited, supply enough voltage to fulfill the maximum possible field voltage at all times of operation. The main generator excitation system (Generrex) consists of four parallel rectifier {RECT} bridges. The four (4) rectifier bridges provide sufficient capacity to carry full generator output under all steady state and fault conditions with one rectifier bridge out of service for maintenance. The Generrex rectifiers have forward and reversed biased diodes connected to the incoming 3-phase 480 volt AC power {EC}. The output of the rectifiers is a DC voltage that supplies the main generator exciter. Silicon Controlled Rectifiers (SCRs) are fired to regulate the output current of the rectifier by shunting the rectifier diodes. The Generrex voltage regulator utilizes a shunt SRC bridge housed in four cabinets and are intended for a N+1 redundancy at generator nameplate rating (three cabinets in service allowing the machine to operate a its full rating and leaves one cabinet available as a redundant cabinet in the event another cabinet is required to taken out of service for maintenance) Due to normally operating at a lower value than nameplate, only two cabinets are required to be in service to maintain normal generator output.

Because it is not always desired to have the generator creating maximum output, the Generrex voltage regulator utilizes the shunt SCR rectification bridge to shunt the generator field supply away from the generator field windings, which effectively diminishes the field strength to create a lower output to the generator rotor. When there is a loss of voltage to the exciter, the Minex circuit of the exciter de-excites the generator field, actuating the exciter protective loss of field relay {KLF-40} which initiates a trip of the 86BU relay. The trip of the 86BU actuates the turbine protection system solenoid valves 20/AST and 20/ASB to dump autostop oil initiating a TT which initiates a RT. The generator relay protection system is designed to trip the generator and associated feeder breakers for events such as faults and sudden loss of excitation to prevent damage to the main generator from excessive current flow and reverse power conditions.

An extent of condition investigation determined the potential does exist for the failure of other Generrex circuit cards which could cause a plant trip or loss of field event. Mitigation of general equipment failures within the Generrex system is achieved through an existing Preventive Maintenance (PM) program which includes 10 year card replacements and calibration every two years. The previous PM program was not robust and did not provide refurbishment for circuit cards, capacitors, or other components in the system. In 2008 a new PM program was implemented to remove cards from the Generrex control cabinets during refueling outages and have them refurbished. The PM program and calibration assists in detection of degraded conditions that would warrant earlier card replacements. The refurbishment of the Generrex control cards meets EPRI and industry recommendations. The Generrex cards currently installed were refurbished and replaced during the refueling outage in 2010. During the replacement maintenance in 2010 a card was damaged and replaced with a spare that was refurbished in 2008. That spare replacement card was the card that failed. Signals from both the automatic control (AC) and direct control (DC) portions of the Generrex converge at a circuit card called an AC/DC Gate Card. During startup the system is in direct control until initial excitation has ended. When the system is brought up to 22kV the regulator is transferred to AC control prior to synchronizing to the grid. The output of the AC/DC Gate Card passes to the Field Voltage Regulator Card then to all three Trigger Generator Cards. Had the output of the AC/DC Gate Card been the cause of the event then it would be expected that all three phases would be affected not just the C phase. However, as a precaution the AC/DC Gate card was replaced with a new card.

Cause of Event

The direct cause of the RT was actuation of the main generator backup lockout relay 86BU due to trip of time delay relay 62BU1/AUX as a result of the actuation of loss of field relay KLF-40. Actuation of relay KLF-40 was in response to loss of generator field excitation due to failure of the Generrex C-Phase Trigger Generation Card. The root cause was indeterminate but most likely due to premature failure of the U5 operational amplifier (op-amp) on the C-Phase Trigger Generation Card which also resulted in the U3 and U6 op-amp to degrade. The card failure caused the board to generate a false full-off signal to the Generrex control system C-Phase SCRs. This signal would cause all the C-Phase SCRs to stay off, allowing the voltage to approach maximum voltage conditions. To regulate field voltage in response to the maximum voltage, the Generrex system would turn the A and B Phases full-on in an attempt to suppress voltage. Gating the remaining two phases to full-on created a rapid loss of field voltage, triggering the KLF-40 relay in response to a loss of generator excitation field.

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

Corrective Actions

The following corrective actions have been or will be performed under Entergy's Corrective Action Program to address the cause and prevent recurrence:

- The C-Phase Trigger Generator and AC/DC Gate cards were replaced with new cards which were then calibrated and monitored for proper operation.
- Shipped failed C-Phase Trigger Generation Card to a vendor for an equipment failure analysis.

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 an automatic RT was initiated at 06:12 hours, on June 6, 2012, and the AFWS actuated as a result of the RT. On June 6, 2012, at 09:38 hours, a 4-hour non-emergency notification was made to the NRC 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 #47999). As all primary safety systems functioned properly therefore there was no safety system functional failure reportable under 10CFR50.73(a)(2)(v).

Past Similar Events

A review was performed of the past three years for Licensee Event Reports (LERs) reporting a RT from a Generrex Main Generator protective trip. The review identified LER-2010-001, and LER-2009-005. LER-2010-001 reported on March 10, 2010, a RT as a result of a turbine generator trip due to loss of generator field excitation caused by a failed exciter rectifier. The cause of the event was due to a loss of two diodes within the # 24 Generrex rectifier cabinet. The root cause was failure of management to implement critical decisions. When confronted with unexpected conditions the team should have stopped and evaluated the as-found data. The corrective actions for LER-2010-001 would not have prevented this event as the cause was different. LER-2009-005 reported a RT on November 2, 2009, due to a Generrex protective trip (86P Lockout Relay). The cause of the event was a poor Original Equipment Manufacturer (OEM) design of the common ground wiring connections on the Generrex power supply distribution block. The cause of the event reported in LER-2009-005 is different and the 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 expected 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.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Indian Point Unit 2	05000-247	2012	- 006 -	00	5 OF 5

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

There were no significant potential safety consequences of this event. The RPS is designed to actuate a RT for any anticipated combination of plant conditions including a direct RT on TT unless the reactor is below approximately 20% power (P-8). The analysis in UFSAR Section 14.1.8 concludes an immediate RT on TT is not required for reactor protection. A RT on TT is provided to anticipate probable plant transients and to avoid the resulting thermal transient. If the reactor is not tripped by a TT, the over temperature delta temperature (OTDT) or over pressure delta temperature (OPDT) trip would prevent safety limits from being exceeded.

The generator is protected by the generator protection system (GPS) which is designed to protect the generator from internal and external faults by tripping the output breakers. During this event the GPS functioned as designed and initiated a TT. This event was bounded by the analyzed event described in UFSAR Section 14.1.8 (Loss of External Electrical Load). The response of the plant is evaluated for a complete loss of steam load from full power without a direct RT and includes the acceptability of a loss of steam load without direct RT on turbine trip below 35 percent power. The analysis shows that the plant design is such that there would be no challenge to the integrity of the reactor coolant system or main steam system and no core safety limit would be violated. The RT and the reduction in SG level is also a condition for which the plant is analyzed. A low water level in the SGs initiates actuation of the AFWS. 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. For this event, rod control was in automatic 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 and code safety valve operation and above the set point for automatic safety injection actuation. Following the RT, the plant was stabilized in hot standby.