May 17, 2012

Mr. Paul Russ, Director
AP1000 Licensing Programs
CWHQ-1 512B
1000 Westinghouse Drive
Cranberry Township, PA 16066

SUBJECT: NRC VENDOR INSPECTION REPORT NO. 99900404/2012-201 AND NOTICE OF NONCONFORMANCE

Dear Mr. Russ:

From March 26 to 30, 2012, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection at the Westinghouse Electric Company (WEC) facility in Cranberry Township, PA. The purpose of the technically-focused inspection was to review implementation of your quality assurance program in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," and 10 CFR Part 21, "Reporting of Defects and Noncompliance." This inspection specifically evaluated the quality assurance program as it pertains to WEC's development of test requirements and specifications for the performance of qualification and functional testing for components to be supplied as part of the AP1000 design. The enclosed report presents the results of this inspection. This NRC inspection report does not constitute NRC endorsement of your overall quality assurance (QA) and 10 CFR Part 21 programs.

During this inspection, the NRC inspection team found that the implementation of your Quality Assurance (QA) program failed to meet certain NRC requirements imposed on you by your customers or NRC licensees. Specifically, the inspection team determined that WEC was not implementing aspects of its design control and document control programs consistent with regulatory requirements. These nonconformances are cited in the enclosed Notice of Nonconformance (NON), and the enclosed inspection report describes in detail the circumstances surrounding them.

Three the issues identified by the inspection team involve the design and testing of the AP 1000 squib valves and their interfaces with associated systems. Since these valves are critical to the safety of the AP 1000 reactor design and cannot be fully tested once installed, the design validation, testing, and qualification of these valves and their interfaces with associated systems are of concern to the NRC. The identified issues are also Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) related, and as such, without appropriate resolution, may impact the ability to demonstrate specific ITAAC have been met.

Please provide a written statement or explanation within 30 days from the date of this letter in accordance with the instructions specified in the enclosed NON. We will consider extending the response time if you show good cause for us to do so.

In accordance with 10 CFR 2.390, “Public Inspections, Exemptions, Requests for Withholding,” of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response 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. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request that such material is withheld from public disclosure, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, “Protection of Safeguards Information: Performance Requirements.”

Sincerely,

/RA/

Richard A. Rasmussen, Chief
Electrical Vendor Branch
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No. 99900404

Enclosures:
1. Notice of Nonconformance
2. Inspection Report No. 99900404/2012-201 and attachment

In accordance with 10 CFR 2.390, “Public Inspections, Exemptions, Requests for Withholding,” of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response 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. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request that such material is withheld from public disclosure, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, “Protection of Safeguards Information: Performance Requirements.”

Sincerely,

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Richard A. Rasmussen, Chief
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Docket No. 99900404

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1. Notice of Nonconformance
2. Inspection Report No. 99900404/2012-201 and attachment

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ADAMS ACCESSION No.: ML12128A072 NRC-001

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DATE	05/17/2012	05/17/2012	05/17/2012	05/17/2012
OFFICE	NRO/DCIP/CMVB	NRO/DCIP/CAEB	NRO/DCIP/CEVB	
NAME	PCoco	TFrye	RRasmussen	
DATE	05/17/2012	05/17/2012	05/17/2012	

NOTICE OF NONCONFORMANCE

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

Inspection Report 99900404/2012-201
Docket No. 99900404

Based on the results of a U.S. Nuclear Regulatory Commission (NRC) inspection conducted at the Westinghouse Electric Company (WEC) facility in Cranberry Township, PA, on March 26–30, 2012, certain activities were not conducted in accordance with NRC requirements that were contractually imposed on WEC by its customers or NRC licensees:

A. Criterion III, "Design Control," of Appendix B, "Quality Assurance Program Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," states, in part, that, "Where a test program is used to verify the adequacy of a certain design feature in lieu of other verifying or checking processes, it should include suitable qualification testing of a prototype unit under the most adverse design conditions."

   Contrary to the above, as of March 30, 2012, WEC failed to verify the adequacy of certain design features and include the most adverse design conditions in the test program for performing functional testing of the squib valve actuators. Specifically:

   1. APP-PV70-VPH-001, "AP1000 Squib Valve Equipment Qualification Test Plan," Revision 0, did not include verification of the "no fire" feature of the squib valve actuators, which allows a small current to be applied to the actuators to verify bridge wire continuity during surveillance testing and also ensures against inadvertent operation of the squib valves due to spurious or induced signals.

   2. APP-PV70-VPH-001, "AP1000 Squib Valve Equipment Qualification Test Plan," Revision 0, specified testing of the valves at a temperature which did not represent the most adverse design conditions with respect to operation of the valve.

   These issues have been identified as Nonconformance 99900404/2012-201-01.

B. Criterion III, "Design Control," of Appendix B to 10 CFR Part 50, states, in part, that, "Measures shall be established for the identification and control of design interfaces…"

   Contrary to the above, as of March 30, 2012, WEC did not identify design interfaces sufficient to allow for the translation of the design basis into specifications. Specifically, APP-GW-J4-072 "Interface Specification for Squib Valve Controller," Revision 1, did not include the full range of temperatures that need to be considered when sizing the field run cable/connector systems located between the Plant Monitoring and Protection System, the Diverse Actuation System, and the squib valve actuators.

   This issue has been identified as Nonconformance 99900404/2012-201-02.

C. Criterion III, "Design Control," of Appendix B to 10 CFR Part 50, states, in part, that, "Measures shall be established to assure that applicable regulatory requirements and the design basis, as defined in 50.2 and as specified in the license application, for those structures, systems, and components to which this appendix applies are correctly translated into specifications, drawings, procedures, and instructions."

Contrary to the above, as of March 30, 2012, WEC did not establish measures necessary to ensure that the design basis for the Diverse Actuation System was correctly translated into specifications, drawings, and instructions. Specifically, WEC did not perform a documented calculation or analysis to justify the selection of resistance values contained in APP-GW-J4-072, "Interface Specification for Squib Valve Controller," Revision 1, for the field run cabling located between the Diverse Actuation System and the squib valve actuators.

This issue has been identified as Nonconformance 99900404/2012-201-03.

D. Criterion VII, "Control of Purchased Material, Equipment, and Services," of Appendix B to 10 CFR Part 50, states, in part, that, "Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery."

Paragraph 7.6.2, "Qualification of Actuator Families," of Section 7, "Development of a Qualification Program," of WEC document APP-GW-VP-010, "Equipment Qualification Methodology and Documentation Requirements for AP1000 Safety-Related Valves and Valve Appurtenances," Revision 2, states, in part, that, "Parent actuators used to qualify a range of operator sizes shall be determined using Annex A of [Institute of Electrical and Electronics Engineers (IEEE)] Std. 382-1996 (Reference 2.3.7). […] 'Parent' actuator sizes used to qualify a range of valve and actuator sizes shall be documented in a report and submitted to Westinghouse for approval."

Contrary to the above, as of March 30, 2012, WEC failed to adequately examine analysis performed by the Limitorque Flowserve Corporation upon delivery. Specifically, WEC did not have objective evidence of review or acceptance of the report entitled "Limitorque Type SB Series Valve Actuator Test Specimen and Methodology for Westinghouse AP-1000 Environmental Qualification Testing." In addition, WEC failed to identify mathematical errors in the tables used to define the actuator groups.

This issue has been identified as Nonconformance 99900404/2012-201-04.

E. Criterion VI, "Document Control," of Appendix B to 10 CFR Part 50, states, in part, that, "Measures shall be established to control the issuance of documents, such as instructions, procedures, and drawings, including changes thereto, which prescribe all activities affecting quality. These measures shall assure that documents, including changes, are reviewed for adequacy and approved for release by authorized personnel and are distributed to and used at the location where the prescribed activity is performed."

Paragraph 2.0, "Policy," of WEC document APP-GW-GEP-010, "Process and Procedures for AP1000 Internal Open Items and Holds," Revision 5, states, in part, that, “AP1000 Program participants are responsible for identifying, documenting, tracking, and closing Open Items and Holds that affect technical documents or drawings.” Paragraph 8.5 of the procedure lists examples of open items which include “Incomplete or preliminary supporting calculations or analysis used as a design input.”

Contrary to the above, as of March 30, 2012, WEC did not appropriately control and distribute changes made to a design specification used for developing equipment qualification test plans and procedures for safety-related valve actuators. Specifically, APP-PV95-VP-001, “Equipment Design Requirements for Safety-Related Limitorque Motor Actuator Test Specimens,” was developed using a draft version of the AP1000 Design Specification APP-PV95-Z0-001. WEC failed to identify the use of the draft design specification as an open item. As a result, a design specification to exclude aluminum in actuator components was omitted from the APP-PV95-VP-001 test plan.

This issue has been identified as Nonconformance 99900404/2012-201-05.

Please provide a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to Richard Rasmussen, Chief, Electrical Inspection Branch, Office of New Reactors within 30 days of the date of the letter transmitting this Notice of Nonconformance. This reply should be clearly marked as a "Reply to a Notice of Nonconformance and should include for each noncompliance: (1) the reason for the noncompliance, or if contested, the basis for disputing the noncompliance; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken; and (4) the date when full compliance will be achieved. Where good cause is shown, consideration will be given to extending the response time.

Because your response 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, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection, described in 10 CFR 73.21.

Dated this 17th day of May 2012

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
DIVISION OF CONSTRUCTION INSPECTION & OPERATIONAL PROGRAMS
VENDOR INSPECTION REPORT

Docket No.:	99900404
Report No.:	99900404/2012-201
Vendor:	Westinghouse Electric Company 1000 Westinghouse Drive Cranberry Township, Pennsylvania16066
Vendor Contact:	Mr. Ron Wessel, Principle Engineer (412) 374-4023 wesselrp@westinghouse.com
Nuclear Industry Activity:	Westinghouse Electric Company (WEC) holds a design certificate for the AP1000 and is responsible for detailed design and testing for safety-related components to be used in AP1000 plants. These tests, including qualification and functional tests, are associated with or directly impact closure of ITAAC from Revision 19 of the certified AP1000 design. Currently, these ITAAC are incorporated into the combined licenses of Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3.
Inspection Dates:	March 26-30, 2012

Inspectors:	Jeffrey Jacobson	NRO/DCIP/CEVB	Team Leader
	Sarah Alexander	NRO/DCIP/CEVB	
	Paul Coco	NRO/DCIP/CMVB	
	Victor Hall	NRO/DCIP/CQAB	
	Chelsea Smith-Standberry	R-II/DCI/CIB1	

Approved:	Richard A. Rasmussen, Branch Chief Electrical Vendor Branch Division of Construction Inspection & Operational Programs Office of New Reactors

EXECUTIVE SUMMARY

This inspection was performed as part of the U. S. Nuclear Regulatory Commission's (NRC's) overall strategy for inspecting targeted ITAAC related to the functional and type testing of components being supplied by Westinghouse Electric Company (WEC) as part of the AP1000 certified reactor design. The purpose of this inspection was to assess WEC's development of test requirements and specifications provided to laboratories and testing facilities. Environmental qualification and functional testing is required by NRC regulations to demonstrate that components that perform a safety function can be relied upon to operate throughout their qualified life after exposure to design basis accident conditions. The NRC inspection team focused its review on WEC's development of qualification and functional testing for a sample of components important to the safety for AP 1000 reactors. For the selected components, the inspection team assessed whether applicable design inputs were correctly translated into specifications, drawings, procedures, and instructions. The team assessed whether the test requirements and specifications were appropriately supported by engineering data and calculations and whether they complied with applicable regulatory requirements and industry standards as described in Revision 19 to the AP1000 Design Certification Document (DCD).

Environmental Qualification Program

Part 50.49 of Title 10 of the *Code of Federal Regulations* (10 CFR) requires that equipment important to safety be environmentally qualified to withstand normal operating conditions and conditions of design basis accidents. Additionally, 10 CFR 50.34(a)(12) and 50.34(b)(10) require design of nuclear power plant structures, systems, and components important to safety to withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform their safety functions. The NRC inspection team reviewed the methods being used by WEC to translate the results of accident analyses performed for the AP1000 reactor design into appropriate testing parameters for radiation, pressure, temperature, and seismic events. The team reviewed applicable DCD commitments, industry codes, and test standards. In addition to document review, the team conducted interviews with WEC staff. The team concluded that WEC's test plans and procedures for equipment qualification were supported by calculations and analysis consistent with Appendix 3D of the AP1000 DCD. No findings of significance were identified.

PV70 Squib Valves

The overall equipment qualification program for the squib valves involves four separate testing programs. Within each program, the team assessed whether the parameters specified for testing were consistent with the design basis for the equipment. The team also assessed whether the testing protocols described in the equipment qualification test plan matched the as-installed conditions of the equipment.

The team identified three nonconformances during its review of squib valve qualification and functional testing. Nonconformance 99900404/2012-201-01 concerns the failure to include certain design features and the most adverse design conditions in the environmental qualification and functional test program. The first example of this concerns the failure to include a test of the "no fire" feature of the squib valve actuators in the qualification testing program. Verification of the "no fire" feature is important to ensure the design of the squib valve is sufficient to prevent spurious actuations of the valves. Another example of Nonconformance 99900404/2012-201-01 concerns the temperature specified for functional testing of the squib valves. The temperature specified in test plan APP-PV70-VPH-001 to perform the testing may not be sufficient to validate operation of the valve at all temperatures where squib valve operation is credited. Nonconformance 99900404/2012-201-02 concerns the failure to clearly define the operating requirements (temperature) for the field cabling and connectors that will be used to fire the squib valves once installed in the plant. This definition of operating requirements is necessary to ensure the resulting cabling/connector system has the proper resistance to support the firing of the valves. Nonconformance 99900404/2012-201-03 concerns the lack of a documented calculation, as related to the analysis of the Diverse Actuation System (DAS) circuits that will be relied upon to fire the squib valves. Such an analysis is necessary to establish the proper resistance of the field cabling/connector system.

PV95 Electric Motor Actuators

The NRC inspection team reviewed WEC's plans for environmentally qualifying safety-related electric motor actuators for the AP1000 reactors. The team reviewed test plans, design specifications, and a sample of purchase orders to ensure that the specifications and requirements had been properly transferred from relevant design documents. The team also reviewed Procurement Advisory Releases, test procedures, and test results related to the supply and testing of the motor actuators.

The inspectors identified Nonconformance 99900404/2012-201-04 for failing to perform an acceptance review of an analysis performed by Limitorque to group actuators for the purposes of qualification testing. The inspectors also identified Nonconformance 99900404/2012-201-05 for failure to appropriately incorporate into the test plan a change to the design specification.

Electrical Penetration Assemblies

The NRC inspection team reviewed the electrical penetration assembly design commitments and equipment qualification testing requirements to ensure they were accurately translated into design specifications, test specifications, test plans, purchase orders, test procedures, and test results. The team also conducted interviews with WEC staff concerning the qualification testing. The team determined that AP1000 DCD commitments, industry standards, and electrical penetration assembly design and qualification requirements were adequately translated into test plans and procedures. No findings of significance were identified.

Seismic Qualification of Specific Components

The NRC inspection team performed seismic evaluations of selected components to assess whether seismic requirements were being appropriately captured in test specifications. Specifically, the team reviewed seismic requirements for the reactor coolant pump switchgear, the main control room/remote shutdown room transfer panel, and the PV70 squib valves. The team determined that AP1000 DCD commitments, industry standards, seismic design, and seismic qualification requirements were adequately translated into WEC's test plans and procedures. No findings of significance were identified.

REPORT DETAILS

This inspection was performed as part of the U. S. Nuclear Regulatory Commission's (NRC's) overall strategy for inspecting targeted ITAAC related to the functional and type testing of components being supplied by Westinghouse Electric Company (WEC) as part of the AP1000 certified reactor design. The purpose of this inspection was to assess WEC's development of test requirements and specifications currently being provided to contracted laboratories and testing facilities for the purpose of qualification and functional testing as required by Title 10 to the *Code of Federal Regulations* (10 CFR) Part 50.49 and as specified by other regulatory and industry standards. Such testing is required by NRC regulations to demonstrate that components that perform a safety function can be relied upon to operate throughout their qualified life after exposure to design basis accident conditions, including radiation, thermal aging, pressure, temperature, humidity, and seismic vibration, as applicable.

The NRC inspection team focused its review on WEC's development of qualification and functional testing for a sample of components important to the safety for AP 1000 reactors, including squib valves, electrical containment penetration assemblies, motor operated valve actuators, operational and control center panels, and reactor coolant pump switchgear. For the selected components, the inspection team assessed whether applicable design inputs were correctly translated into specifications, drawings, procedures, and instructions being provided by WEC to the testing facilities and vendors. The team assessed whether the test requirements and specifications were appropriately supported by engineering data and calculations and whether they complied with applicable regulatory requirements and industry standards as described in Revision 19 to the AP1000 Design Certification Document (DCD).

1. Environmental Qualification Program

a. Inspection Scope (ITAACs 2.1.02.07a.i, 2.2.01.06a.i, 2.1.02.05a.ii, 2.2.01.05.ii, 2.2.02.05a.ii, 2.2.04.05a.ii, 2.3.02.05.ii, 2.3.06.05a.ii, and 2.5.02.02.ii)

Part 50.49 of the 10 CFR requires that equipment important to safety be environmentally qualified to withstand normal operating conditions and conditions of design basis accidents (DBAs). WEC's overall methodology for qualifying safety related electrical and mechanical equipment is contained in Appendix 3D, "Methodology for Qualifying AP1000 Safety-Related Electrical and Mechanical Equipment," to Tier 2 of the AP1000 DCD, Revision 19. The NRC inspection team reviewed the methods being used by WEC to translate the results of accident analyses performed for the AP1000 reactor design into appropriate testing parameters for radiation, pressure, temperature, and seismic events. The team reviewed applicable DCD commitments, industry codes, and test standards. In addition to document review, the team conducted interviews with WEC staff. The team also performed specific reviews to assess whether component specific functional requirements were being appropriately captured in the testing requirements and specifications.

b. Observations and Findings

b1. Radiation

As stated above, 10 CFR 50.49 requires that equipment important to safety be environmentally qualified to withstand the effects of the radiation, both due to normal operating conditions over the qualified life of the equipment and due to DBAs. As described in paragraph 3.11.4 of Tier 2 to the AP 1000 DCD, Revision 19, the maximum combined radiation dose for equipment inside containment is based on the effects of the normally expected gamma radiation environment over the equipment's installed life and the most severe gamma and beta radiation environment associated with the most severe DBA during or following which the equipment is required to remain functional.

With respect to the radiation expected from the normal environment, Table 2-1 of calculation APP-GW-VPC-010, "AP1000 Equipment Qualification Radiation Values for Safety-Related Component Aging," provides a summary of the expected 60 year integrated dose rate for selected areas inside containment. Likewise, Table 2-2 of the same calculation provides for the expected 60 year integrated dose rate for equipment outside of containment.

For the radiation dose associated with a design basis accident, WEC used the guidance provided in Regulatory Guide 1.183, "Alternate Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" and NUREG 1465, "Accident Source Terms for Light-Water Nuclear Power Plants." The team identified that rather than calculating a radiation exposure due to the design basis accident that is dependent on the specific location of the equipment, WEC used an estimated does based upon a location in the middle of the AP1000 containment. WEC explained that the source term used in the analysis assumed a much larger percentage of fuel damage than that which would occur from a design basis accident. The standard approximation used was still conservative and is allowed by paragraph five of Appendix I to Regulatory Guide 1.183. As such, the team found the overall approach used by WEC to be adequate.

With regard to the effects of neutron radiation on equipment, WEC explained that they had considered whether specific testing protocols need be developed specific to neutron radiation for the components located inside containment. Such exposure to neutron radiation would be expected during normal operation at times when the reactor is critical. For areas inside of containment, the radiation values in APP-GW-VP-030, "Master Equipment Qualification Environmental Summary," were determined using predictive radiation analysis software, as mentioned in the AP1000 DCD, Tier 2, Section 12.3.2.3. As part of this predictive modeling, neutron and gamma ray contributions to dose rates were analyzed, and identified separately in AP1000 documents. Therefore the neutron component of the radiation dose within each room is established, and this value is multiplied by a correction factor of three to determine an equivalent gamma radiation dose for equipment qualification (EQ). The gamma equivalent radiation dose of the neutron component is then added to the estimated gamma radiation dose for that room to find the Total Integrated Dose for a given space. The total integrated does (TID) is what is reflected in APP-GW-VP-030, and is also what is used in downstream EQ testing. This method of determining a TID based on neutron and gamma radiation doses is described in Appendix B of APP-GW-VP-030, and is based upon section 2 in EPRI Report NP-2129, "Radiation Effects on Organic Materials in Nuclear Plants," dated November 1981.

Unlike above, for the squib valves located inside containment, WEC developed a specific testing protocol to subject the valves to neutron bombardment as part of the EQ testing program. This was done to ensure that neutron radiation does not produce an undesirable chemical effect on the squib valve propellant, as WEC could not locate any industry information on this subject. For other components within the plant, the safety-related functions are based upon mechanical operation of the structures, systems and components (SSC), and thus, neutron irradiation was not required as neutron-induced mechanical damage for these SSCs can be simulated by exposure to gamma radiation.

b2. Pressure

Part 50.49 to the 10 CFR requires that equipment important to safety be environmentally qualified to withstand the effects of temperature and pressure during normal operating conditions over the qualified life of the equipment and during the most severe DBAs. The team reviewed WEC design documents and calculations, including the electrical penetration assemblies pressure curves, to determine if the bounding pressure inside containment during DBAs was appropriately specified in qualification testing plans and was in conformance with the DCD commitments and design requirements.

The team reviewed several calculations that included pressure transients for the following DBA scenarios: double ended cold leg guillotine, double ended hot leg guillotine, and main steam line break (MSLB) inside containment. The EQ envelope curves for temperature and pressure inside containment were compiled for these scenarios and were translated from calculations into test plans and procedures. The team reviewed APP-SSAR-GSC-125 “AP100 Long-term LOCA Containment Pressure and Temperature Response” in which several composites of different compartment pressure profiles were captured such as the core make-up tank compartment and the steam generator compartment. The highest temperature and pressure was used. The time was extrapolated for a year in order to determine the long-term containment pressure and temperature transient response for a double ended hot leg guillotine loss of coolant accident (LOCA) and a double ended cold leg guillotine LOCA. The team also reviewed documents CN-CRA-01-95, “AP1000 LOCA Containment Pressure Analysis” and CN-CRA-02-16, “AP1000 MSLB Containment Pressure”. Within these documents, there were several composites of pressure curves for a LOCA or MSLB within containment. As specified in the DCD, the worst case scenario for containment pressure is taken as 70 psig, even though some parts of containment do not see this pressure during a DBA. The team reviewed calculation APP-SSAR-GSC-123, “In-Containment DBA Curves Developed for Determination of Equipment Qualification Envelope Curves,” which explains that temperature and pressure transients for each DBA were generated with software known as WGOTHIC. The transients were then compiled into composite curves and a maximum pressure was determined with a 1 psig bias, in conformance with Regulatory Guide 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants.”

According to APP-GW-VP-100, “Equipment Qualification Specifications and Documentation Requirements for AP1000 Safety-Related Electrical and Electro-Mechanical Equipment”, qualification tests to DBA conditions shall envelop the AP1000 DCD specific DBA temperature and pressure profiles. The team reviewed the Environmental Zone 1 DBA/Post-DBA pressure profiles within this document to verify the DBA containment pressure is consistent with the above mentioned calculations. APP-GW-VP-030, “Master Equipment Qualification Environmental Summary” was also reviewed and pressure requirements verified.

The team reviewed test procedure for the medium voltage power, low voltage power, and the instrument and control electrical penetration assemblies in order to verify the flow down of pressure calculations.

b3. Temperature

As noted above, 10 CFR 50.49 requires that equipment important to safety be environmentally qualified to withstand the effects of temperature and pressure during normal operating conditions over the qualified life of the equipment and during DBAs. APP-GW-VPC-010, “AP1000 Equipment Qualification Radiation Values for Safety-Related Component Aging,” indicates that AP1000 safety-related equipment is installed in 11 distinct environmental zones. This qualification methodology document described the characteristics, including temperature, of the 11 zones. The parameters described included normal, abnormal, and DBA environmental conditions.

The team noted that the temperature parameters mentioned above were based on WEC calculations and analysis. APP-GW-VPC-011, “AP1000 Equipment Qualification DBA/Post-DBA Temperature and Pressure Envelopes,” described DBA and post-DBA temperature envelopes. This document incorporated calculated temperature and pressure transients. Calculation APP-SSAR-GSC-123, “In-Containment DBA Curves Developed for Determination of Equipment Qualification Envelope Curves,” noted that it provided bounding equipment qualification envelope curves for temperature consistent with Regulatory Guide 1.89. Calculation APP-SSAR-GSC-168, “AP1000 Steamline Break MSIV Compartment Temperature Response for Advanced First Core,” analyzed the temperature response in the in the AP1000 auxiliary building main steam isolation valve (MSIV) rooms after a steamline break. The team noted that test plans and procedures reviewed properly referenced the envelopes described in APP-GW-VPC-010.

b4. Seismic

In addition to 10 CFR 50.49 requirements for environmental qualification, 10 CFR 50.34(a)(12) and 50.34(b)(10) require design of nuclear power plant structures, systems, and components important to safety to withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform their safety functions. Paragraph 3.10 of Tier 2 to the AP1000 DCD, Revision 19, requires that structural integrity and operability of mechanical and electrical equipment and instrumentation, in the event of a safe shutdown earthquake (SSE) after a number of postulated occurrences of an earthquake smaller than an SSE in combination with other relevant dynamic and static loads, is demonstrated. Seismic qualification is used to show that the equipment will perform its safety-related functions after an SSE at the end of its qualified life.

APP-GW-G1-002, “AP1000 Plant Equipment Qualification Methodology,” is the primary procedure used by WEC to govern all equipment qualification for the AP1000. Sections of this procedure provide seismic margin and engineering design criteria, approved in Revision 15 of the AP1000 DCD, for testing and analysis for certified seismic design response spectra and hard rock high frequency screening for structure response spectra. This procedure also follows seismic qualification methods and derives all test plans for seismic testing in compliance with IEEE 344-1987.

The team reviewed a sample of seismic qualification test plans for tests performed at various test facilities. When testing was not to be performed directly by WEC, purchase orders for procurement of testing services were assessed. Where available, the team also reviewed the test reports resulting from the testing. The purpose for the testing was to ensure that all safety-related equipment maintained full functionality during and/or after being subjected to the forces resulting from a SSE.

For the sample of test plans reviewed, it was verified that technical information and contract specifications were adequately translated into test parameters. Additionally, the team verified that testing monitored and controlled necessary parameters across the range of interest for each component tested. Each test plan followed the appropriate guidance from WEC's equipment qualifications procedures, IEEE standards, and, if applicable, contractual obligation for technical, administrative, regulatory, and reporting quality requirements imposed by the purchase orders for testing services.

c. Conclusions

The team concluded that WEC's test plans and procedures for equipment qualification were supported by calculations and analysis consistent with Appendix 3D of the AP1000 DCD. No findings of significance were identified.

COMPONENT SPECIFIC ENVIRONMENTAL QUALIFICATION

2. PV70 Squib Valves

a. Inspection Scope (ITAACs 2.2.01.06a.i, 2.2.03.07a.i, and 2.2.03.12a.i)

The overall equipment qualification program for the 8-inch and 14-inch squib valves involves four separate testing programs: actuator qualification testing, electromagnetic interference testing of the actuators, seismic testing of both the actuators and the valves, and functional testing of the actuators and valves per ASME QME-1. For this inspection, the NRC inspection team focused on the actuator qualification, seismic testing of the actuators and valves, and functional testing programs. Within each program, the team assessed whether the parameters specified for testing were consistent with the design basis for the equipment. The team also assessed whether the testing protocols described in the equipment qualification test plan matched the as-installed conditions of the equipment.

b. Observations and Findings

b1. Squib Valve Equipment Qualification Test Plan

As described in test plan APP-PV70-VPH-001, "AP1000 Squib Valve Equipment Qualification Test Plan," WEC has allocated eleven 8-inch and nine 14-inch actuators to serve as actuator qualification test samples. WEC has established a targeted qualified life for the 8-inch and 14-inch squib valve actuators (cartridges and initiators) of eight years for the purposes of the environmental qualification testing. The environmental qualification testing protocol includes thermal aging, radiation aging, mechanical cycling, vibration aging, pressure testing, and design basis accident testing. The test plan calls for firing one actuator of each size after each phase of the testing program. Because the actuators are qualified independently of the squib valves, the actuators will be fired into an instrumented closed volume and their functionality will be determined by plotting a pressure versus time curve and comparing it against specific acceptance criteria. This method of qualification was determined to be acceptable by the NRC inspection team.

The team identified that the environmental parameters contained in test plan APP-PV70-VPH-001 were appropriately transcribed from the squib valve data sheets in APP-PV70-ZOR-001, “PV70 Squib (Pyrotechnic Actuated) Valves, ASME Section III Class 1, Data Sheet Report.” With respect to radiation, the team identified that the gamma and beta radiation levels specified for testing and contained in the qualification test plan were consistent with those contained in the DCD and calculation APP-SSAR-GSC-507, “AP1000-Equipment Qualification and Sever Accident Radiation Dose.” The team verified that the radiation levels accounted for both normal and accident conditions. As described previously in this report, WEC used calculated radiation levels for accident conditions for a point midway in the containment. This is allowed by paragraph five of Appendix I to Regulatory Guide 1.183. In addition to beta and gamma radiation doses, WEC also performed a specific calculation of the neutron dose that would be received by the squib valves due to neutron radiation and has specified requirements for neutron testing in the test plan. The team verified the calculated neutron radiation values were appropriately transferred from APP-1100-N5C-002, “AP1000-Equipment Qualification Radiation Values in Normal Operation Conditions for Safety-Related Components” into the qualification test plan.

The team identified that the time/temperature profiles associated with the thermal aging of the actuators had not yet been developed and, as such, were not included in the qualification test plan. As stated in test plan APP-PV70-VPH-001, the profiles are to be developed by the testing laboratories using the Arrhenius equation methodology. Inputs into this methodology include a determination of the activation energies of the materials in question and the expected temperatures for the normal and abnormal operating equipment environment. The team verified that the activation energies for the propellants in the squib valve initiator assembly and cartridges were determined using a separate analysis included as Attachment I to the test plan. Activation energies for other materials were not provided in the test plan, but rather are being left up to the testing laboratories to determine. Once the activation energies for these materials are identified, the test plan calls for the testing laboratories to apply the Arrhenius equations and determine the proper time/temperature testing protocols, as necessary to address the thermal aging requirements. A note will be added to the NRC’s CIPIMS database to highlight this issue for potential inspector follow-up.

The test plan specifies that the actuators be subjected to the maximum calculated containment temperature and a 15% design margin. The test plan also specifies that four of the 8-inch and two of the 14-inch actuators will be subjected to a design basis accident (DBA) profile that envelopes the calculated accident temperatures, pressures, and containment spray. Since the design basis for the 8-inch valves includes submergence, the test plan specifies that two 8-inch actuators be submerged (one for 1 hour and one for 72 hours) and then fired to demonstrate performance under submergence conditions. This was acceptable to the inspection team.

As described above, during each phase of the qualification testing, some of the actuator test specimens will be destructively fired. The team assessed whether the method specified to fire the actuators during testing was representative of how the actuators will actually be fired once installed in the plant. While a description of the specific equipment to be used to fire the actuators was not included in the test plan, Appendix A of the test plan specifies that a "firing box" be set for 3.7 amps and 10 msec and that this current then be applied to the test specimens. These values were taken directly from the design specification for the actuators; no additional margin was added to account for instrument uncertainties. WEC indicated to the team that this "firing box" will actually be a constant current source and that instrument uncertainties will be addressed during the data analysis of the resultant test report.

The team identified that the test plan did not include verification of the "no fire" requirement of the squib valve actuators. Specifically, the actuators have a requirement to not spuriously fire when subjected to a current of one ampere for one minute. This specification is important as it allows for a small current to be applied to the actuators to verify bridge wire continuity during surveillance testing and it also guards against inadvertent operation of the squib valves due to spurious or induced signals. The team noted that a spurious operation of the 14-inch squib valves is not analyzed in the AP1000 DCD. During the inspection, WEC initiated Issue Report #12-089-M004 to document the team's concern and indicated they plan to add this testing requirement to the qualification test plan. The lack of testing for the no-fire feature of squib valves during qualification testing was identified by the team as one example of Nonconformance 99900404/2012-201-01.

For the ASME QME-1 functional testing, WEC is testing one each of the three squib valve designs: 8-inch low pressure, 8-inch high pressure, and 14-inch automatic depressurization system valves. Testing on these valves includes a valve submergence test, leakage tests, functional capability tests, and flow tests. During the inspection, the team questioned whether using the highest design temperature for testing the valves represented the most adverse design basis conditions. In response to the team's question, Westinghouse consulted with the vendor of the squib valves, SPX, and it was determined that the shear caps that prevent fluid flow through the valve are actually easier to shear at higher temperatures, thus testing the valve at the highest design temperature may not be conservative with respect to all operating conditions where squib valve operation is credited. WEC initiated Issue Report #12-090-M0007 to document and evaluate this concern. The planned functional testing of the squib valves at conditions which may not represent the most adverse design basis conditions was identified by the team as one example of Nonconformance 99900404/2012-201-01.

b2. Protection and Safety Monitoring System and Diverse Actuation System Firing Circuits

During the inspection, the team reviewed diagrams of the AP1000 Protection and Safety Monitoring System (PMS) to assess the degree that the configuration of the as-designed plant interfacing circuitry mimicked that of the test configuration. The team identified that unlike the circuitry used in the test program to apply current to the actuator, the electrical current used to fire the actuators in the plant will be derived from a capacitor bank that is discharged once a fire signal is generated by the PMS system. Because the capacitor bank is charged to a pre-determined voltage and then depletes quickly over time, the ability to achieve the required current to fire the actuators within a specified time is largely dependent upon the resistance of the actuator-initiator circuit, including the resistance of the initiator bridge wire, field cabling, and connectors. APP-GW-J4-072, "Interface Specification for Squib Valve Controller," provides a maximum round trip resistance value of 3 ohms for this field wiring. This resistance was calculated by a formal analysis of the associated circuitry as documented in WNA-CN-00206-GEN, "PMS Squib Valve System Operating Parameters." Likewise, a minimum total resistance of 1.3 ohms is also specified to limit the flow of current through the capacitor bank. However, these resistance values are uncorrected for the temperature of the field cabling/connectors. While the interface specification alludes to the fact that these resistances need to be verified and accident conditions need to be considered when designing the field cabling system, the specification states that it is the responsibility of the cable designer to meet the resistance requirements of the system. The team identified that the interface document does not, however, provide sufficient information that would allow for the proper sizing of the cables, as it does not include the full range of temperatures that need to be considered when sizing the cables. The team identified this as Nonconformance 99900404/2012-201-02.

The team noted that the squib valves can also be fired by the Diverse Actuation System (DAS). As such, the team attempted to perform a similar review of the DAS system circuitry, as necessary to ensure that the specified minimum and maximum field cabling/connector resistances for that system were based upon verified design information. Unlike the PMS system, WEC could not produce a specific calculation that had been performed to analyze the DAS circuitry. Through interviews conducted with WEC staff, it was determined that such an analysis had been performed informally and that there was no documentation available to support the outcome of that review. Consequently, the adequacy of the stated required resistance values for this DAS system's cabling/connector system could not be verified by the inspection team. The team identified the lack of a documented design analysis to support the required DAS resistance values for field cabling and connectors to the squib valve as Nonconformance 99900404/2012-201-03.

The team noted that the design of the field run cabling/connector system for both the PMS and the DAS systems has not been completed. This correct design of this system will have to account for both the specified minimum and maximum resistance specifications for the PMS and DAS over the full range of temperatures that the squib valves are required to operate. The team noted that cable resistance can increase by almost a factor of two between ambient and accident temperatures and that consequently, it appears that a very small window of acceptable resistance for the cabling resistance will result. Since the proper design of this cabling/connector system will be critical to ensuring the operability of the squib valves a note will be added to the NRC's CIPIMS database to highlight this issue for potential inspector follow-up.

c. Conclusions

The team identified three nonconformances during its review of squib valve qualification and functional testing. Nonconformance 99900404/2012-201-01 concerns the failure to include a test of the "no fire" feature of the squib valve actuators in the qualification testing program. Verification of the "no fire" feature is important to ensure the design of the squib valve is sufficient to prevent spurious actuations of the valves. Another example of Nonconformance 99900404/2012-201-01 concerns the temperature specified for functional testing of the squib valves. The temperature specified in test plan APP-PV70-VPH-001 to perform the testing may not be sufficient to validate operation of the valve at all temperatures where squib valve operation is credited. Nonconformance 99900404/2012-201-02 concerns the failure to clearly define the operating requirements (temperature) for the field cabling and connectors that will be used to fire the squib valves once installed in the plant. This definition of operating requirements is necessary to ensure the resulting cabling/connector system has the proper resistance to support the firing of the valves. Nonconformance 99900404/2012-201-03 concerns the lack of a documented calculation, as related to the analysis of the DAS circuits that will be relied upon to fire the squib valves. Such an analysis is necessary to establish the proper resistance of the field cabling/connector system.

The team also identified two items for potential follow-up NRC inspection. The first item involves the specification of activation energies for the squib valve actuator components and the calculation of time/temperature thermal aging profiles. The second item concerns the design of the cabling/connector system for both the PMS and DAS systems, as necessary to ensure total resistances are within design specifications.

3. PV95 Electric Motor Actuators

a. Inspection Scope (ITAACs 2.2.02.06a.i, 2.2.04.07a.i, 2.3.02.06a.i, and 2.3.06.07a.i)

The NRC inspection team reviewed WEC's plans for environmentally qualifying safety-related electric motor actuators for the AP1000 reactors. These actuators are manufactured by Limitorque and are designated by WEC as PV95 under the "valve" equipment type classification. The inspectors reviewed the engineering methodology used by WEC for selecting representative Type SB valve actuators for type testing. The actuators chosen for testing were selected to cover the broad range of actuator sizes to be used as part of the AP1000 design.

The team also reviewed the test plan, APP-PV95-VP-001 "Equipment Design Requirements for Safety-Related Limitorque Motor Actuator Test Specimens" to ensure that the specifications and requirements contained within the plan had been properly transferred from relevant design documents, including the DCD. The information in the test plan is used by the test vendors to write test procedures and actually perform the qualification testing work.

The team reviewed the AP1000 design specification APP-PV95-Z0-001, the associated test plan APP-PV95-VPH-002, "AP1000 Test Plan for 10-Year and 60-Year Qualification of Limitorque Valve Actuators," and calculation APP-PV96-VPC-001, "AP1000 Limitorque Valve Actuator Equipment Qualification Radiation and Thermal Aging Calculation." The team also reviewed a sample of purchase orders to vendors who will be supplying the test specimens and performing testing. Lastly, the team reviewed Procurement Advisory Releases, test procedures, and test results related to the supply and testing of the motor actuators.

The team focused its review on the following activities related to the environmental qualification of the actuators:

- Implementation of the methodology utilized to select specific actuators as representative samples for qualification testing
- Supply of motor operated actuator test specimens
- Mechanical cycling of test specimens
- Radiation ageing of test specimens

- Seismic testing of actuators
- DBA testing of actuators

The team also reviewed the WEC processes to ensure that the above activities were being performed consistent with Institute of Electrical and Electronics Engineers, (IEEE) 382-1996 “IEEE Standard for Qualification of Actuators for Power-Operated Valve Assemblies With Safety-Related Function for Nuclear Power Plants,” and American Society of Mechanical Engineers (ASME) QME-1-2002, “Qualification of Active Mechanical Equipment Used in Nuclear Power Plants,” as committed to in the AP 1000 DCD, Revision 19.

b. Observations and Findings

b1. Methodology for the Selection of Parent Actuators

The team noted that Paragraph 7.6.2 “Qualification of Actuator Families,” of Section 7 “Development of a Qualification Program,” of WEC’s APP-GW-VP-010 “Equipment Qualification Methodology and Documentation Requirements for AP1000 Safety-Related Valves and Valve Appurtenances,” Revision 2, states in part that:

> “Parent actuators used to qualify a range of operator sizes shall be determined using Annex A of [Institute of Electrical and Electronics Engineers (IEEE)] Std. 382-1996 (Reference 2.3.7). […] ’Parent’ actuator sizes used to qualify a range of valve and actuator sizes shall be documented in a report and submitted to Westinghouse for approval.”

The team noted that WEC contracted the engineering methodology for selecting representative actuators to Limitorque per Purchase Order 4500263856. Limitorque was contracted to perform the analysis in accordance with IEEE 382-1996. Annex A of the IEEE standard contains a methodology to select representative actuators for type testing. The results of the analysis were provided to WEC in a report entitled “Limitorque Type SB Series Valve Actuator Test Specimen and Methodology for Westinghouse AP-1000 Environmental Qualification Testing,” Revision 2, dated November 17, 2008.

The team identified several mathematical errors in the report. Specifically, the tables used to define the actuator groups identified incorrect sets of actuators. In addition the report did not contain an analysis comparable to Table A.3 “Selection of test models,” of Annex A of IEEE 382-1996. WEC could not provide any objective evidence of their review, approval, or acceptance of the report as required its “Procurement Advisory Release” process, and by APP-GW-VP-010. The inspectors concluded that WEC failed to adequately examine analysis performed by the Limitorque. This issue has been identified as Nonconformance 99900404/2012-201-04. Notwithstanding the above concerns, the team verified that the conclusions of the report, regarding the final selection actuators to be tested, were correct. In response to this issue, WEC issued Corrective Action Program Report CAP 12-089-M020, dated March 29, 2012.

b2. Translation of Design Requirements into Test Plans

Paragraph 2.0 “Policy” of WEC’s APP-GW-GEP-010 “Process and Procedures for AP1000 Internal Open Items and Holds,” Revision 5, required WEC to identify the use of a draft design specification as an open item.

The team noted one instance where WEC failed to appropriately translate a design specification into the test plan. In this case, the test plan was developed using a draft version (Revision C) of the AP1000 design specification APP-PV95-Z0-001. In the final version of the design specification, a note was added to ensure that the actuator components were free from aluminum. However this specification was not included in the APP-PV95-VP-001 test plan. This issue has been identified as Nonconformance 99900404/2012-201-05.

As a result, WEC opened Corrective Action Program Report CAP 12-089-M043, dated March 29, 2012. WEC noted that the design requirements for the actual production actuators, to be used in the plant, contain the proper aluminum exclusion. WEC also explained that the actuator test specimens do not contain any aluminum components.

The team noted one instance where Limitorque took exception to performing a test included in the test plan. In this case, the proposed test involved a production stall test of the test specimen's direct current motors. The team found that WEC provided adequate analysis to support Limitorque's proposed change to the test plan.

The team also noted that WEC included adequate requirements in its purchase orders to vendors supplying services. For example, WEC referenced its test plans to ensure that the vendors met WEC's design requirements. WEC documented its reviews of incoming vendor documents, such as test procedures and reports, in Procurement Advisory Releases.

b3. Quantification of Actuator Performance During Testing

As discussed previously, the qualification program for the AP1000 valve actuators involves testing of three representative actuator specimens chosen to be representative of the total family of actuators to be used in the AP1000 design. WEC indicated that the actual actuators to be supplied as part of the AP1000 design will be sized using standard industry sizing equations that account for the valve's thrust requirements, ambient temperature effects, actuator motor capability, actuator gear ratios, friction coefficients, degraded voltage requirements, test equipment accuracies, and various other parameters. The correct matching (sizing) of the correct motor actuator to each specific valve is critical to ensuring the operability of the valve/actuator combination under all design basis.

The team noted that the effects of radiation exposure and other design basis environmental conditions on overall actuator performance are not typically modeled by the standard industry sizing equations. Consequently, such effects need to be specifically considered as part of the qualification testing program. Since the amount of actual margin (thrust available versus thrust required) that exists once a specific actuator is matched to a specific valve can vary significantly, it is therefore necessary to quantify any losses in actuator performance due to the design basis environmental conditions.

The team noted that test plan APP-PV95-VPH-002, "AP1000 Test Plan for 10-Year and 60-Year Qualification of Limitorque Valve Actuators," did not require that an analysis be performed to quantify the loss of actuator output capability during and after the planned design basis testing. Rather, the test plan only required that the tested actuators be shown to be operational. The team identified that while this approach may be adequate for qualifying the specific actuator/valve combination for the specific conditions of the test, additional data analysis will be necessary to utilize the information gathered during the test for the purposes of extrapolating the test results to other operating conditions of the tested actuator/valve combination or to other actuator/valve combinations. Specifically, WEC will have to quantify any loss of actuator capability observed during and after the DBA testing in order to ensure that these losses are properly accounted for when sizing actuator/valve combinations. While the team identified that it appears that sufficient instrumentation and data will be available to perform such an analysis, no mention of the need to perform this analysis was included in the test plan.

WEC indicated that such an analysis will be performed as part of the qualification packages that will be produced for each valve/actuator combination. A note will be added to the NRC's CIPIMS database to highlight this issue for potential inspector follow-up.

c. Conclusions

The inspectors identified Nonconformance 99900404/2012-201-04 for failing to perform an acceptance review of an analysis performed by Limitorque to group actuators for the purposes of qualification testing. The inspectors also identified Nonconformance 99900404/2012-201-05 for failure to appropriately incorporate into the test plan a change to the design specification. The team identified one item for potential NRC inspection follow-up involving the quantification of margin reduction in the tested actuators and extrapolation of this data to non-tested actuator/valve combinations.

4. Electrical Penetration Assemblies

a. Inspection Scope (ITAACs 2.2.01.04a.ii, 2.2.01.06a.i, 2.2.01.06a.ii, 2.2.01.06d.i, and 2.2.01.06d.ii)

The NRC inspection team reviewed the electrical penetration assembly (EPA) design commitments and equipment qualification (EQ) testing requirements to ensure they were accurately translated into design specifications, test specifications, test plans, purchase orders, and test procedures in accordance with pertinent industry standards and the AP1000 DCD, Revision 19, commitments.

b. Observations and Findings

b1. Methodology and Procedures

The team reviewed documents and conducted interviews with WEC staff concerning the qualification testing for the three types of EPAs: medium voltage penetration assembly (MVP), low voltage penetration assembly (LVP), and instrumentation and control (I&C) penetration assembly. The team reviewed the EQ requirements specified in the AP1000 DCD, Revision 19, and verified that they were appropriately transferred into the associated documents: APP-GW-G1-002, "AP1000 Plant Equipment Qualification Methodology;" APP-GW-VP-100, "Equipment Qualification Specifications and Documentation Requirements for AP1000 Safety-Related Electrical and Electro-Mechanical Equipment;" APP-EY01-VPH-001, "AP1000 Test Plan 60-Year Qualification of Electrical Penetrations;" and APP-EUY01-Z5-008, "Appendix 3.0 Technical and Quality Purchase Order Requirements." The team also verified that these documents incorporated the applicable requirements of 10 CFR Part 21 and Part 50 to Appendix B of 10 CFR Part 50.

The team verified that the test procedures developed by Kinectrics Inc., appropriately incorporated the above testing requirements. The test procedures reviewed included K-403869-PSWI-0002, "Kinectrics Inc. Test Procedure for Qualification Testing of IST Low Voltage Electrical Penetrations"

- K-403869-PSWI-0001, "Kinectrics Inc. Test Procedure for Qualification Testing of IST Medium Voltage Electrical Penetrations"
- K-403869-PSWI-0005, "Kinectrics Inc. Test Procedure for Qualification Testing of IST Low Voltage Power and I&C Electrical Penetrations"
- K-403869-DSF-0040, "Kinectrics Inc. Test Procedure for Proof Testing of IST Low Voltage Electrical Penetrations Feedthrough Assemblies"

Since a portion of the testing for the LVP EPA was already complete, the team reviewed the test results. The team noted that during the loss of coolant accident (LOCA) portion of the test program a seal failure occurred on the inboard end of the assembly and an electrical short circuit was identified on one of the feed through conductors. WEC explained to the team that they believed that these failures were caused by test anomalies. This conclusion was based upon a root cause analysis which was performed after identification of the test specimen failures. The teamed reviewed IPS-2385, "Root Cause Analysis for LVP EPA Sealant Leak Anomaly and Short-Circuit Anomaly", which determined that the failures were due to the high temperatures caused by excessive current loading during the testing. The report also indicated that the test specimen had been irradiated to levels higher than required which was thought to have degraded the Polysulfone sealants used in the penetration assembly. This degradation, along with the LOCA steam environment, was believed to have resulted in the degradation of the Kapton insulation of the penetration conductors, causing an electrical failure. The team determined that the conclusions of the root cause analysis report seemed reasonable and that the test procedures were revised appropriately. Additional testing of the penetrations will be performed as necessary to ensure qualification of the EPAs.

b2. <u>Installation Welding Test Requirement</u>

The team determined that Section 6.2.11 of IEEE 317-1983, "IEEE Standard for Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations", requires an installation welding test to be performed, as necessary to demonstrate that an EPA can be successfully welded into the containment vessel without damage using the manufacturer's recommended procedures. The IEEE standard further states that these are design tests that can be performed on the test specimen in any sequence and do not have to be performed on those specimens that have been subjected to qualified life tests.

Interviews with WEC personnel revealed that an installation welding test was completed for an LVP EPA test specimen by the manufacturer IST/Conax Buffalo per IEEE 317 and documented in a Design Qualification Report of a Low Voltage Power and Control EPA, IPS-1525. However, the team determined that the design of the LVP/Control EPA referenced in the report was different than that of the penetrations to be supplied as part of the AP 1000 design. According to WEC, a justification that includes a comparison of the EPA design used during the manufacturer's installation welding test and the EPA design of the current test specimen will be completed and included within the Environmental Qualification Summary report for the EPAs.

c. Conclusions

The team determined that AP1000 DCD commitments, industry standards, and EPA design and qualification requirements were adequately translated into test plans and procedures. No findings of significance were identified.

5. Seismic Qualification of Specific Components

a. Inspection Scope (ITAACs 2.5.02.02.ii.and 2.2.03.05a.ii)

The NRC inspection team performed reviews of selected components to assess whether functional requirements were being appropriately captured in WEC test specifications and requirement documents. Some of the seismic testing is being performed by WEC at a WEC owned facility, some testing is being performed at a vendor test facility by WEC staff, and some testing is being performed at a vendor facility by vendor staff. For the purposes of this inspection, the seismic qualification of one component associated with each of the above three possible testing paths was selected for review. The team reviewed applicable seismic DCD commitments, industry codes, and test standards. These were compared with the test plans to verify that all requirements were incorporated appropriately.

b. Observations and Findings

b1. Reactor Coolant Pump Switchgear

The team reviewed test plan APP-ES02-VPH-01, “AP1000 Seismic Test Plan for RCP Switchgear,” for seismic qualification of Class 1E 6.9kV Reactor Coolant Pump (RCP) Switchgear. The team identified that the parameters specified in the test plan appropriately enveloped the required response spectra defined in APP-GW-G1-002 “AP1000 Plant Equipment Qualification Methodology,” and a generic required response spectra for use in replacement applications. APP-ES02-VPH-01 provided the seismic qualification information that was reviewed to confirm that adequate test objectives, quality assurance requirements, test parameters, procedures to be followed, preconditioning, data collection, and acceptance criteria were established in accordance with the design requirements of the DCD.

The team verified that WEC test procedures NA 11.1 and NSNP 11.1, provide for proper control of the testing process and test data, including requirements for a detailed log documenting test and recording equipment, date of test, test procedures, calibration information, preconditioning details, mounting details, each test run and test results, post test inspection results, signature of tester or data recorder, signature of confirming EQ test engineer, and a listing of all deviations.

The team identified that the above testing program had already been completed at Clark Laboratories facility in Jefferson Hills, Pennsylvania from September 24-28, 2011. Purchase Order (PO) 4500408913 detailed the testing scope, and it specified that functionality checks and electrical monitoring of the RCP switchgear would be completed by WEC personnel, while Clark Laboratories personnel would perform the seismic testing.

The team reviewed the RCP swtichgear test report and verified that all testing was done in accordance with the stipulations of the PO, the test plan, and other WEC related procedures. At the time of inspection, the test report had yet to be analyzed for use towards the closure of AP1000 DCD ITAAC. In the test report, all anomalies were clearly identified and appropriate corrective actions were taken. The team also verified that the test report was reviewed, approved, and submitted to the design organization for final approval.

b2. Main Control Room/Remote Shutdown Room Transfer Panel

The inspectors reviewed APP-JW03-VPP-003, "Seismic Test Procedure for the AP1000 Main Control Room/Remote Shutdown Room Transfer Panel," to verify that DCD commitments and test specifications were appropriately transferred into test requirements. This panel includes Seismic Category 1E equipment, and these tests will be performed by WEC at the WEC testing facility in New Stanton, Pennsylvania. Because of this, there was no PO associated with the seismic qualification of these components.

APP-JW03-VPP-003 seismic qualification information was reviewed to confirm that adequate test objectives, quality assurance (QA) requirements, test parameters, procedures, preconditioning, data collection, and acceptance criteria were established and met design requirements of the DCD. Test documentation, as required by WEC test procedures NA 11.1 and NSNP 11.1, included a detailed log documenting test and recording equipment, date of test, test procedures, calibration information, preconditioning details, mounting details, each test run and test results, post test inspection results, signature of tester or data recorder, signature of confirming EQ test engineer, and a listing of all deviations.

b3. PV70 Squib Valves

The team reviewed WEC PO 4500312821 and PO 4500312838 issued to Wyle Laboratories to perform seismic qualification tests for the AP1000 safety-related squib valves. The POs were reviewed to verify that seismic testing and quality assurance requirements were adequately incorporated into the procurement documents. The POs require that the testing be performed using WEC approved test plan APP-PV70-VPH-001, "AP1000 Squib Valve Equipment Qualification Test Plan." The team reviewed the test plan to ensure that DCD commitments and test specifications were correctly translated into test requirements with respect to the seismic testing. Additionally, the team verified that the test documentation required to be returned to WEC was sufficient. The inspectors also verified that technical information interfaces were controlled and accurate.

The inspectors reviewed APP-PV70-T5-001, "Qualification Plan for Safety-Related Squib Valve Actuators and Electrical Connection Assemblies for Westinghouse Electric Company for using in Westinghouse AP1000 Nuclear Power Plants," to verify that it incorporated all seismic qualification requirements of the PO. This test plan incorporated IEEE requirements, DCD commitments, and Wyle-Westinghouse Meeting Minutes commitments. The team verified that the test order specified by the qualification plan for the various environmental qualification tests was sufficient to ensure that necessary aging of the squib valves would be completed prior to the seismic testing. Wyle-Westinghouse Meeting Minuets dated March 4, 2009 specifically document clarification of discrepancies between the WEC test plan APP-PV70-VPH-001 and the Wyle Laboratories qualification plan APP-PV70-T5-001 as of March 4, 2009, the qualification plan was reviewed to ensure that it specified that discrepancies be documented in accordance with 10 CFR Part 21 and Part 50, Appendix B.

PO 4500312838 also requires Wyle Laboratories to meet APP-PV70-T5-003, "Qualification Plan QME-1-2007 Qualification 8" and 14" Squib Valves," specifically for seismic qualification. Since QME-1-2007 does not directly address squib valves, the qualification plan includes an additional modal test outlined in QVP-7341.1 of ASME QME-1-2002 using the Fast Fourier Transformation Method.

c. Conclusions

The inspectors determined that AP1000 DCD commitments, industry standards, seismic design, and seismic qualification requirements were adequately translated into WEC's test plans and procedures. No findings of significance were identified.

6. Inspections, Tests, Analyses, and Acceptance Criteria

The NRC inspection team identified the following inspections, tests, analyses, and acceptance criteria (ITAAC) related to environmental qualification, seismic qualification, MOVs, squib valves, and electrical penetrations. These ITAAC are referenced in this section for future use by the NRC staff during the ITAAC review process. Although these ITAAC relate to the topics discussed in this inspection report, this report by no means constitutes that the ITAAC have been met or fully inspected by the NRC.

AP1000 Design Control Document, Tier 1, Revision 19	
Table 2.1.2-4	ITAAC 5.a.ii ITAAC 7.a.i ITAAC 11.a.i
Table 2.2.1-3	ITAAC 4.a.ii ITAAC 5.ii ITAAC 6.a.i ITAAC 6.a.ii ITAAC 6.d.i ITAAC 6.d.ii
Table 2.2.2-3	ITAAC 5.a.ii ITAAC 6.a.i
Table 2.2.3-4	ITAAC 5.a.ii ITAAC 7.a.i ITAAC 12.a.i
Table 2.2.4-4	ITAAC 5.a.ii ITAAC 7.a.i

AP1000 Design Control Document, Tier 1, Revision 19	
Table 2.3.2-4	ITAAC 5.ii ITAAC 6.a.i
Table 2.3.6-4	ITAAC 5.a.ii ITAAC 7.a.i
Table 2.5.2-8	ITAAC 2.ii

7. <u>Exit Meeting</u>

On March 30, 2012, the NRC inspection team presented the inspection scope and findings during an exit meeting with Jan Dudiak, Vice President of Operations, Nuclear Automation.

ATTACHMENT

1. PERSONS CONTACTED AND ENTRANCE/EXIT MEETING ATTENDEES

Name	Title	Affiliation	Entrance	Exit
Gary Ament	Environmental Qualification Manager	WEC	X	X
Amy Aughtman		Southern Nuclear		X
Don Behnke	Environmental Qualification Project Manager	WEC	X	X
Jim Bloom		WEC		X
Gerry Boldt		Southern Nuclear		X
Michael Canton		WEC		X
Suresh Channarasappa	Environmental Qualification Technical Lead	WEC	X	X
Ashleigh Chicko	Environmental Qualification Engineer	WEC	X	X
Tom Dent	Vice President and Consortium Director	WEC	X	X
Edward Drake	Environmental Qualification Engineer	WEC	X	X
Tim Drouin	Project Integration	WEC	X	X
Jan Dudiak	Vice President of Operations	WEC	X	X
Joni Faiascino	Vice President of Major Projects Delivery	WEC	X	
Steve Feder	Environmental Qualification Engineer	WEC	X	X
Brian Gaia	Environmental Qualification Manager	WEC	X	X
Al Gillott	Principal Engineer	WEC	X	X
Laura Goossen	Environmental Qualification Program Manager	WEC	X	X
Dan Harris		WEC		X
Aaron Hatok	Electrical Equipment Program Manager	WEC	X	X
Joel Hjelseth		WEC		X
John Iacovino		WEC		X
Ricardo Llovet		WEC		X
John Mallory	SOE	WEC	X	X
Clint Medlock		Southern Nuclear		X
J. Monahan	Plant Analysis & Integration Manager	WEC		
Thom Ray	Manager of AP1000 COL Support	WEC	X	X

Name	Title	Affiliation	Entrance	Exit
Bill Rice		WEC		X
Paul Russ	Director of AP1000 Licensing	WEC	X	
Brian Schleger	Environmental Qualification Engineer	WEC	X	X
Ron Tomon	Supply Chain Management	WEC	X	
Cuong Truong		Southern Nuclear		X
Ron Wessel		WEC	X	X
John Wheless	Principal Engineer for AP1000 Licensing	Southern Nuclear		X
Cory Vogel	SCM	WEC	X	

2. INSPECTION PROCEDURES USED

IP 43002, "Routine Vendor Inspection,"
IP 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance"

3. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Item Number	Status	Type	Description
99900404/2012-201-01	Opened	NON	Criterion III
99900404/2012-201-02	Opened	NON	Criterion III
99900404/2012-201-03	Opened	NON	Criterion III
99900404/2012-201-04	Opened	NON	Criterion VII
99900404/2012-201-05	Opened	NON	Criterion VI

4. DOCUMENTS REVIEWED

Specifications and Procedures

APP-ECS-E8C-101, "ECS Instrumentation Requirements", 1/28/11
APP-ES02-VPH-001, "Seismic Test Plan for RCP (Reactor Coolant Pump) Switchgear," Revision 0, September 2011
APP-EUY01-Z5-008, "Appendix 3.0 Technical and Quality Purchase Order Requirements," Revision 1
APP-EY01-VPH-001, "AP1000 Test Plan 60-Year Qualification of Electrical Penetrations," Revision 0, December 2009
APP-EY01-Z0-001, "Westinghouse EPA design specification," Revision 4, June 27, 2011
APP-GW-G1-002, "AP1000 Plant Equipment Qualification Methodology," Revision 2, April 30, 2010
APP-GW-G1-002, "AP1000 Plant Equipment Qualification Methodology," Revision 2, April 30, 2010
APP-GW-G1-003, "AP1000 Seismic Design Criteria," Revision 6, August 11, 2011
APP-GW-GEP-010, "Process and Procedures for AP1000 Internal Open Items and Holds," Revision 5, August 29, 2011
APP-GW-GEP-010, "Process and Procedures for AP1000 Internal Open Items and Holds," Revision 5

APP-GW-J4-072, “Interface Specification for Squib Valve Controller,” Revision 1
APP-GW-VP-010, “Equipment Qualification Methodology and Documentation Requirements for AP1000 Safety-Related Valves and Valve Appurtenances,” Revision 2, April 30, 2010
APP-GW-VP-030, “Master Equipment Qualification Environmental Summary” Revision 2, September 16, 2010
APP-GW-VP-100, “Equipment Qualification Specifications and Documentation Requirements for AP1000 Safety-Related Electrical and Electro-Mechanical Equipment,” Revision 1
APP-GW-VPC-010, “Equipment Qualification Methodology and Documentation Requirements for AP1000 Safety-Related Valves and Valve Appurtenances,” Revision 2, April 2010
APP-JW03-VPP-003, “Seismic Test Procedure for the AP1000 Main Control Room/Remote Shutdown Room Transfer Panel,” Revision 0, March 2012
APP-PV70-T5-001, “Qualification Plan for Safety-Related Squib Valve Actuators and Electrical Connection Assemblies for Westinghouse AP1000 Nuclear Power Plants,” Revision 2, October 27, 2010
APP-PV70-T5-003, “Qualification Plan for QME-1-2007 Qualification 8” and 14“ Squib Valves,” Revision 0, dated October 27, 2010
APP-PV70-VPH-001, “AP1000 Squib Valve Equipment Qualification Test Plan,” Revision 0, January 31, 2012
APP-PV70-VPH-001, “AP1000 Squibb Valve Equipment Qualification Test Plan,” Revision 0
APP-PV95-VP-001, “Equipment Design Requirements for Safety-Related Limitorque Motor Actuator Test Specimens,” Revision 1, May 18, 2011
APP-PV95-VPH-002, “AP1000 Test Plan for 10-Year and 60-Year Qualification of Limitorque Valve Actuators,” Revision 2, September 27, 2010
APP-PV95-Z0-001, Revision 1, September 30, 2008
APP-PV95-Z0-001. Revision C (draft version)
K-403869-DSF-0040, “Kinectrics Inc. Test Procedure for Proof Testing of IST Low Voltage Electrical Penetrations Feedthrough Assemblies,” Revision 2, June 29, 2011
K-403869-DSF-0040, “Kinectrics Inc. Test Procedure for Proof Testing of IST Low Voltage Electrical Penetrations Feedthrough Assemblies,” Revision 2, September 13, 2011
K-403869-PSWI-0001, “Kinectrics Inc. Test Procedure for Qualification Testing of IST Medium Voltage Electrical Penetrations,” Revision 7, July 30, 2011
K-403869-PSWI-0005, “Kinectrics Inc. Test Procedure for Qualification Testing of IST Low Voltage Power and I&C Electrical Penetrations,” Revision 3, February 29, 2012
NA 11.1, “In-House Seismic Testing,” Revision 0, December 30, 2011
NSNP 11.1, “Test Control,” Revision 1, October 6, 2010
WEC 6.1, “Document Control,” Revision 4, January 1, 2012

Drawings

APP-IDS-E3-001, “Class 1E DC System Station One Line Diagram Divisions A & C,” Revision D
APP-1030-P2-001, “Nuclear Island General Arrangement Plan El 100’-0 and 107’-2”, Revision 3
APP-1040-P2-001, “Nuclear Island General Arrangement Plan El 117’-6”, Revision 4

7zR1-10000, MVP Electric Penetration Assembly (AP1000)

Calculations

APP-SSAR-GSC-125 "AP100 Long-term LOCA Containment Pressure and Temperature Response," Revision
APPSSAR-GSC-123, "In-Containment DBA Curves Developed for Determination of Equipment Qualification Envelope Curves," Revision 1
APP-1100-N5C-002, "AP1000-Equipment Qualification Radiation Values in Normal Operation Conditions for Safety-Related Components," Revision 2
APP-SSAR-GSC-507, "AP1000-Equipment Qualification (EQ) and Sever Accident Radiation Dose," Revision 4
APP-1100-N5C-002, "AP1000-Equipment Qualification Radiation Values in Normal Operation Conditions for Safety-Related Components," Revision 2
APP-GW-J4-072, "Interface Specification for Squib Valve Controller," Revision 1
WNA-CN-00206-GEN, "PMS Squib Valve System Operating Parameters," Revision 3
APP-GW-VPC-011, "AP1000 Equipment Qualification DBA/Post-DBA Temperature and Pressure Envelopes," Revision 2, December 13, 2010
APP-SSAR-GSC-123, "In-Containment DBA Curves Developed for Determination of Equipment Qualification Envelope Curves," Revision 1,
APP-SSAR-GSC-168, "AP1000 Steamline Break MSIV Compartment Temperature Response for Advanced First Core," Revision 0, January 4, 2010
APP-PV96-VPC-001, "AP1000 Limitorque Valve Actuator Equipment Qualification Radiation and Thermal Aging Calculation," Revision 0, October 30, 2009
CN-CRA-01-95, "AP1000 LOCA Containment Pressure Analysis," Revision 2
CN-CRA-02-16, "AP1000 MSLB Containment Pressure," Revision 0
CN-EQT-07-16/APP-GW-VPC-010, Revision 2

Purchase Orders (POs):

PO No. 4500312821, "Squib Valve IEEE Qualification", Wyle Laboratories, dated July 30, 2009 and applicable Change Notices
PO No. 4500408913, "Seismic Testing of RCP Switchgear," Clark Laboratories, dated September 26, 2011
PO No. 4500312838, "QME-1-2007 Qualification Testing of 8" and 14" Squib Valves," Wyle Laboratories, dated July 30, 2009

Miscellaneous:

APP-PV70-ZOR-001, "PV70 Squib (Pyrotechnic Actuated) Valves, ASME Section III Class 1, Data Sheet Report," Revision 5
IPS-2385, "Root Cause Analysis for LV1 EPA Sealant Leak Anomaly and Short-Circuit Anomaly", 11/23/11
Issue Report #12-089-M004, dated March 29, 2012
Issue Report #12-090-M007, dated March 30, 2012
Corrective Action Program Report CAP 12-089-M020, dated March 29, 2012
Corrective Action Program Report CAP 12-089-M043, dated March 29, 2012
Report entitled "Limitorque Type SB Series Valve Actuator Test Specimen and Methodology for Westinghouse AP-1000 Environmental Qualification Testing," Revision 2, November 17, 2008
Wyle-Westinghouse Meeting Minuets, dated March 4, 2009.

5. LIST OF ACRONYMS USED

10 CFR	Title 10 of the Code of Federal Regulations
ASME	American Society of Mechanical Engineers
CIPIMS	Construction Inspection Program Information Management System
DAS	Diverse Actuation System
DBA	design basis accident
DCD	Design Control Document
DCIP	Division of Construction and Inspection Programs
EPA	electrical penetration assembly
EPRI	Electric Power Research Institute
EQ	equipment qualification
I&C	instrumentation and control
IEEE	Institute of Electrical and Electronics Engineers
IP	Inspection Procedure
LOCA	loss of coolant accident
LVP	low voltage power
MSIV	main steam isolation valve
MSLB	main steam line break
MVP	medium voltage power
No.	number
NRC	U. S. Nuclear Regulatory Commission
NRO	Office of New Reactors
PAR	Procurement Advisory Release
PMS	Protection and Safety Monitoring System
PO	purchase order
RCP	reactor coolant pump
SSE	safe shutdown earthquake
WEC	Westinghouse Electric Company