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W3F1-2010-0044

June 02, 2010

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

Subject: Licensee Event Report 2008-004-01, Loose Intercell Connecting Bolts
on 125 vdc Station Battery (Revised)
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

Dear Sir or Madam:

Entergy is hereby submitting revised Licensee Event Report (LER) 2008-004-01 for Waterford Steam Electric Station Unit 3. This report provides details associated with the discovery of loose bolts on an intercell connection on 125 vdc Station Battery 3B-S, which resulted in low battery cell voltage. The condition is being reported herein pursuant to 10CFR50.73(a)(2)(i)(B), 10CFR50.73(a)(2)(ii)(B), and 10CFR50.73(a)(2)(v)(D).

This report contains no new commitments. Please contact William J. Steelman at (504) 739-6685 if you have questions regarding this information.

Sincerely,

A handwritten signature in dark ink, appearing to read "William Steelman", with a stylized flourish at the end.

WJS/JDW/ssf

Attachment: Licensee Event Report 2008-004-01

cc: Mr. Elmo E. Collins, Jr.
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Attachment

W3F1-2010-0044

Licensee Event Report 2008-004-01

NRC FORM 366 U.S. NUCLEAR REGULATORY COMMISSION (9-2007)				APPROVED BY OMB NO. 3150-0104				EXPIRES 8/31/2010																																							
LICENSEE EVENT REPORT (LER)																																															
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1. FACILITY NAME Waterford 3 Steam Electric Station, Unit 3						2. DOCKET NUMBER 05000382			3. PAGE 1 OF 7																																						
4. TITLE Loose Intercell Connecting Bolts on 125 vdc Station Battery (Revised)																																															
5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED																																						
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FACILITY NAME Waterford 3 Steam Electric Station, William J Steelman								TELEPHONE NUMBER (Include Area Code) (504) 739-6685																																							
13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT																																															
CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX																																											
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ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)								<div style="font-size: small;"> On 9/3/2008, at 0105 hours, with the plant in MODE 4 (associated with Hurricane Gustav), Operations declared 125 vdc Station Battery 3B-S INOPERABLE due to low voltage and entered Technical Specification (TS) 3.8.2.1. Loose bolts were discovered on an intercell connector connecting two of the 60 battery cells (57-58). The bolts were immediately tightened, and satisfactory intercell resistance readings were verified. The battery was declared OPERABLE on 9/3/2008 at 0430 hours. The point in time that an unacceptable intercell resistance formed at the loose connection was not determined when originally reported on 11/3/2008 by the voluntary LER 2008-004-00, as it was not observable by previously weekly battery surveillances. The Root Cause Analysis (RCA) was revised after this condition was reported. The RCA concluded the most likely cause of the loose connection was that the bolts were left loose during the replacement of the battery cell #56 on 5/24/2008, without tracking the configuration of this loosened connection. The clamping force from adjacent bolts was sufficient to pass the battery load test on 5/26/2008 and to declare the battery OPERABLE even though the loose connection was later reported on 1/6/2009 to have had a resistance of approximately 200 micro-ohms, as estimated by a vendor analysis of the 5/26/2008 test data. The TS 3.8.2.1 intercell resistance limit of 150 micro-ohms was exceeded for longer than allowed. The revised RCA determined that the most likely time that the connection was further degraded to the extent that the Station Battery 3B-S was no longer reasonably capable of performing its safety function occurred on 8/25/2008, when disturbed by the weekly voltage check measurement. </div>																																							

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NARRATIVE

REPORTABLE OCCURRENCE

On 9/3/2008, at approximately 0105, 125 vdc system [EJ] Station Battery [BTRY] 3B-S was declared INOPERABLE due to low voltage, and Technical Specification (TS) 3.8.2.1 was entered. Technical Specification 3.8.2.1 is applicable in MODES 1, 2, 3, and 4. The plant was in MODE 4 at the time of discovery. Technical Specification ACTION 'a.' states that, "With one of the required battery banks inoperable, restore the inoperable battery bank to OPERABLE status within 2 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours." The condition was corrected in 3 hours and 25 minutes from the time of declaring the battery INOPERABLE by adequately torquing the loose battery intercell (57-58) connection [CON] bolts. The point in time that an unacceptable intercell resistance formed at the loose bolt connection was not determined at the time originally reported on 11/3/2008 by the voluntary LER 2008-004-00, as it was not observable by normal weekly battery surveillances which had previously provided satisfactory results. The Root Cause Analysis (RCA) was revised after this condition was reported. The RCA concluded the most likely cause of the loose connection was that the bolts were left loose and not retightened during replacement of a nearby battery cell (56) during Refuel 15 (May 2008). The clamping force, on the link bars, from the bolts at the adjacent battery cell post was sufficient to pass the battery load test on 5/26/2008 and to declare Station Battery 3B-S OPERABLE even though the loose connection was later reported on 1/6/2009 to have had a resistance of approximately 200 micro-ohms, as estimated by a vendor analysis of the 5/26/2008 test data. The TS 3.8.2.1 intercell resistance limit of 150 micro-ohms was exceeded for longer than allowed. The revised RCA determined that the most likely time that the connection was further degraded to the extent that the Station Battery 3B-S was no longer reasonably capable of performing its safety function occurred on 8/25/2008, when unintentionally disturbed by the weekly voltage check measurement.

On 4/7/2010, during a self-assessment of the loose battery intercell connection RCA (CR-WF3-2008-4179), Waterford 3 Licensing staff discovered that the LER (2008-004-00) associated with this battery loose connection did not reflect the associated reportable conditions reflected in the revised RCA. On 1/6/2009, a condition report (CR-WF3-2009-0069) was initiated that included information that quantified the loose connection resistance as approximately 200 micro-ohms, as estimated by a vendor analysis of the 5/26/2008 test data. However, this historical information was not recognized to meet 10 CFR 50.73 LER reporting criteria by the licensing staff through comparison to the TS 3.8.2.1 intercell resistance limitation of 150 micro-ohms. The previous version of this LER reported time the condition was assumed to have occurred, based on not having objective evidence at the time, was at the time of discovery, on 9/2/2008.

The revised RCA and associated risk assessment evaluations indicated reasonable doubt that the Station Battery 3B-S (train B) would have been capable of performing its safety function from 8/25/2008, when the loose connection was unintentionally disturbed by the weekly voltage check measurement, until the connection was torqued on 9/3/2010. While preparing this revised report, the licensing staff further identified that during this 8.5 day period of time that the train B Station Battery intercell connection resistance is believed to have been significantly more than the initial 200 micro-ohms, there were periods of time that a redundant train (A) safety system was removed from service.

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NARRATIVE**REPORTABLE OCCURRENCE (continued)**

This condition is reportable under 10CFR 50.73(a)(2)(i)(B), as a condition prohibited by Technical Specification. The loose connection was reported on 1/6/2009 to have had a resistance of approximately 200 micro-ohms, as estimated by a vendor analysis of the 5/26/2008 test data. The TS 3.8.2.1 intercell resistance limit of 150 micro-ohms was exceeded for approximately 102 days, which is longer than allowed by TS 3.8.2.1 while the plant was in the modes 1, 2, 3, and 4 during that time.

The condition is reportable under 10CFR 50.73(a)(2)(v)(D), a condition that alone could have prevented the fulfillment of a safety function needed to mitigate the consequences of an accident. The revised RCA and associated risk assessment evaluations indicated reasonable doubt that the Station Battery 3B-S (train B) would have been capable of performing its safety function from 8/25/2008, when the loose connection is believed to have been unintentionally disturbed by the weekly voltage check measurement, until the connection was torqued on 9/3/2010. During this 8.5 day period of time that the train B Station Battery intercell connection resistance is believed to have been significantly more than the initial 200 micro-ohms, there were periods of time that the redundant train (A) of safety systems were removed from service.

On a loss of off-site power condition, the initial battery load currents are such that a higher battery (source) connection resistance would have a magnified battery (source) voltage reduction (voltage drop = current X resistance). When the intercell connection significantly degraded (after 5/26/2008 and probably 8/25/2008), with a much higher connection resistance, the 125 vdc source voltage could drop low enough to prevent the functioning of safety systems that rely on the train B Station Battery to for the safety system to function and to start the associated train B Emergency Diesel Generator [DG] to power the emergency onsite power system [EK].

Between 21:52 and 22:40 on 8/25/2008, the A High Pressure Safety Injection system [BQ] train (A) was removed from service and unavailable, and again between 00:11 and 03:40 on 8/27/2008. Between 10:11 and 13:45 on 8/26/2008, the train A Containment Vacuum Relief system [BF] was unavailable due to planned maintenance. Between 02:31 on 8/27/2008 and 10:28 on 8/28/2008, the train A Control Room cooling system [VI] was removed from service for planned maintenance.

With the B train Station Battery potentially unable to perform its safety function during this 8.5 day period, there was reasonable doubt that these mitigating systems would have been capable of fulfilling their safety functions in the potential event of an accident.

As reported in LER 2010-003-00 on 5/6/2010, the train A Emergency Diesel Generator was determined to have been INOPERABLE from approximately 8/31/2005 until the time identified and repaired on 2/8/2010. This includes the 8.5 day period of the significantly degraded train B Station Battery intercell connections. Due to rubbing of a fuel oil tube, the train A Emergency Diesel Generator was determined to be capable of meeting only approximately 14 days of its required 30 day mission time. During the estimated 14 day period, it is reasonable that the train B Station Battery loose connection would have been identified and corrected.

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NARRATIVE**REPORTABLE OCCURRENCE (continued)**

This condition is reportable under 10CFR 50.73(a)(2)(ii)(B), a condition that resulted in the nuclear power plant being in an unanalyzed condition that significantly degraded plant safety. As stated above, during the 8.5 day period of time, between 8/25/2008 and 9/3/2008, during which the train B Station Battery intercell connection resistance is believed to have been significantly more than the initial 200 micro-ohms, there were periods of time that a redundant train (A) safety system was removed from service for maintenance and associated system alignment changes. The inability to perform a required safety function generally corresponds to a condition that significantly degrades plant safety.

INITIAL CONDITIONS

At the time of discovery, the plant was in Mode 4 during the Hurricane Gustav forced outage. There were no other structures, systems, or components INOPERABLE at the time of discovery that contributed to the condition.

EVENT DESCRIPTION

On 9/2/2008 at approximately 2200 hours, during a weekly surveillance of Station Battery [BTRY] 3B-S, voltages for both pilot cells (30 and 57) were found to be below acceptance criteria values prescribed in the surveillance procedure (ME-003-200). Pilot cell 30 was found to be at 2.067 vdc. Pilot cell 57 was found to be at 2.063 vdc. A check of 10 additional cells yielded the same approximate results. Trouble shooting activities identified a loose connection at cell 57 negative posts intercell connector, which connects to cell 58 positive posts. At approximately 0105 hours, Operations declared Station Battery 3B-S INOPERABLE due to low voltage (less than 2.07 Volts), and Technical Specification 3.8.2.1 was entered.

Immediate action was taken to tighten the bolts. One of the two loose bolts on the battery cell negative post was 6.5 flats loose. The other loose bolt was 16 flats loose, less than finger tight. The bolt heads have six flats. At 0430 hours, Operations declared Station Battery 3B-S OPERABLE and exited Technical Specification 3.8.2.1.

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NARRATIVE**CAUSAL FACTORS**

The root cause analysis identified the cause of the condition as a failure to maintain plant equipment status control due to a lack of specific work instructions and a lack of work order documentation of intercell connectors that were loosened or removed. Record searches and personnel interviews did not provide objective evidence as to the cause for the loose connection. Most probably, the bolts were left loose during Refuel 15 (May 2008) when cell 56 in Station Battery 3B-S was replaced. Cell 56 was replaced during Refuel 15 after it was determined that the cell would not maintain an adequate charge. For reference information, all of the sixty cells of Station Battery 3B-S had earlier been replaced during the same refueling outage (Refuel 15). When cell 56 was replaced, work instructions with sufficient specificity were not included in the work package necessary to document the removal and reinstallation of each intercell connector for cells 54, 55, 56 and 57.

CORRECTIVE ACTIONS

- Station Battery 3B-S negative post bolts on cell 57 were appropriately torqued.
- Torque and intercell resistance checks were made for all Station Battery 3B-S intercell and inter-tier connections. No other loose connections on Station Battery 3B-S were identified.
- Additional checks were performed on the battery which included individual cell voltage and specific gravity checks of each installed cell. No abnormalities were noted.
- Precautionary checks of Station Battery 3A-S and 3AB-S torque and intercell resistance were completed. No similar abnormalities were noted on either battery.
- A level 1 human performance error review was performed with appropriate personnel.
- Other actions were evaluated and conducted as appropriate in accordance with the Corrective Action Program (CR-WF3-2008-04179).
- Clarifying guidance has been implemented for stopping work when conditions are outside of the established procedure/process, how to recognize a change in scope, requiring a work order to be returned to Planning with a change in scope, and complete documentation of activities in the work package.
- Battery intercell connections links have been established to require tracking as a function of maintaining plant configuration and status control, requiring tracking and verification for lifting and restoring, and has been incorporated into the battery cell replacement and intercell connection maintenance procedures. Maintenance Guide MG-39 (Verification of DC Connectivity) has been put in place to also require tracking of each battery cell connection that is loosened, removed, or otherwise disturbed to ensure each connection is retorqued to the required value and verified to have acceptably low resistance.

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NARRATIVE**SAFETY SIGNIFICANCE**

The safety function for Station Battery 3B-S is, in conjunction with the 'B' battery chargers, to provide reliable continuous DC power to the 'B' train of reactor control (SUPS-3B), plant protection system (SUPS-MB and SUPS-MD), and DC powered safe shutdown equipment, including power to start the 'B' train Emergency Diesel Generator. Should AC power be lost, Station Battery 3B-S provides the source of power for safety related DC loads and uninterruptible power supplies until AC power is restored. Peak load on the battery is 692 amps, and the peak load occurs as the Emergency Diesel Generator 'B' is started within the first few seconds of a loss of AC power.

The 'B' train safety related battery is located in a separate room in the Reactor Auxiliary Building which is a Seismic Category I structure which provides protection from potential missile hazards. Station Battery 3B-S and associated DC loads are physically and electrically separated from Station Battery 3A-S (two redundant trains) such that the loss of either train will not prevent the minimum safety function from being performed. Since only Station Battery 3B-S was replaced in RF15 and based on finding no other loose intercell connections with Station Battery 3A-S and Station Battery 3AB-S, there is no common cause failure.

Technical Specification 3.8.2.1 requires 125-volt Station Battery 3B-S and one associated full capacity charger (3B1-S or 3B2-S) to be Operable in Modes 1-4. The battery passed its Service Discharge Test on May 26, 2008 and demonstrated its capability to meet its safety function to supply required loads for at least 4 hours.

At the time of discovery on September 2, 2008, 'A' train offsite power and all mitigating systems were available. 'B' Train offsite power had been declared inoperable on September 1, 2008 due to high bus voltages. However, the bus was available to provide offsite power. Additionally, a temporary Emergency Diesel Generator capable of supplying the Train 'B' safety loads was onsite and staged. The loose connection was tightened, and the battery was restored to operable status within 6 hours from time of discovery.

The battery passed its Service Discharge Test on 5/26/08 and demonstrated its capability to meet its safety function to supply required loads for at least 4 hours. At the low resistance values calculated for the Service Discharge Test, the loose inter-cell connection would not have a substantial voltage drop and the battery would continue to support an Emergency Diesel Generator B start including during a loss of AC power; however, it may not have been able to perform this same function during a seismic event. The as-found condition was indicative of a high resistance connection that could limit the battery current capability, to the extent that the Emergency Diesel Generator B could not be reasonably expected to start during a loss of AC power until additional recovery actions were performed. Evaluations determined that the recovery actions were feasible and that the resistance change at the loose connections was a discrete change occurring on or about 8/25/08, thus resulting in minimal safety significance.

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NARRATIVE**SAFETY SIGNIFICANCE (continued)**

Probabilistic safety evaluation results, based on a 52 day exposure period ($t/2$), indicated the significance of this condition corresponds to the white range of risk significance using the NRC's Significance Determination Process (SDP). Using a conservative sensitivity case which assumes that the passage of Hurricane Gustav increased the risk of loss of offsite power by a factor 10, gave an upper bound core damage probability increase of $9.12E-06$, based on the average maintenance availability associated with redundant train safety systems.

There is no Industrial or Radiological Safety Significance associated with the event discussed in this LER. The condition did not significantly compromise public health and safety.

SIMILAR EVENTS

A record search was performed for other similar reported events at Waterford 3. No similar events were reported over the last 3 years.

ADDITIONAL INFORMATION

Energy Industry Identification System (EIIS) codes are identified in the text within brackets [].