UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
612 EAST LAMAR BLVD, SUITE 400
ARLINGTON, TEXAS 76011-4125

November 6, 2009

EA-09-018

Joseph Kowalewski, Vice President, Operations
Entergy Operations, Inc.
Waterford Steam Electric Station, Unit 3
17265 River Road
Killona, LA 70057-3093

SUBJECT: WATERFORD STEAM ELECTRIC STATION, UNIT 3 NRC INSPECTION REPORT 05000382/2009008 PRELIMINARY WHITE FINDING

Dear Mr. Kowalewski:

On September 24, 2009, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Waterford Steam Electric Station, Unit 3. The enclosed inspection report documents the inspection finding, which was discussed on September 24, with you and other members of your staff. The report documents baseline inspection activities related to the Train B 125 Vdc battery surveillance failure on September 2, 2008. The inspection examined activities conducted under your license as they related to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

The enclosed inspection report discusses a finding that appears to have low to moderate safety significance (White). As described in Section 1R15 of the report, the Train B 125 Vdc battery was rendered inoperable because electricians failed to properly assemble and test a battery intercell connection following corrective maintenance in May, 2008. This finding was assessed based on the best available information, using the applicable Significance Determination Process (SDP). The preliminary significance was based on the battery being incapable of performing its safety function for between 50 and 100 days, depending on the failure mode assumptions. The primary assumptions associated with the preliminary SDP are documented in Attachment 2 to this report. The finding is also an apparent violation of NRC requirements and is being considered for escalated enforcement action in accordance with the NRC Enforcement Policy, which can be found on the NRC's Web site at http://www.nrc.gov/reading-rm/doc-collections/enforcement.

Before we make a final decision on this matter, we are providing you with an opportunity to (1) attend a Regulatory Conference where you can present to the NRC your perspective on the facts and assumptions the NRC used to arrive at the finding and assess its significance, or (2) submit your position on the finding to the NRC in writing. If you request a Regulatory Conference, it should be held within 30 days of the receipt of this letter and we encourage you to submit supporting documentation at least one week prior to the conference in an effort to make the conference more efficient and effective. If a Regulatory Conference is held, it will be open for public observation. If you decide to submit only a written response, such submittal should be sent to the NRC within 30 days of your receipt of this letter. If you decline to request a Regulatory Conference or submit a written response, you relinquish your right to appeal the final SDP determination, in that by not doing either, you fail to meet the appeal requirements stated in the Prerequisite and Limitation sections of Attachment 2 of IMC 0609.

Please contact Jeff Clark by phone at (817) 860-8147 and in writing within 10 days from the issue date of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision. The final resolution of this matter will be conveyed in separate correspondence.

Because the NRC has not made a final determination in this matter, no Notice of Violation is being issued for these inspection findings at this time. In addition, please be advised that the number and characterization of the apparent violation(s) described in the enclosed inspection report may change as a result of further NRC review.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html

Sincerely,

/RA/

Dwight D. Chamberlain, Director
Division of Reactor Projects

Docket: 50-382
License: NPF-38

Enclosures:
NRC Inspection Report 05000382/2009008
w/Attachments:
1. Supplemental Information
2. Significance Determination

cc w/Enclosure:
Senior Vice President
Entergy Nuclear Operations
P. O. Box 31995
Jackson, MS 39286-1995

Senior Vice President and
Chief Operating Officer
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Vice President, Operations Support
Entergy Services, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Senior Manager, Nuclear Safety
and Licensing
Entergy Services, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Site Vice President
Waterford Steam Electric Station, Unit 3
Entergy Operations, Inc.
17265 River Road
Killona, LA 70057-0751

Director
Nuclear Safety Assurance
Entergy Operations, Inc.
17265 River Road
Killona, LA 70057-0751

General Manager, Plant Operations
Waterford 3 SES
Entergy Operations, Inc.
17265 River Road
Killona, LA 70057-0751

Manager, Licensing
Entergy Operations, Inc.
17265 River Road
Killona, LA 70057-3093

Chairman
Louisiana Public Service Commission
P. O. Box 91154
Baton Rouge, LA 70821-9154

Parish President Council
St. Charles Parish
P. O. Box 302
Hahnville, LA 70057

Director, Nuclear Safety & Licensing
Entergy, Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

Louisiana Department of Environmental
Quality, Radiological Emergency Planning
and Response Division
P. O. Box 4312
Baton Rouge, LA 70821-4312

Chief, Technological Hazards
Branch
FEMA Region VI
800 North Loop 288
Federal Regional Center
Denton, TX 76209

Electronic distribution by RIV:
Regional Administrator (Elmo.Collins@nrc.gov)
Deputy Regional Administrator (Chuck.Casto@nrc.gov)
DRP Director (Dwight.Chamberlain@nrc.gov)
DRP Deputy Director (Anton.Vegel@nrc.gov)
DRS Director (Roy.Caniano@nrc.gov)
DRS Deputy Director (Troy.Pruett@nrc.gov)
Senior Resident Inspector (Mark.Haire@nrc.gov)
Resident Inspector (Dean.Overland@nrc.gov)
Branch Chief, DRP/E (Jeff.Clark@nrc.gov)
Senior Project Engineer, DRP/E (Ray.Azua@nrc.gov)
WAT Site Secretary (Linda.Dufrene@nrc.gov)
Public Affairs Officer (Victor.Dricks@nrc.gov)
Branch Chief, DRS/TSB (Michael.Hay@nrc.gov)
RITS Coordinator (Marisa.Herrera@nrc.gov)
Regional Counsel (Karla.Fuller@nrc.gov)
Congressional Affairs Officer (Jenny.Weil@nrc.gov)
ACES (Rick.Deese@nrc.gov)
OE (Cynthia.Carpenter@nrc.gov)
RIDSOeMailCenter
OEMail Resource
ROPreports
DRS STA (Dale.Powers@nrc.gov)
OEDO RIV Coordinator (Leigh.Trocine@nrc.gov)

File located: R_REACTORS_WAT\2009\WAT 2009-008.doc ADAMS ML093100257

SUNSI Rev Compl.	☒Yes ☐ No	ADAMS	☒Yes ☐ No	Reviewer Initials	RA
Publicly Avail	☒Yes ☐ No	Sensitive	☐ Yes ☒ No	Sens. Type Initials	RA

Acting SRI:DRP/E	RI:DRP/E	SPE:DRP/E	C:DRP/E	SRA:DRS
M. Haire	D. Overland	R. Azua	J. Clark	M. Runyan
/RA – E//	***/RA – E/***	***/RA/***	***/RA RAzua for/***	***/RA Caniano/***
11/05/09	11/05/09	11/05/09	11/05/09	11/05/09
ES/ACES	C:OE	D:NRR/ADES	D:DRS	D:DRP
RDeese	GBowman	MCunningham	RCaniano	DChamberlain
/RA –E/	***/RA –E/***	***/RA –E/***	***/RA/***	***/RA/***
11/05/09	11/02/09	11/02/09	11/05/2009	11/06/2009

OFFICIAL RECORD COPY T=Telephone E=E-mail F=Fax

U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Docket:	50-352
License:	NPF-38
Report:	05000285/2007011
Licensee:	Entergy Operations, Inc
Facility:	Waterford Steam Electric Station, Unit 3
Location:	17265 River Road Killona, LA 70057-3093
Dates:	December 15, 2008 through September 24, 2009
Inspector:	D. Overland, Resident Inspector
Reactor Analyst:	M. Runyan, Senior Reactor Analyst
Branch Chief	Jeff Clark, Chief, Project Branch E Division of Reactor Projects
Approved By:	Dwight Chamberlain, Director Division of Rector Projects

SUMMARY OF FINDINGS

IR 05000382/2009008; 12/15/08 – 09/24/09; Waterford Steam Electric Station, Unit 3; Operability Evaluation.

The report covered a 40 week period of inspection by a resident inspector. One preliminary White violation was identified. The significance of most findings is indicated by their color (Green, White, Yellow, or Red) using Inspection Manual Chapter 0609, "Significance Determination Process." Findings for which the significance determination process does not apply may be Green or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. NRC-Identified Findings and Self-Revealing Findings

Cornerstone: Mitigating Systems

- TBD. Following a September 2, 2008 train B 125 Vdc battery failure, the licensee identified an apparent violation of Technical Specification 6.8.1.a for the failure to follow plant procedures during corrective maintenance on the safety-related battery. Following the replacement of the entire battery bank during a 2008 refueling outage, craftsmen identified a faulty battery cell. When replacing the faulty cell, plant workers did not follow all of the specified procedural steps in the work package. The additional work resulted in a loose battery connection that rendered the entire battery bank inoperable. The licensee also failed to address an indicator of the loose connection during the battery discharge test. The condition then went undetected for several months. The licensee entered this finding in their corrective action program as Condition Report CR-WF3-2008-4179.

  This finding was greater than minor because it was similar to non-minor example 4.a in NRC Inspection Manual Chapter 0612, Appendix E, "Examples of Minor Issues," in that the failure to follow site procedures adversely affected safety related equipment. Using the Inspection Manual Chapter 0609, "Significance Determination Process," Phase 1 screening worksheet, the finding required a "Phase 2" significance determination because it resulted in the loss of a single train of safety related equipment for greater than the technical specification allowed outage time. Using a "T/2" exposure time of 50 days, the inspectors used the "Risk-Informed Inspection Notebook for Waterford Nuclear Power Plant Unit 3," Revision 2.01 and its associated "Phase 2 Pre-Solved Table," and determined that a "Phase 3" significance determination was necessary. A Region IV senior reactor analyst performed a preliminary "Phase 3" significance determination and found that the finding was White. This preliminary "Phase 3" significance determination is included as Attachment 2 to this report. This finding had a cross cutting aspect in area of Human Performance (work practices component) because maintenance personnel failed to use appropriate human error prevention techniques, such as peer checking (quality control hold points) and tracking battery components that were loosened (H.4.a). (Section 1R15).

REPORT DETAILS

1. REACTOR SAFETY

Cornerstones: Initiating Events, Mitigating Systems, and Barrier Integrity

1R15 Operability Evaluations (71111.15)

a. Inspection Scope

The inspectors reviewed the operability evaluation for the safety-related Train B 125 Vdc station battery. The inspectors selected this potential operability issue based on the risk-significance of the associated component. The inspectors compared the operability and design criteria in the appropriate sections of the Technical Specifications and Updated Safety Analysis Report to the licensee's evaluations, to determine whether the components or systems were operable and to ensure the licensee is operating and maintaining the battery in accordance with specified requirements. The inspectors developed a full chronology (time-line) that included significant event elements of the September 2, 2008 Train B battery failure. This included a review of work orders and actions associated with the May 2008 battery replacement. The inspectors determined that sufficient information was communicated to operators and station management to make informed decisions regarding the operability of the battery. The inspectors reviewed the licensee's DC load and battery design calculations to determine if proper consideration was given to the effect of the loose battery connection and how it affected the battery operability. Specific documents reviewed during this inspection are listed in the attachment.

This activity constitutes completion of one (1) operability evaluations inspection sample as defined in Inspection Procedure 71111.15-05

b. Findings

Introduction. Following a September 2, 2008 Train B 125 Vdc battery failure, the licensee identified a preliminary white violation of Technical Specification 6.8.1.a for the failure to follow plant procedures during corrective maintenance on the safety-related battery. Following the replacement of the entire battery bank during a 2008 refueling outage, the licensee identified a faulty battery cell. When replacing the faulty cell, plant workers did not follow all of the specified procedural steps in the work package. The additional work resulted in a loose battery connection that rendered the entire battery bank inoperable. The licensee also failed to address an indicator of the loose connection during the battery discharge test. The condition then went undetected for several months.

Description. In May 2008, during refuel outage 15, the Train B 125, Vdc battery was replaced under Work Order 152819. The battery bank was composed of 60 individual cells that were connected in series via bolted bus bars. Each individual cell had four posts, two positive and two negative. The two negative posts of one cell were connected to the two positive posts of the next cell via an intercell connector. Each intercell connector consists of four bus bars and four bolts (one bolt for each post connection). Electricians were required to torque the bolts on each battery post to 160 inch-pounds.

On May 24, 2008, as part of the postmaintenance testing for the battery bank replacement, intercell connection resistance checks were performed on all of the battery connections in accordance with Procedure ME-004-213, “Battery Intercell Connections,” Revision 12. The intercell resistance checks involved resistance measurements across the bolted connections. Technical Specification Surveillance Requirement 4.8.2.1.c.3 delineated a maximum acceptable intercell resistance of 150 micro-Ohms (a very small resistance value). The inspectors noted that because battery discharge currents can be very high (more than 700 Amperes), even relatively low values of intercell resistance can have adverse consequences. The large current across a high resistance connection dissipates a relatively large amount of energy at the connection point.

During additional postmaintenance testing on May 24, electricians determined that cell 56 would not charge. Electrical maintenance and engineering personnel decided to replace cell 56 with a spare battery cell. Work Order 152819 did not contain specific work instructions to replace cell 56 but the licensee believed that the replacement of cell 56 could be accomplished under the general guidance in the existing work package. While station procedures recommended that the package be returned to the planning department for the inclusion of specific maintenance steps and postmaintenance testing, this was not required for minor scope changes. Procedure EN-WM-105, “Planning,” Revision 3 stated, in part:

> When the scope of work changes from that originally planned, determine if new instruction or postmaintenance testing are necessary and if the work document classification is still adequate. Scope changes should [emphasis added] be subject to the same level of reviews as the original planning of the task.

Since the original work package was utilized to replace cell 56, the scope change was not subject to the same level of reviews as the original planning of the task.

After cell 56 was replaced, the licensee tightened the connections and performed intercell resistance checks on the battery posts that they believed were disturbed by the maintenance. However, one additional battery post (between cells 57 and 58) was loosened but not retightened.

The licensee identified that critical steps of Work Order 152819 were not completed. In summary, the plant personnel did not: (1)torque all of the affected intercell connections to 160 in-pounds; (2) obtain the required quality control inspector verification that all affected connections were torqued appropriately; (3) ensure that all of the necessary intercell resistance checks were performed; and (4) obtain a quality control verification that the intercell resistance checks met technical specification limits.

On May 27, the licensee conducted Procedure ME-003-230, “Battery Service Test,” Revision 301. During the test, the battery was discharged at a rate of over 700 Amperes. Since the battery passed the test, the licensee concluded that the defective connection was made up reasonably well at the time. It was possible to pass this particular test with a battery intercell resistance that exceeded the technical specification limit of 150 micro-Ohms. The battery appeared capable of performing its safety function during this test, however, it may not have been able to perform this same function during a seismic event.

The licensee also noted that plant personnel had failed to follow the corrective action program in response to an unexpected test result. Specifically, plant workers noted an indicator of a loose connection during the ME-003-230 service test. During the test, voltage across cell 57 dipped to an unusually low level (about 1.76 Vdc, while all the other cells maintained voltage above 1.84 Vdc). The test apparatus alarmed on this condition. Plant personnel failed to follow Procedure EN-LI-102, "Corrective Action Program," Revision 12. Attachment 9.2 required that a condition report be initiated for events or conditions that could negatively impact reliability or availability. It also required a condition report for conditions affecting a safety related system or component that rendered the quality of an item indeterminate.

During the next several months, the licensee performed routine checks of the battery in accordance with technical specifications. Those surveillances were limited to pilot cell checks, total battery voltage checks, and visual inspections. None of these checks were intended to identify a high resistance battery connection. The pilot cell check verified that the battery cell voltage (for the selected pilot cell) was greater than 2.13 Vdc. The total battery voltage check verified that the overall battery voltage was greater than 125 Vdc.

On September 2, 2008, both pilot cells for the train B 125 Vdc battery were found at less than 2.07 Vdc. Subsequent troubleshooting identified the loose connection between cells 57 and 58. While the connection appeared tight during a visual inspection, the licensee found the intercell resistance at more than 5 Ohms (more than 33,000 times the limit). Two bolts on the connection were loose. The bolts should have been torqued to 160 inch-pounds but one was found 1 full turn loose while the second was about three full turns loose.

The licensee postulated that the battery connections were in sufficient contact to pass the discharge test on May 27. However, because of the loose connection, at some point between May 27 and September 2, some slight movement occurred which increased the intercell resistance. At the time of discovery, September 2, 2008, the battery was inoperable.

Analysis. The failure to follow work order instructions was a performance deficiency. This finding was greater than minor because it was similar to non-minor example 4.a in NRC Inspection Manual Chapter 0612, Appendix E, "Examples of Minor Issues," in that the failure to follow site procedures adversely affected safety related equipment. Using the Inspection Manual Chapter 0609, "Significance Determination Process," Phase 1 screening worksheet, the finding required a "Phase 2" significance determination because it resulted in the loss of a single train of safety related equipment for greater than the technical specification allowed outage time. Using a "T/2" exposure time of 50 days, the inspectors used the "Risk-Informed Inspection Notebook for Waterford

Nuclear Power Plant Unit 3," Revision 2.01 and its associated "Phase 2 Pre-Solved Table," and determined that a "Phase 3" significance determination was necessary. A Region IV senior reactor analyst performed a preliminary "Phase 3" significance determination and found that the finding was potentially White. This preliminary "Phase 3" significance determination is included as Attachment 2 to this report. This finding had a cross cutting aspect in area of Human Performance (work practices component) because maintenance personnel failed to use appropriate human error prevention techniques, such as peer checking (quality control hold points) and tracking battery components that were loosened (H.4.a).

Enforcement. Technical Specification 6.8.1.a states that "written procedures shall be established, implemented, and maintained covering… a. The applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Revision 2, February 1978." Regulatory Guide 1.33, Appendix A, "Typical Procedures for Pressurized Water Reactors and Boiling Water Reactors," Section 9, "Procedures for Performing Maintenance," recommends procedures for maintenance that can affect the performance of safety-related equipment. Work Order 152819 was a procedure that could affect the performance of the safety-related Train B 125 Vdc battery. The work order stated, in part:

> The following work instructions can be worked out-of-sequence OR omitted at the discretion of the cognizant supervisor, as long as the work scope is fully met [emphasis added]…
>
> 4.12 Torque in accordance with Vendor Technical Manual RS-1476 intercell connections to 160 in-pounds (+10/-0).
>
> Inspector Note: Step 4.12 included a quality control hold point which required that an independent quality control inspector verify that the appropriate torque was applied to each connection.
>
> 4.13 Perform ME-004-213, "Station Battery 3A OR 3B OR 3AB Intercell Resistance (18-Month) Surveillance," Revision 301, Sections 9.3, 9.4 and 9.5 in conjunction with, Vendor Technical Manual RS-1476 for interior and interaisle connections [intercell resistance checks].
>
> Inspector Note: Step 4.13 also included a quality control hold point which required that an independent quality control inspector verify that the intercell resistance values for each connection were less than the technical specification limits.

Contrary to the above, on May 24, 2008, the licensee performed Work Order 152819 steps out of sequence, when battery cell 56 was replaced with a new cell, but failed to ensure that the work scope was fully met. Specifically, the electricians did not: (1) torque all of the affected intercell connections to 160 in-pounds (+10/-0); (2) obtain the required quality control inspector verification that all affected connections were torqued appropriately; (3) ensure that all of the necessary intercell resistance checks were performed; and (4) obtain a quality control verification that the intercell resistance checks met technical specification limits. The licensee entered this finding in their corrective action program as Condition Report CR-WF3-2008-4179. This is a preliminary White apparent violation pending completion of a final significance determination. White 05000382/2009008-01: Inoperable 125 Vdc battery because electricians failed to follow work instructions (EA-09-018).

4OA6 Meetings

Exit Meeting Summary

On September 24, the inspector presented the preliminary results of the inspection to Mr. J. Kowalewski, Vice President, Operation, and other members of the licensee staff who acknowledged the findings. The inspector verified that no proprietary information was retained.

ATTACHMENTS:
1. SUPPLEMENTAL INFORMATION
2. PHASE 3 SIGNIFICANCE DETERMINATION

SUPPLEMENTAL INFORMATION
KEY POINTS OF CONTACT

Licensee Personnel
M. Adams, Supervisor, System Engineering
S. Anders, Manager, Plant Security
B. Briner, Technical Specialist IV, Componet Engineering
K. Christian, Director, Nuclear Safety Assurance
K. Cook, Manager, Operations
C. Fugate, Assistant Manager, Operations
D. Gallodoro, Senior Engineer, Design Engineering
J. Kowalewski, Site Vice President, Operations
B. Lanka, Manager, Design Engineering
J. Lewis, Manager, Emergency Preparedness
B. Lindsey, Manager, Maintenance
M. Mason, Senior Licensing Specialist, Licensing
W. McDonald, Senior Engineer, System Engineering
W. McKinney, Manager, Corrective Action and Assessments
R. Murillo, Manager, Licensing
K. Nicholas, Director, Engineering
O. Pipkins, Senior Licensing Specialist, Licensing
R. Putnam, Manager, Programs and Components
G. Scot, Engineer, Licensing
R. Williams, Senior Licensing Specialist, Licensing

LIST OF ITEMS OPENED

Opened

05000382/2009008-01	AV	Inoperable 125 Vdc battery because electricians failed to follow work instructions

LIST OF DOCUMENTS REVIEWED

Section 1R15: Operability Evaluations

CONDITION REPORTS

CR-WF3-2008-4179	CR-WF3-2008-5852	CR-WF3-2009-0729	CR-WF3-2008-4636
CR-WF3-2008-4151	CR-WF3-2008-2515	CR-WF3-2009-0894	CR-WF3-2009-0780
CR-WF3-2008-2431			

WORK ORDERS

108092	152819	51655765	148345
51639921	51641394	51642811	51645301
51646600	51647737	51655919	51648845
51654686	51655765	163830	51670476
164047	160936	154656	51653558
51649933	51651031	51652069	

PROCEDURES/DOCUMENTS

NUMBER	TITLE	REVISION / DATE
EN-LI-118	Root Cause Analysis Process	8
EN-HU-103	Human Performance Error Reviews	1
EN-WM-102	Work Implementation and Closeout	2
EN-WM-105	Planning	4
EN-MA-101	Conduct of Maintenance	6
MG-33	Configuration and Control Guidelines & Completing Lifted Lead & Switch Manipulation Forms	1
White Paper	Evaluation of Potential Tampering or Sabotage to Station Battery 3B-S	12/22/08
White Paper	Recovery Action Evaluation for Battery 3B-S Loose Cell #57 Connection	

NUMBER	TITLE	REVISION / DATE
White Paper	Engineering Evaluation for Potential to Damage Battery 3B-S Loose Cell #57 Connection	
White Paper	Core Damage Risk Associated with Waterford 3 DC-EBAT-B Unavailable	2
ME-004-213	Battery Intercell Connections	13
ME-003-220	Station Battery Bank and Charger (18 month)	301
ME-003-230	Battery Service Test	301
ME-003-200	Station Battery Bank and Charger (Weekly)	301
ME-003-210	Station Battery Bank and Charger (Quarterly)	12
OP-901-313	Loss of a 125V DC Bus	300
OI-037-000	Operations Risk Assessment Guideline	2
OP-006-003	125 VDC Electrical Distribution	301
OP-902-005	Station Blackout Recovery	13
OP-009-002	Emergency Diesel Generator	308
08-0540	EOS Checklist for Battery 3B-S Inoperable	9/3/08

Phase 3 Analysis
Waterford 3
Battery Loose Inter-cell Connection

Performance Deficiency:

Inadequate maintenance following replacement of a cell on Station Battery 3B-S on May 24, 2008, resulted in a loose connection between cells 57 and 58. The battery was determined to be non-functional on September 2, 2008, based on a measurement of connector resistance and tests of individual cell voltage.

Assumptions:

1. Battery 3B-S was potentially capable of performing its safety function immediately following its replacement on May 24, 2008, based on a satisfactory service test. The battery became non-functional sometime after May 24 and sometime before September 2 (100 days later). The weekly individual cell voltage measurements were not true tests of the battery's ability to perform its safety function because they did not simulate the initial load condition that would exist following a loss of offsite power. Therefore, the point in time that the battery became non-functional is unknown, but is assumed as being half way between the two known points (t/2). Repair time was approximately 2 days. Therefore, the exposure time of the condition is estimated as 100 days/2 + 2 days = 52 days.

2. During the exposure period, it is assumed that the battery would fail to provide any service function, including the start of the Train B emergency diesel generator. Following a loss of offsite power event, recovery of the battery would be possible depending on the extent of damage from the current surge across the loose connection. For the purpose of this analysis, it is assumed, based on a qualitative estimate, that there is a 15 percent probability that damage of an irreparable nature would occur, and an 85 percent chance that the battery would remain intact and could be recovered by tightening the loose connection, jumpering out the damaged cell, or by installing a spare.

   The core damage sequences that contribute to the delta-CDF are of durations of 1 or 6 hours. It is assumed that a one-hour recovery of the battery would not be possible and therefore, only the 6-hour sequences are considered available for recovery.

   Using the SPAR-H Human Reliability Analysis Method, NUREG/CR-6883, the following assumptions were made for the diagnosis and action performance shaping factors:

DIAGNOSIS (0.01 NOMINAL)		
Performance Shaping Factor	***Level***	***Factor***
Available Time	Expansive Time	0.01
Stress	High	2
Complexity	Moderate	2
Experience/Training	Low	10
Procedures	Not Available	50
Ergonomics	Nominal	1
Fitness for Duty	Nominal	1
Work Processes	Nominal	1

Diagnostic Result = (0.01)(20)/[(0.01)(20 - 1) +1] = 0.168

Available Time: It is estimated that the nominal time to diagnose the condition would be one hour. Considering the short time needed to correct the problem, approximately 3 hours of time would be available to diagnose the condition and leave enough time to either tighten the connection, jumper the cell, or replace it. Therefore, the time available is greater than 2 times nominal and > 30 minutes, meeting the criteria for "expansive."

Stress: The condition of an SBO would be high stress for the operators, but not extreme, because immediate threats to health and life would be absent.

Complexity: There could be conditions under which the source of the battery problem would not be readily apparent. This could lead to a need to check all of the cells individually, or a decision to abandon recovery of the battery and focus on recovering the alternate EDG.

Experience/Training: Operators do not have experience in diagnosing this type of failure (low).

Procedures: Procedures were not available directing the diagnosis of the battery condition.

Ergonomics: There are no ergonomic impediments.

Fitness for Duty and Work Processes: These factors were considered nominal.

ACTION (0.001 NOMINAL)		
Performance Shaping Factor	***Level***	***Factor***
Available Time	>5 times nominal	0.1
Stress	High	2
Complexity	Nominal	1
Experience/Training	Low	3
Procedures	Nominal	1
Ergonomics	Nominal	1
Fitness for Duty	Nominal	1
Work Processes	Nominal	1

Action result = 6E-4

Available Time: It is estimated that the nominal time to perform the actions would be one-half hour. Given diagnosis within 3 hours, an additional 3 hours would be available before battery depletion. This meets the criteria for being > 5 times nominal.

Stress: The condition of an SBO would be high stress for the operators, but not extreme, because immediate threats to health and life would be absent.

Complexity: The steps needed to perform the recovery are not complex.

Experience/Training: Operators do not have experience in performing this recovery.

Procedures: Procedures are available and are of a quality commensurate with standard plant procedures.

Ergonomics: There are no ergonomic impediments.

Fitness for Duty and Work Processes: These factors were considered nominal.

Total HRA result = 0.168 + 0.0006 = 0.169

3. In the event that the battery is heavily damaged and cannot be recovered, it would be possible to recover the Train B EDG (and dc bus through the battery charger) by connecting an alternate dc source and starting the Train B EDG. Because loss of the dc bus would be obvious, the diagnosis portion of the recovery was considered to be the operator decision to attempt the special recovery. Although a procedure (using a special rigging of automobile batteries) existed previously to perform this recovery, a subsequent revision removed it prior to the beginning of the exposure period for this condition. Using the SPAR-H Human Reliability Analysis Method, NUREG/CR-6883, the following assumptions were made for the diagnosis and action performance shaping factors:

   [Note: the CDF sequences that lead to core damage within one hour were considered to be too short in time to accomplish a recovery. Therefore, the following assessment applies only to sequences with a time to core damage of greater than one hour, which, in this case, are exclusively the 6-hour sequences.]

DIAGNOSIS (0.01 NOMINAL)		
Performance Shaping Factor	***Level***	***Factor***
Available Time	Extra Time	0.1
Stress	High	2
Complexity	Nominal	1
Experience/Training	Low	10
Procedures	Not Available	50
Ergonomics	Nominal	1
Fitness for Duty	Nominal	1
Work Processes	Nominal	1

   Diagnostic Result = (0.01)(100)/[(0.01)(100 - 1) +1] = 0.502 (1 in 2 chance that the operators will attempt the alternate recovery procedure)

   Available Time: It is estimated that the nominal time to diagnose the condition and decide to proceed with the alternate dc procedure would be approximately two hours. Therefore, for 6 hour or greater sequences, the amount of time available to decide to use the procedure, but still have enough remaining time to perform the actions, would between 1X and 2X nominal and greater than 30 minutes.

   Stress: The condition of an SBO would be high stress for the operators, but not extreme, because immediate threats to health and life would be absent.

   Complexity: Nominal

Experience/Training: Operators do not have experience in diagnosing this type of failure (low).

Procedures: Procedures were not available directing the use of the alternate dc source.

Ergonomics: There are no ergonomic impediments

Fitness for Duty and Work Processes: These factors were considered nominal.

ACTION (0.001 NOMINAL)		
Performance Shaping Factor	***Level***	***Factor***
Available Time	Nominal	1
Stress	High	2
Complexity	Moderately Complex	2
Experience/Training	Low	3
Procedures	Not Available	50
Ergonomics	Poor	10
Fitness for Duty	Nominal	1
Work Processes	Nominal	1

Action Result = (0.001)(6000)/[(0.001)(6000 - 1) +1] = 0.857

Available Time: It is estimated that the nominal time to perform the actions necessary to start the Train B EDG with an alternate dc source would be approximately two hours. Therefore, for 6 hour or greater sequences, the amount of time available would be considered nominal.

Stress: The condition of an SBO would be high stress for the operators, but not extreme, because immediate threats to health and life would be absent.

Complexity: The steps needed to perform the recovery are moderately complex.

Experience/Training: Operators do not have experience in performing this recovery.

Procedures: Procedures are available but are not of a quality commensurate with standard plant procedures.

Ergonomics: There are some difficulties associated with ergonomic impediments.

Fitness for Duty and Work Processes: These factors were considered nominal.

The total failure probability is the inverse of the probability that both diagnosis and action are successful. Total HEP = 1 - (1 - 0.502)(1 - 0.857) = 0.93.

4. A common cause failure of the other vital 125 volt batteries (3A-S and 3AB-S) was not considered to be applicable to this failure. The replacement and maintenance performed on Battery 3B-S was not performed contemporaneously on the other batteries. Also, the condition, if it had previously existed on the other batteries, would most likely have been discovered through testing. All of the connections on the other two batteries were verified to

be tight. The probability of the basic event for the common cause loss of all vital 125-volt dc batteries is 1.551E-7 in the base case. When the failure of battery 3B-S is assigned a value of 1.0 in SAPHIRE (indicating an independent failure), the common cause probability is recalculated to reflect a two-battery system (instead of three). The revised common cause failure probability is 4.789E-7. Because the independent failure of the batteries is 4.8E-5, the change in the common cause probability had a negligible effect on the analysis. For reference, if the condition had been determined to be a common cause situation, and the Battery 3B-S basic event was assigned a value of TRUE instead of 1.0, the common cause failure probability would have been adjusted to 3.231E-3. This would have significantly increased the estimated significance of the finding.

5. An error was discovered in the Waterford 3 SPAR model concerning power supplies to the EFW flow control valves. A revised model was provided by INL for use by the analyst. The impact of the change was to decrease the significance of the finding by approximately 20 percent.

6. An error was found in the Waterford 3 SPAR model concerning excluded test and maintenance basic events. The events ACW-CTF-TM-A/B (ACCW wet cooling tower test and maintenance) were miscoded as ACW-CTW-TM-A/B. Because of this problem, test and maintenance situations prohibited by technical specifications were being inappropriately included in the tabulation. This error was corrected.

7. The Waterford 3 SPAR model credits a 4-hour battery capacity for station blackout sequences. The licensee PRA model credits a battery capacity of 6 hours following a station blackout. This value is contingent on operators implementing a dc load shed procedure that is part of their training program. The Waterford SPAR model credits a 4-hour battery capacity. The analyst revised the SPAR model to credit a 6-hour battery. Although operator action is required to extend the battery capacity, the probability that operators will fail to shed loads according to the procedure is very small (~E-3), such that the contribution to the significance of the finding that would result in modeling this operator failure would be negligible.

8. Hurricane Gustav, which passed several hundred miles west of the plant during the exposure period, increased the probability of a loss of offsite power. However, for SDP analyses, average conditions are assumed for external events as well as test and maintenance activities, reflecting the philosophy that the performance deficiency could have occurred at any time. Also, the plant shut down when projected local wind speeds were within the range of hurricane force. Therefore, no adjustments were made for the hurricane.

<u>Analysis</u>:

The analysis was performed with the Waterford 3 SPAR model, Revision 3.45, dated July 13, 2008, and revised by INL and corrected as discussed above. Average test and maintenance was used and truncation was set at 1.0E-13. The basic event DCP-BAT-LP-3BS, Failure of Division 3B 125 VDC Battery 3B-S, was set to a value of 1.0.

[*for reference purposes, the first analysis was performed without recovery of the Train B EDG]*

The result using SAPHIRE 7.27 was a Delta-CDF of 7.914E-5/yr. The following were the top 8 sequences contributing to the change in CDF (99.8% of the total):

SEQUENCE	INITIATING EVENT AND SYSTEMS THAT FAIL	DELTA-CDF	PERCENTAGE OF TOTAL CDF
LOOP 15-21	(LOOP)(EPS)(CBO)(RSUB)(OPR-06H)(DGR-06H)	6.149E-5	77.7
LOOP 15-30	(LOOP)(EPS)(EFW)(OPR-01H)(DGR-01H)	1.239E-5	15.7
LOOP 14	(LOOP)(EFW)	4.007E-6	5.06
LOOP 15-27	(LOOP)(EPS)(SRV)(OPR-01H)(DGR-01H)	5.169E-7	0.653
LOOP 15-24	(LOOP)(CBO)(RSUB)(RCPSI)(OPR-01H)(DGR-01H)	3.549E-7	0.448
LDCAB 12	(LDCAB)(FW)(COND)	7.651E-8	0.097
LOMFW 12	(LOMFW)(FW)(COND)	5.749E-8	0.073
LOCHS 12	(LOCHS)(FW)(COND)	4.598E-8	0.058

LOOP: Loss of offsite power
EPS: Emergency AC power (diesel generators)
CBO: Controlled bleedoff isolated
RSUB: Reactor coolant subcooling maintained
OPR-01H: recovery of offsite power in 1 hour
DGR-01H: recovery of an emergency diesel generator in 1 hour
OPR-06H: recovery of offsite power in 4 hours
DGR-06H: recovery of an emergency diesel generator in 4 hours
EFW: Emergency feedwater system
FW: EFW and main feedwater systems
LOMFW: Loss of main feedwater
COND: Secondary cooling using condensate system
SRV: Safety relief valves are closed
LOCHS: Loss of condenser heat sink
RCPSI: RCP seal integrity maintained
LDCAB: Loss of DC Bus 3AB-DC-S

The non-LOOP sequences, contributing slightly over 0.3% to the result, included failures of a fast-bus transfer to the vital 4160 vac bus following a reactor trip, followed by battery failure and a failure to start the Train B EDG. This scenario would challenge the battery in a manner equivalent to a LOOP event and therefore the associated sequences were considered applicable to this analysis.

Assuming an exposure period of 52 days, the estimated "no-recovery"delta-CDF of the finding is 7.914E-5/yr (52 days/yr/365 days/yr) = 1.13E-5/yr.

Application of Train B Battery and EDG B recoveries:

In the SAPHIRE result above, 99.99 percent of the delta-CDF was developed through base case cut sets that contained the independent failure of Battery 3B-S (base failure probability = 4.8E-5) that were increased in value by assigning a failure probability of 1.0. The common cause basic event (which was increased from 1.551E-7 in the base to 4.789E-7 in the case) was virtually not represented in the tabulation because it was very small and was almost entirely truncated out (almost all cutsets containing the common cause term had values less than the truncation limit of 1.0E-13).

Sequence LOOP 15-21 is a six-hour sequence and was considered applicable to both recoveries. The other listed sequences (LOOP 15-30, LOOP 14, LOOP 15-27, LOOP 15-24, LDCAB 12, LOMFW 12, and LOCHS 12) are short sequences and were not credited with a recovery.

According to Assumption #2, there is 85 percent probability that the battery will not be damaged beyond a state that allows for its recovery. The HRA estimate for this recovery is 0.169.

For this situation, the basic event DCP-BAT-LP-3BS was set to a failure probability of 0.169 (the non-recovery probability) and the common cause basic event DCP-BAT-CF-ALL was reset to its original 2-battery group value of 4.789E-7. Sequence LOOP 15-21 was re-quantified. The change in Delta-CDF for this sequence is shown below:

SEQUENCE	DELTA-CDF VALUE W/O RECOVERY	DELTA-CDF VALUE W/ RECOVERY	DECREASE IN DELTA-CDF
LOOP 15-21	6.149E-5	1.040E-5	5.009E-5

According to Assumption #2, there is 15 percent probability that the battery will be damaged beyond a state that allows for its recovery. The HRA estimate for recovery (Assumption 3) of the EDG is 0.93.

The basic event DCP-BAT-LP-3BS was set to a failure probability of 0.93 (this acceptably simulates an EDG recovery for modeling purposes), and the common cause basic event DCP-BAT-CF-ALL was reset to the 2-battery group value of 4.789E-7. Sequence LOOP 15-21 was re-quantified. The change in Delta-CDF for this sequence is shown below:

SEQUENCE	DELTA-CDF VALUE W/O RECOVERY	DELTA-CDF VALUE W/ RECOVERY	DECREASE IN DELTA-CDF
LOOP 15-21	6.149E-5	5.719E-5	0.430E-5

The effective decrease in the Delta-CDF of Sequence 15-21 is therefore:

0.85(5.009E-5) + 0.15(0.430E-5) = 4.322E-5

The Delta-CDF of the finding, considering recoveries is:

(7.914E-5/yr – 4.322E-5/yr.) (52/365) = 5.117E-6/yr.

External Events:

Seismic

The analyst used seismic data contained in the Risk Assessment of Operational Events Handbook, Volume 2 - External Events, Revision 1, September 2007 to estimate the change in Delta-CDF for seismic events. A total of 10 seismic intensity bins were evaluated. The Waterford SPAR model was used to determine the change in CCDP caused by the condition of Battery 3B-S.

A bounding assumption was made that Battery 3B-S would fail in response to any earthquake exceeding 0.05g. Also, the exposure time was assumed to be the entire time that the inter-cell connections were loose, 102 days (t/2 was considered not applicable to this situation because dynamic forces would likely change the state of the loose connection).

The following table illustrates the results:

SEISMIC RANGE (G)	FREQUENCY (PER YEAR)	DELTA-CDF (PER YEAR NORMALIZED TO 102 DAY EXPOSURE)
0.05-0.08	6.98E-4	1.11E-8
0.08-0.15	1.08E-4	2.82E-8
0.15-0.25	3.41E-5	5.27E-8
0.25-0.30	6.87E-6	2.04E-8
0.30-0.40	7.24E-6	3.02E-8
0.40-0.50	3.45E-6	1.82E-8
0.50-0.65	2.49E-6	1.50E-8
0.65-0.80	1.17E-6	7.56E-9
0.80-1.00	7.62E-7	5.07E-9
1.00-1.20	7.62E-7	5.09E-9
Total Seismic Delta-CDF		**1.94E-7/yr**

Fire

The contribution to the risk of the finding from fires is limited to fires that cause a loss of offsite power to the Train B vital ac bus (this assumes that the battery charger and upstream circuitry do not fail, such that absent a loss of offsite power, the Train B vital dc bus would remain energized for a 24-hour recovery period). In this scenario, the battery fails to start the Train B EDG which results in a loss of the Train B vital ac and dc buses. Absent the finding, the Train B EDG would start, subject to a failure not attributable to the fire, and energize the Train B vital ac bus as well as the battery charger supplying the Train B vital dc bus. This difference generates an increase in risk above baseline attributable to the condition.

In fire scenarios where a partial LOOP occurs affecting only the Train B vital bus, but Train A remains energized, the potential for core damage would remain low because power from either offsite or EDG A would be available to power the Train A ECCS. Although failures or maintenance could affect the functionality of Train A systems, these scenarios would have risk impacts well less than those modeled in the internal events LOOP scenarios, and therefore were qualitatively dismissed.

Fires in the control room (Fire Area RAB-1A) and the cable spreading room (RAB-1E) could result in a loss of both trains of offsite power. Fires in other fire areas could remove one train of offsite power but would not likely affect both.

According to the Waterford IPEEE, the frequency of fires in the control room is 9.7E-3/yr. and the fire non-suppression probability is 3.4E-3. Fires in any of 5 cabinets in the control room (CP-1, CP-8, CP-18, CP-46, and CP-50) could result in a complete loss of offsite power. With a total of 50 cabinets in the control room, this would imply that there is approximately a one in ten chance that a control room fire will result in a total LOOP, or a frequency of 9.7E-4/yr. It can then be assumed, that because almost all fires in the control room are suppressed without the need for evacuation, that the delta-CDF for fires in the control room that remove offsite power and are successfully suppressed is equal to the frequency (9.7E-4/yr.) multiplied by the internal CCDP result for LOOP events. This makes the assumption that recovery of offsite power would remain approximately equal to the baseline assumptions ((in this case, the effect of the damage state (a single cabinet lost)) would offset the fact that power remains available in the switchyard and could be recovered sooner than the average LOOP which includes, for example, severe weather events.).

The CCDP of the internal events result is approximately equal to the delta-CDF divided by the LOOP frequency.

5.117E-6/yr/3.59E-2 = 1.43E-4

Therefore an estimate of the risk of the finding associated with suppressed control room fires is 9.7E-4/yr (1.43E-4) (52 days/365days/yr.) = 1.98E-8/yr.

For control room fires that remove offsite power and are not suppressed, the frequency is 9.7E-4/yr (3.4E-3) = 3.3E-6/yr. According to the Waterford IPEEE, the CCDP of a control room evacuation is 6.2E-2. However, in this case, because the evacuation included a loss of offsite power and failure of all Train B electrical buses, the CCDP can be approximated by taking the square root of the nominal value: $(6.2E\text{-}2)^{1/2}$ = 2.5E-1. Therefore, the delta-CDF associated with control room evacuations is estimated as:

3.3E-6/yr. (2.5E-1- 6.2E-2) (52 days/365 days/yr.) = 8.8E-8/yr.

Fires in the cable spreading room are not considered to be significant with respect to this finding. This is because the major ignition sources are transient combustible and welding fires that would not likely occur during power operations. However, discounting this fact, the fire frequency for the cable spreading room from the Waterford IPEEE is 3.2E-5/yr. and the failure probability of the automatic suppression system is 5E-2. Therefore, the frequency of fires in the cable spreading room that would potentially result in the need for control room evacuation is (3.2E-5) (5E-2) = 1.6E-6. Assuming that the fire would result in a complete loss of offsite power, the change in CCDP for alternate shutdown attributable to the finding, as shown above, is approximately 0.19. Therefore, an estimate of the risk associated with cable spreading room fires is 1.6E-6/yr. (0.19) (52 days/365 days/yr.) = 3.0E-7/yr. = 4.3E-8/yr.

Internal Flooding

The licensee PRA model was used to estimate the impact of the finding with respect to internal flooding. This model considers approximately 120 internal flooding scenarios. With the Train B vital battery assumed failed, the result of the analysis was a delta-CDF of 9.5E-8/yr.

External Flooding

The updated FSAR, Chapter 2, discusses hurricane surge, levee failure, and probable maximum precipitation with respect to external flooding. In each of these cases, the maximum water elevation is below the flood protection level provided by the reinforced concrete box exterior walls that form the nuclear plant island structure. A flood necessary to affect plant safety would require an event well beyond design assumptions. Therefore, that analyst qualitatively dismissed external flooding as a significant contributor to the risk of this finding.

High Winds/Tornadoes

The only effects from high winds and tornadoes that would contribute to the delta-CDF of this finding are loss of offsite power events. The SPAR model contains a contribution from severe weather events in the loss of offsite power initiator and, therefore, an additional adjustment is not necessary.

Total External Events Result:

SOURCE	DELTA-CDF
Seismic	1.94E-7
Fire- Control Room suppressed	1.98E-8
Fire- Control Room- unsuppressed	8.8E-8
Fire- Cable Spreading Room	4.3E-8
Internal Flooding	9.5E-8
TOTAL	4.4E-7/yr.

Total Delta-CDF:

Internal CDF	5.117E-6
External CDF	4.4E-7/yr
Total CDF	5.6E-6/yr.

Large Early Release

Based on information provided in IMC 0609, Appendix H, core damage sequences resulting from station blackout and other events related to loss of power do not contribute more than negligibly to the probability of a large early release of radiation following a core damage event. Therefore, the significance of this finding is determined solely by the core damage frequency.