February 2, 2017

Ms. Sarah DiTommaso
Manager, AP1000 Licensing and Inspection
1000 Westinghouse Drive
Cranberry Township, PA 16066

SUBJECT: NUCLEAR REGULATORY COMMISSION VENDOR INSPECTION OF WESTINGHOUSE/WECTEC REPORT NO. 99901467/2016-201

Dear Ms. DiTommaso:

During the period from November 14-18, 2016, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection at the Westinghouse/WECTEC facility in Charlotte, North Carolina. The inspection period was held open until December 20, 2016, at which time an exit meeting was held, to allow Westinghouse additional time to respond to several technical issues identified during the inspection. The purpose of the inspection was to review implementation of Westinghouse's processes for transferring the design requirements contained in the AP1000 Design Control Document into detailed engineering, procurement, and construction documents, consistent with NRC requirements. The focus of this inspection was on the Class 1E dc and Uninterruptible Power Supply System (IDS) and supporting systems. The inspection team also reviewed aspects of your quality assurance program applicable to the design engineering process.

While the inspectors focused primarily on the engineering work performed by WECTEC, other related work performed by other entities within the Westinghouse Electric Company was also reviewed during this inspection. The enclosed report presents the results of this inspection. This NRC inspection report does not constitute NRC endorsement of your overall quality assurance (QA) program.

As noted in the enclosed inspection report, some of the detailed design work reviewed by the inspection team is associated with specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) from Appendix C of the Combined License for Vogtle, Units 3 and 4, and V.C. Summer, Units 2 and 3. While these ITAAC have not been submitted to the NRC for closure, applicable ITAAC are noted in the report as the inspection results might be useful to the NRC staff that will ultimately be tasked with verifying ITAAC closure, as applicable.

During this inspection, the NRC inspectors identified one ITAAC finding and an associated Nonconformance with NRC regulations. The finding is material to the acceptance criteria of ITAAC 2.6.03.08, in that Westinghouse had not fully verified the commercially-manufactured circuit breakers and fuses would be capable of interrupting the analyzed fault currents. The inspectors determined that Westinghouse did not fully implement its QA program in the areas of design control and commercial-grade dedication regarding this finding. The specific findings and references to the pertinent requirements are identified in the enclosures to this letter. In response to the enclosed Notice of Nonconformance, Westinghouse should document the results of the extent of condition review for these findings and determine if there are any effects on other safety-related components.

In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 2.390, "Agency Rules of Practice and Procedure," a copy of this letter, its enclosure(s), and your response (if applicable) will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), accessible at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response (if provided) 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, 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 be 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/

Terry W. Jackson, Chief
Quality Assurance Vendor Inspection Branch-1
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No.: 99901467

Enclosures:
1. Notice of Nonconformance
2. Inspection Report No. 99901467/2016-201
   and Attachment

Letter to Sarah DiTommaso from Terry W. Jackson dated February 2, 2017.

SUBJECT: NUCLEAR REGULATORY COMMISSION VENDOR INSPECTION OF WESTINGHOUSE/WECTEC REPORT NO. 99901467/2016-201

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DATE	02/02/17	01/17/17	01/13/17
OFC	NRR/DE/EEEB	Contractor	NRO/DCIP/QVIB-1:BC
NAME	TMartinez-Navedo	ADGreca	TJackson
DATE	01/18/17	01/17/17	02/02/17

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NOTICE OF NONCONFORMANCE

WECTEC/Westinghouse Electric Company
Charlotte, NC 28208

Docket No. 99901467
Report No. 2016-201

Based on the results of a U.S. Nuclear Regulatory Commission (NRC) inspection conducted at the Westinghouse facility located in Charlotte, North Carolina, on November 14-18, 2016, certain activities were not conducted in accordance with NRC requirements.

A. Criterion III, "Design Control," of Appendix B, "Quality Assurance 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, "Measures shall also be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions for the structures, systems and components."

   Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) 2.6.03.08 from Appendix C of the Combined License for Vogtle, Units 3 and 4, and V.C. Summer, Units 2 and 3, states, "Circuit breakers and fuses installed in IDS battery, battery charger, dc distribution panel, and MCC circuits are rated to interrupt fault currents." The acceptance criteria for this ITAAC states, "Analyses for the as-built IDS dc electrical distribution system exist and conclude that the analyzed fault currents do not exceed the interrupt capacity of circuit breakers and fuses in the battery, battery charger, dc distribution panel, and MCC circuits, as determined by their nameplate ratings."

   Contrary to the above, prior to November 18, 2016, Westinghouse failed to ensure the suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions for certain components supplied to the nuclear industry. Specifically, Westinghouse failed to identify and verify the adequacy of circuit breaker and fuse interrupting current ratings as a critical characteristic, as part of its commercial grade dedication process. The associated circuit breakers and fuses are being supplied to Vogtle, Units 3 and 4, and V.C. Summer, Units 2 and 3, as part of the AP1000 new reactor construction. The issue is material to ITAAC 2.6.03.08 because if the interrupting ratings (nameplate ratings) for the circuit breakers and fuses cannot be verified, the analyses which compares the available fault currents to those ratings would be invalid.

This issue is identified as Nonconformance 99901467/2016-201-01.

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 the Chief, Quality Assurance Vendor Inspection Branch-1, Division of Construction Inspection and Operational Programs, 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 to avoid noncompliances, and (4) the date when your corrective action will be completed. 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 the 2nd day of February 2017.

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

Docket No.:	99901467
Report No.:	99901467/2016-201
Vendor:	WECTEC/Westinghouse Electric Company Lakepointe Corporate Center 5 3735 Glenlake Dr. Charlotte, NC 28208
Vendor Contact:	Curtis Castell Lakepointe Corporate Center 5 3735 Glenlake Dr. Charlotte, NC 28208 (980) 859-6373
Nuclear Industry Activity:	WECTEC, a subsidiary of Westinghouse Electric Company, is performing the detailed design engineering for the AP1000 electrical system. This work includes design, qualification, and analyses that are associated with and may directly impact closure of Inspections, Tests, Analyses, and Acceptance Criteria (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:	November 14-18, 2016
Inspectors:	Jeffrey Jacobson, NRO/DCIP/QVIB-1, Team Leader Jermaine Heath, NRO/DCIP/QVIB-3 Guillermo Crespo, RII/DCO Tania Martinez-Navedo, NRR/DE Aniello Della Greca, contractor
Approved:	Terry W. Jackson, Chief Quality Assurance Vendor Inspection Branch-1 Division of Construction Inspection and Operational Programs Office of New Reactors

EXECUTIVE SUMMARY

WECTEC/Westinghouse Electric Company
99901467/2016-201

During the period from November 14-18, 2016, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection at the Westinghouse/WECTEC facility in Charlotte, North Carolina. The purpose of the inspection was to review implementation of Westinghouse's processes for transferring the design requirements contained in the AP1000 Design Control Document into detailed engineering, procurement, and construction documents, consistent with NRC requirements. Using the guidance contained in Inspection Procedure 37805, "Engineering Design Verification Inspection," the NRC inspectors focused their review on the Class 1E dc and Uninterruptible Power Supply System (IDS) and supporting systems.

This inspection was a follow-on inspection to the engineering design verification (EDV) inspection that was conducted in 2011 (ADAMS Accession No.: ML112440588). At that time, the detailed design for the electrical systems was not sufficiently complete to allow for an NRC inspection, and as a result, Open Item 99900404/2011-201-07 was identified. The scope of this inspection was sufficient to close that open item.

The inspection scope included a review of both system level and component level design information. The inspectors reviewed applicable calculations, analyses, drawings, component specifications, qualification test plans, and other documents as necessary to assess whether the detailed design for the selected safety systems and components would support the safety functions as described in the AP1000 Design Control Document (DCD).

As noted in the enclosed inspection report, some of the detailed design work reviewed by the inspectors is associated with specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) from Appendix C of the Combined License for Vogtle, Units 3 and 4, and V.C. Summer, Units 2 and 3. While these ITAAC have not yet been submitted to the NRC for closure, applicable ITAAC are noted in the report as the inspection results might be useful to the NRC staff that will ultimately be tasked with verifying ITAAC closure, as applicable.

Based on the results of this inspection, and for the sample of systems/components inspected, the NRC concluded the detailed design was in conformance with the DCD. However, the inspectors identified one ITAAC finding and an associated Nonconformance in the area of procurement/commercial grade dedication associated with certain circuit breakers and fuses. The acceptance criteria of ITAAC 2.6.03.08 requires analyses for the as-built Class 1E dc electrical distribution system and uninterruptible power supply exist and conclude that the analyzed fault currents do not exceed the interrupt capacity of circuit breakers and fuses in the battery, battery charger, dc distribution panel, and motor control circuits, as determined by their nameplate ratings. Westinghouse had not taken the actions necessary to ensure the commercially manufactured circuit breakers and fuses conformed to their published interrupting current ratings and were suitable for their intended application. This issue is identified in the inspection report as Nonconformance 99901467/2016-201-01 and is material to ITAAC 2.6.03.08.

The inspectors also identified an Unresolved Item associated with the qualification of the Class 1E batteries in that the established qualified life does not support the currently stated technical specification surveillance intervals. This issue is identified as Unresolved Item 99901467/2016-201-02 in the report.

REPORT DETAILS

1. Background and General Scope

   The purpose of the inspection was to review implementation of Westinghouse's processes for transferring the design requirements contained in the AP1000 Design Control Document (DCD) into detailed engineering, procurement, and construction documents, consistent with NRC requirements. The focus of this inspection was on the Class 1E dc and Uninterruptible Power Supply System (IDS), supporting systems, and specific electrical interfaces within and between safety systems. The inspectors also reviewed Westinghouse's processes for validating and controlling certain design analyses software used in performing the detailed electrical system design.

   This was a follow-on inspection to the engineering design verification (EDV) inspection that was conducted in 2011 (ADAMS Accession No.: ML112440588). At that time, the detailed design for the electrical systems was not sufficiently complete to allow for an NRC inspection, and as a result, Open Item 99900404/2011-201-07 was identified. The scope of this inspection was sufficient to close that open item. The inspectors utilized Appendix A to NRC Inspection Procedure 37805, "Electric Power Inspection Plan Guidelines," in performing its review.

   While this inspection was focused primarily on the work performed by WECTEC, a subsidiary of Westinghouse Electric Company, certain aspects of the work reviewed by the inspectors were performed by other Westinghouse organizations. For simplicity sake, we have not attempted to differentiate which work was performed by which Westinghouse entity and we have used the terminology "Westinghouse" to apply to all work identified in this report that was performed by any Westinghouse entity.

2. Translation of Equipment Specification into Procurement Documents – Interrupting Rating of Circuit Breakers (ITAAC 2.6.03.08)

   a. Scope

      ITAAC 2.6.3-3.8 states that "Circuit breakers and fuses in the IDS battery, battery charger, dc distribution panel, and MCC circuits are rated to interrupt fault currents." The inspectors reviewed selected documents to ensure that important equipment technical requirements were appropriately included in procurement documents to vendors and that appropriate measures were implemented to ensure these technical requirements were met. Since Westinghouse procures the circuit breakers and fuses it installs into the Class 1E IDS dc distribution panels and motor control centers as commercial grade equipment, the inspectors also reviewed Westinghouse's process for dedicating this equipment as contained in Document CDI 3398, "AB Deion, Series C, Seltronic and Quicklag Molded Case Circuit Breakers (Thermal Magnetic, Magnetic Only, Motor Circuit Protectors, Tri-Pac) and Accessory Devices."

   b. Findings and Observations

      The inspectors identified that Document CDI 3398 does not list the circuit breakers' interrupting current rating as a critical characteristic. Consequently, no specific actions were taken as part of the dedication process (or as part of any other Westinghouse process) to identify and verify the validity of the breakers' interrupting current ratings.

The inspectors noted the interrupting current capacity of these components is a critical element of the IDS design and is also specifically called out in ITAAC 2.6.03.08. While Westinghouse performed commercial grade surveys of the commercial manufacturer, as described in Document CDI 3398, these surveys did not specifically evaluate the adequacy of the methods used by the commercial manufacturer to establish the interrupting current ratings, or whether sufficient quality controls were implemented at facilities utilized to test the interrupting current capacity of the breakers. While not specifically reviewed during this inspection, Westinghouse indicated the concern raised by the inspectors would also apply to fuses, as their interrupting capacity was also not captured via the dedication process.

Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) 2.6.03.08 from Appendix C of the Combined License for Vogtle, Units 3 and 4, and V.C. Summer, Units 2 and 3, states, "Circuit breakers and fuses installed in IDS battery, battery charger, dc distribution panel, and MCC circuits are rated to interrupt fault currents." The acceptance criteria for this ITAAC states, "Analyses for the as-built IDS dc electrical distribution system exist and conclude that the analyzed fault currents do not exceed the interrupt capacity of circuit breakers and fuses in the battery, battery charger, dc distribution panel, and MCC circuits, as determined by their nameplate ratings."

Contrary to the above, prior to November 18, 2016, Westinghouse failed to identify and verify the adequacy of circuit breaker and fuse interrupting current ratings as a critical characteristic, as part of its commercial grade dedication process. The associated circuit breakers and fuses are being supplied to Vogtle, Units 3 and 4, and V.C. Summer, Units 2 and 3, as part of the AP1000 new reactor construction. The issue is material to ITAAC 2.6.03.08 because if the interrupting ratings for the circuit breakers and fuses cannot be verified, the analyses which compares the available fault currents to those ratings would be invalid.

The inspectors identified Westinghouse's failure to verify the interrupting current rating of the breakers as part of its commercial grade dedication process as a Nonconformance to Criterion III of Appendix B to Title 10 of the Code of Federal Regulations (10 CFR) Part 50 (Nonconformance 99901467/2016-201-01). Using Appendix E of Inspection Manual Chapter 0617, Paragraph E.7, the inspectors screened this issue as being more than minor because, it is an issue, that if left uncorrected, could potentially prevent a licensee from closing an ITAAC and is material to the acceptance criteria of the ITAAC. During the inspection, Westinghouse entered this issue into their corrective action program as CAPAL #100430258.

c. <u>Conclusions</u>

The inspectors identified Westinghouse's failure to verify the interrupting rating of the breakers and fuses as a Nonconformance to Criterion III of Appendix B to 10 CFR Part 50.

3. Squib Valve Circuit Resistance Calculation (ITAAC 2.1.02.11b.i, 2.1.02.11c.i, 2.2.03.11b.i, and 2.2.03.11c.i)

a. Scope

The inspectors reviewed Calculation Note APP-PMS-DW-001, “Squib Valve Field Circuit Resistance Calculations.” This calculation pertains to the cabling and connectors that carry the electrical current pulse generated from the Squib Valve Controller Termination Unit in the Main Control Room to the Squib Valve Initiators located on the explosive cartridges which are part of the squib valves themselves and are located inside of containment. The inspectors evaluated whether the calculated resistance for the circuit would be sufficient to ensure that the proper current pulse would be delivered to the initiator. The inspectors evaluated whether Westinghouse had properly accounted for the resistances and tolerances associated with all cabling and connectors in the circuit, as well as the degree these resistances can vary over the wide temperature range for which the squib valves are required to operate.

The inspectors also reviewed Design Document APP-PV98-T6-001, “Squib Valve Firing Circuit Verification Test Design Document,” which contains instruction for field verification of the actual installed circuit resistance, as well as, for verifying the output of the squib valve controller.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The acceptance criteria for the “round-trip” squib valve field circuit resistance is defined in Design Document APP-GW-J4-072, “Interface Specification for Squib Valve Controller,” as between 1.3 and 3 ohms, not including the resistance of the initiator and including consideration of worst-case accident temperature conditions. This small window of operation is due to the design of the initiation circuitry which is basically a fixed-voltage, capacitive-discharge circuit and the relatively narrow current pulse requirements of the squib valve initiators. Since the circuit voltage is essentially fixed, the proper current pulse is achieved by ensuring the total circuit resistance is within a pre-calculated value (the 1.3 to 3 ohms). Further complicating the issue is that this resistance needs to be achieved over the full range of possible squib valve operating temperatures. In order to achieve the proper calculated resistance, Westinghouse performed Calculation Note APP-PMS-DW-001 to evaluate possible solutions. The inspectors verified that the calculation note considered all contributions to the circuit resistance and the effects of temperature change on the various cables and connectors that make up the circuit. The inspectors identified that overall, the calculation appeared to be conservative in that it utilized maximum inside containment accident temperatures for both inside and outside containment cabling.

The calculation note determined that proper resistance could not be achieved through just the standard method of selecting various pre-qualified cable sizes, as the inside containment temperature variations resulted in too great an impact on the total circuit resistance. In order to achieve the correct resistance, the calculation note proposed two possible solutions: Option A - adding an additional length of “tuning” cable located outside of the containment; and Option B - adding a tuning resistor to the squib valve firing circuitry. By locating these tuning devices outside of containment a smaller

percentage of the total circuit resistance would be subject to the inside containment accident environment and associated temperature swings.

During discussions with Westinghouse during the inspection, Westinghouse indicated they were planning to implement Option A; adding the tuning cabling. If this option was chosen, according to the calculation, there would be a margin of approximately 0.1 ohms for the circuit. This calculated margin is very small and the calculation also includes some assumptions associated with the actual cable and connector resistances, as the information utilized in the calculation was taken from nominal commercial information and will need to be verified in the field.

During the inspection Westinghouse informed the inspectors that they had addressed the low margin concerns by developing a test methodology for actual field verification of the as-installed circuit. The inspectors reviewed Design Document APP-PV98-T6-001, "Squib Valve Firing Circuit Verification Test Design Document," which is intended to perform this field verification. The inspectors verified the test document provides for an appropriate method of measuring the circuit resistance and includes steps for correcting the measured temperatures to consider worst-case accident (temperature) conditions. The inspectors verified the resistance acceptance criteria contained in the test document appeared to be appropriate and would provide assurance that the proper current signal would be received by the squib valve initiators under all design basis conditions. The resistance measurements are also utilized in the test setup for evaluating the squib valve controller output; however, this aspect of the test was not evaluated during this inspection.

c. Conclusions

The inspectors concluded that the calculated circuit resistance should be adequate to ensure the current provided to the initiator would be within the specified range under all normal and abnormal conditions. The analysis will be further supported by an actual field verification which contains acceptance criteria providing assurance that the proper current signal would be received by the squib valve initiators.

4. Translation of Equipment Specification into Procurement Documents – Inverter Power Quality

a. Scope

The inspectors assessed whether appropriate technical requirements, including requirements for power quality, were contained in Appendix C of Westinghouse Design Specification APP-DU01-Z0-001, "Design Specification for Class 1E Inverters, Static Transfer and Manual Bypass Switches for IDS system."

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

Westinghouse explained that their power quality strategy is divided into two parts. One part of the strategy is to limit the amount of harmonics that are induced on the auxiliary electrical system from non-linear components that are installed within the plant, such as the dc/ac inverters, and the other part is to test the susceptibility of Class 1E power

equipment to conducted and radiated emissions. In order to limit the amount of harmonics that are emitted to the auxiliary electrical power systems, all non-linear components are required to meet the limits for total harmonic distortion (THD) and single frequency distortion to less than 5 percent THD or less than 3 percent for a single harmonic of the fundamental voltage. The inspectors verified that this specification was included in the design specification for the inverter.

The inspectors also identified that all Class 1E electrical equipment that is potentially susceptible to electromagnetic interference (EMI) or radio frequency interference (RFI) is required to be tested for susceptibility to conducted and radiated emissions. The vendor testing programs must meet the requirements of NRC Regulatory Guide (RG) 1.180. These components include the IDS battery chargers, UPS inverters and voltage-regulating transformers. The testing program requires that emissions conducted back onto the power system are within the limits of MIL-STD-461E or IEC 61000-4. This requirement addresses the harmonics impressed on the system by the safety-related power conversion equipment. The other part of the test demonstrates the ability of the equipment to continue to operate without degradation during all loading conditions within the range of discrete frequencies outlined in the testing procedure.

c. <u>Conclusions</u>

The inspectors concluded that the combination of the inverter design requirements and the susceptibility testing requirements for the connected equipment provided an adequate basis to ensure compatibility between the inverters and the connected Class 1E equipment.

5. <u>Verification of Penetration Protection</u> (ITAAC 2.2.01.08)

a. <u>Scope</u>

The inspectors reviewed Calculation APP-IDS-E0C-014, “Verification of IDS Low Voltage Class 1E Safety-Related Electrical Penetrations,” to verify that adequate primary and backup electrical protection exists for the IDS Class 1E safety-related low voltage power and control containment electrical penetrations, as per design requirements of Design Document APP-GW-E1-004. The calculation provides time-current curves for different sizes of penetrations that indicate their thermal limits and show the protection provided by the primary and backup fuses. The inspectors reviewed penetration manufacturer (Mirion Technologies) AP1000 EPA Conductor Parameters Document APP-EY01-V7Y-001, “Archival of Mirion IPS-2402, EPA Conductor Parameters,” to confirm the source for the thermal limit (I^2t) curves provided in the calculations. The inspectors reviewed Design Specification APP-EY01-Z0D-010, “Specification Datasheet for Class 1E Power and Control Electrical Penetration Assemblies,” to verify conductor fill tables compared to drawings showing the size of conductors, feeder designations and isolation between conductors. The inspectors reviewed the adequacy of the isolation for different wiring circuits passing through the same penetration assembly. The inspectors reviewed combined wiring diagrams to study the application and size of penetration primary and backup fuse protection. The inspectors reviewed Engineering & Design Coordination Report APP-DK01-GEF-014 for Class 1E MCCs 250A to 200A fuse change. The inspectors reviewed wire and cable design criteria to verify proper conductor sizing for load and overcurrent protection schemes.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

No deviations from acceptance criteria and component operational limits were identified from the documentation and calculation results reviewed. The circuit protection provided was adequate for penetration assemblies' thermal limits as indicated in the time-current curves developed. In every case presented, there was adequate protection for both the thermal limits and the penetration's ampere capacities.

c. Conclusions

The inspectors concluded that an adequate level of protection and isolation for the circuits passing through the penetration assemblies.

6. Verification of MOV Cable Lengths

a. Scope

The inspectors reviewed design specifications, drawings, calculations and purchase orders for selected motor-operated valves (MOVs). The scope of review included motor control center (MCC) design specifications including load listings to MOVs and associated schematic diagrams. Also, the inspectors reviewed cable lengths, sizes, and voltage drop for MOV circuit conductors.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

Design Document APP-IDS-E0C-004, "IDS Power Cable Sizing and Voltage Drop Analysis," concluded that the Class 1E 250 Vdc batteries in Division D had the worst duty cycle profile. The largest voltage drop for MOV circuits was identified in calculations for Division B. According to the calculations reviewed, the worst-case voltage drop was from the Spare Battery Division "B", with a battery terminal voltage of 210 Vdc. Downstream from the battery terminals, the acceptance criteria for the MCC minimum voltage was established at 200 Vdc. The calculated lowest voltage identified from the battery terminals to the MCC was 203.96 Vdc and was within acceptable limits. The worst-case voltage at the MOV motor leads was for RCS-PL-V013B at 182.5 Vdc, which was adequate to maintain the minimum voltage of 180 Vdc per the MOV manufacturer requirements.

The calculations appeared to be conservative when considering conductor runs inside containment as well as outside containment. These calculations included conservative ambient temperatures for normal and harsh environment conductor ohmic resistance based on manufacturer information. The calculations covered equipment load characteristics, conductor lengths and sizes, and ambient temperature correction factors to determine anticipated operating voltage at the MOV pigtail connections. The maximum conductor temperatures used were conservatively applied temperatures of 90°C for outside containment and 152°C for Zones 5 or 10, and 155°C for inside

containment, accident temperature conditions. The calculations included penetration segments and the voltage drop across other accessories such as fuses and distribution panels.

The minimum voltage required to operate MOVs per design specifications was indicated to be 180 Vdc, with the exception of four MOVs requiring a higher minimum voltage (185 Vdc). These MOVs were APP-SGS-PL-V027A, APP-SGS-PL-V027B, APP-RCS-PL-V001A, and APP-RCS-PL-V001B. The voltage drop limit criteria for the remainder of the MOVs was set at a 30 Vdc drop limit from the battery terminal to MOV leads based on a minimum battery terminal voltage of 210 Vdc.

c. Conclusion

The inspectors determined that the design included adequate cable sizing for the loads, and that conductor routing, length, and minimum voltage levels were calculated for the proper operation of MOVs

7. Class 1E dc and Uninterruptible Power Supply (IDS) Coordination Studies (ITAAC 2.6.03.07, 2.6.03.08, 2.6.03.09, and 2.6.03.10)

a. Scope

The inspectors reviewed Calculation APP-IDS-EOC-011, “Class 1E (IDS) 250V DC System – Coordination Study.” This calculation addressed the ratings and the protection characteristic of the overcurrent devices used in the IDS. The inspectors also reviewed Calculation APP-IDS-EOC-010, “Coordination Study - Class 1E 208/120V AC System.” This calculation determined the ratings and the protection characteristic of the overcurrent devices used in the IDS. The review of these calculations by the inspectors assessed whether the various protective devices, i.e., circuit breakers and fuses, adequately protected the associated equipment and cables from overloads and available short circuit currents. Additionally, the inspectors verified that selectivity existed between upstream and downstream protective devices to assure that such overload and/or short circuit conditions were isolated in a timely manner by the protective device closest to the anomalous condition such as to minimize loss of equipment important to safety.

The inspectors also reviewed Calculations APP-IDS-E0C-015, APP-IDS-E0C-016, and APP-IDS-E0C-017 addressing motor protection. Specifically, Calculation APP-IDS-E0C-015, “IDS MCC Power Fuse RG1.106 Compliance,” verified the protective fuse for MOVs was sufficiently large to assure that it would not blow and stop the motor during the safety actuation of the valve, in accordance with the guidance of Regulatory Guide (RG) 1.106, “Thermal Overload Protection for Electric Motors on Electric Operated Valves.” Calculation APP-IDS-E0C-016, “AP1000 IDS Motor Circuit Protector Sizing,” verified that the Motor Circuit Protector (MCP) of each IDS powered dc-powered MOV conformed to the guidance of RG 1.106. Specifically, the calculation verified the setpoint of the MCP was such as not to trip the overload during valve operation while protecting the contactor and motor starter from faults in excess of the motor locked-rotor current. Calculation APP-IDS-E0C-017, “IDS MCC TOL Requirements per IEEE741,” determined the setting criteria of the Thermal Overload (TOL) devices for the Class 1E dc-powered MOVs. Specifically, the calculation calculated the setting of the valve TOL to comply with the requirements of the Institute of Electrical and Electronics Engineers

(IEEE) Standard 741-1997, “IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations,” also endorsed by RG 1.106. The review of these calculations verified that the criteria used in establishing the MOV circuit protection adequately addressed the criteria set forth by the IEEE Standard and the guidance of the RG.

To address design capabilities of the distribution equipment within the Class 1E, 250 Vdc and 208/120 Vac UPS system, the inspectors reviewed applicable sections of available specifications, including:

- Design Specification APP-IDS-E8-001, “Class 1E DC and UPS System Specification Document”
- APP-DD01-Z0-010, “Design Specification for Class 1E 250 VDC Distribution Panels for System IDS”
- APP-DF01-Z0-001, “Design Specification for Class 1E Fused Transfer Switch Boxes”
- APP-DK01-Z0-010, “Class 1E Motor Control Centers”
- APP-DS01-Z0-010, “Design Specification for Class 1E 250 VDC Switchboards for System IDS”
- APP-EA01-Z0-001, “Specification for Class 1E 250 AC Distribution Panels for IDS System”
- APP-EA03-Z0-001, “Design Specification for Class 1E Fuse Panels for System IDS”

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The inspectors’ review of the above specifications verified the distribution equipment within the IDS system was adequately sized to carry and protect the intended loads. The inspectors’ review of the above calculations also determined that, in general, adequate criteria were used in the selection of circuit protectors, that fuses and circuit breakers adequately protected the associated equipment and cables from overload and short circuit currents and that selectivity existed between upstream and downstream circuit protector to assure that an overload or faulted condition was isolated by the circuit protector closest to the abnormal condition.

Based on the single-line diagrams and the coordination study, the Class 1E 208/120 Vac bus normally receives its power from a 15 kVA inverter. As stated in Design Specification APP-DU01-Z0-001, “Design Specification for Class 1E Inverters, Static Transfer and Manual Bypass Switches for IDS System,” the inverter is provided with a static transfer switch that constantly monitors the inverter output voltage. Design Specification APP-DU01-Z0-001 stated, “In case of abnormal condition at the inverter output due to inverter malfunction or input source failure, a loss of inverter output voltage shall be sensed and the static switch shall automatically disconnect the inverter output and switch over to the alternate power source. A control circuit shall be provided to automatically restore the inverters to normal operation whenever the inverter’s output voltage is restored and stabilized after an abnormal condition.” Appendix C of the specification indicates that the transfer time is $\leq$ ¼ cycle and that the nominal re-transfer delay is 5 seconds (adjustable 2-6 seconds).

The circuit supplying power to the bus from the inverter is protected by a 110 A fuse. The circuit supplying power to the same bus from the regulating transformer is protected by a series combination of a 700 A fuse and two circuit breakers; Breaker CB-2 set to operate at 200 A and Breaker 2-1 set to operate at 100 A. A third circuit breaker (CB-1) on the line side of the regulating transformer has the same time-current curve as Breaker 2-1 with a short-time pickup of 1000 A. The inverter is current-limited at 150 percent of its rating or at less than 65 A at 208 Vac.

The inspectors reviewed the 208/120 Vac system design and fault protection and verified that a short circuit on the 208 Vac bus would result in a lowering of the inverter output voltage and a transfer of the fault to the regulating transformer with the intent of having the fault be isolated by Circuit Breaker 2-1 at the output of the regulating transformer (or CB-1 on the line side) rather than by the inverter output fuse. Westinghouse calculated that the short circuit available from the voltage-regulating transformer was 1770 A. Therefore, either circuit breaker would instantaneously isolate a fault of this magnitude. However, the inspectors expressed a concern that an impedance fault on the 208 Vac bus that produced less than 300 A could cause damage to the inverter. This is because the fault current would not be sufficient to activate either the 700 A fuse or Circuit Breakers 2-1 and CB-1. These circuit breakers are set well above the normal bus loading and would not actuate for more than 5 sec. at 300 A, causing the postulated fault to be transferred back to the inverter (with normal output voltage at that time). The subsequent inverter voltage drop would cause the static switch to transfer the source to the regulating transformer for the second time and back to the inverter for a new cycle until the fault reached a magnitude that could be isolated by either transformer breaker.

The issue was discussed with Westinghouse to determine whether they had calculated the system impedance or the maximum fault the inverter could tolerate without damage. Westinghouse's review of the issue concluded that a bolted fault would produce sufficient amperage to be readily isolated by either transformer breaker. For the case of the impedance fault, Westinghouse agreed that the breakers may not be set to actuate, but in this case, the fault should be considered a single failure of the affected inverter. The inspectors agreed that any fault on the 208/120 Vac bus, whether bolted or impedance, would result in the loss of the bus and, hence, represented a single failure of that bus; however, the other remaining trains would not be affected and the overall plant safety function would be preserved. The inspectors noted, however, that complete coordination between the protective devices within the bus was not achieved for the situation of an impedance fault.

c. <u>Conclusion</u>

Overall the coordination of protective devices within the IDS was found to be acceptable.

8. Class 1E 250 Vdc Distribution System and UPS Cable Sizing and Voltage Drop Calculation (ITAAC 2.6.03.10)

a. Scope

The inspectors reviewed applicable drawings and calculations to verify that adequate voltage would be available to the Class 1E components for the duration of an event during which batteries are isolated from their respective battery chargers.

The Class 1E dc distribution system is comprised of four 250 Vdc batteries banks divided into four independent divisions (A, B, C, and D), rated for a 24-hour duty cycle, and two additional 250 Vdc battery banks, Divisions B & C, rated for a 72-hour duty cycle. Each battery supplies power to a 208/120 Vac uninterruptible power supply system through independent inverters. The Class 1E dc and ac systems are outlined in a series of single-line diagrams; Drawings APP-IDS-E3-001 through APP-IDS-E3-014. The 250 Vdc loads supplied by the individual batteries are described in the following associated series of drawings:

- Drawing APP-IDSA-E3-DD101, for 250 Vdc Distribution Panel IDSA-DD-1
- Drawings APP-IDSA-E3-DS101, and -DS102 for Class 1E 250 Vdc Switchboard IDSA-DS-1
- Drawings APP-IDSA-E3-DK101, -DK102, and –DK103 for Class 1E 250 Vdc MCC IDSA-DK-1 Division A.

The 208/120 Vac loads supplied by the individual inverters are described in Drawings APP-IDSB-E3-EA101, -EA201, -EA301, and –EA401 for 208/120 Vac Distribution Panels IDSA-EA-1, -2, -3, and -4, respectively, for Division B.

Cable sizing and voltage drop analysis are addressed in the following two calculations. Calculation APP-IDS-EOC-004, “IDS Power Cable Sizing and Voltage Drop Analysis,” determined the cable sizes for the AP1000 Class 1E 250 Vdc and UPS system loads under the worst-case environmental conditions of the batteries. Calculation APP-IDS-EOC-009, “IDS Powered Air and Solenoid Operated Valves, Plant Monitoring System Cabinets, and Switchgear Cable Lengths,” determined the maximum power cable lengths for air-operated valves, solenoid-operated valves, switchgear, Plant Monitoring and Safety System cabinets, and the Radiation Monitoring System cabinets fed by the IDS system. The intent of these analyses was to assure that the calculated cable sizes and lengths met the minimum voltage criteria for each ac and dc load supplied by the batteries and inverters at the end of the batteries’ duty cycle. The inspectors’ review addressed the assumptions made in the calculations, the criteria used in determining cable sizes and lengths, and the methodology used in the calculation of voltage drop between specified points. The inspectors assessed whether the assumptions and methods utilized were acceptable and whether the results conformed to the intended acceptance criteria.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The inspectors’ review of the above calculations determined that, in general, adequate criteria were used in determining the required cable sizes, considering the calculated

cable lengths. Also, the inspectors determined that the voltage requirements for individual components had adequate design bases and that the results of the calculations indicated sufficient margin to assure adequate performance of safety-related equipment and components during anticipated plant transients or design basis event.

The inspectors did note that all the Division A and C battery changers and voltage regulating transformers were fed by the same MCC, 480 Vac MCC ECS-EC-121, and that all the Division B and D battery chargers and voltage regulating transformers were fed by a second MCC, 480 Vac MCC ECS-EC-221. The inspectors also observed that the spare battery charger was fed by 480 Vac MCC ECS-EC-121. While this design conformed to the criteria set forth in the AP1000 Design Control Document, the inspectors noted that loss of one MCC due to any abnormal operating condition would result in the ac and dc loads of two divisions having to be fed by their respective batteries for the duration of the abnormal condition. The inspectors verified this condition is addressed by Technical Specification Action 3.8.1.B.1, which requires the battery terminal voltage be restored to greater than or equal to the minimum float voltage within two hours, or the unit be in Mode 3 in 6 hours if the required action and associated completion time are not met (Action 3.8.1.G.1).

c. Conclusions

The inspectors determined the results of the calculations indicated sufficient margin to assure adequate performance of safety-related equipment and components during anticipated plant transients or design basis events.

9. Degraded Grid Voltage to Regulating Transformers

a. Scope

The voltage-regulating transformer provides backup voltage to the 208/120 Vac UPS system when the inverter is not available or inverter output voltage falls below the minimum voltage requirements. This is done through a make-before-break static switch within the inverter assembly. In addressing adequacy of voltage available to the voltage regulating transformers, the inspectors determined that a calculation specifically addressing degraded grid condition and degraded grid relays and timer settings had not been performed yet. Westinghouse, however, provided a load flow analysis that addressed available voltage at regulating transformers under degraded grid voltage conditions.

Calculation APP-ZAS-EOC-001, “AC Electrical System Load Flow, Short Circuit and Motor Starting Calculation,” verified the “adequacy of the AP1000 electrical power system design” using the ETAP electrical design analysis software, Version 5.5.6N. One purpose of the load flow study was to assess the adequacy of calculated voltage based on the voltage acceptance criteria. In particular, the study calculated the minimum steady state voltages at the medium- and low-voltage switchgear, as well as at MCC buses under maximum running load and minimum source voltage condition.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

Although Westinghouse had not yet prepared a calculation addressing the setting of the degraded grid voltage relays and associated timers, the inspectors' review of Calculation APP-ZAS-EOC-001 determined that at minimum source voltage and design loading, the voltage drop to the regulating transformer was approximately 5 percent on the 480 Vac basis, with a voltage drop of less than 4.8 percent to the MCCs and an additional loss of less than 0.2 percent from the MCC to the transformer. The minimum available voltage is, therefore, well above the regulating transformer voltage input rating of 480 Vac ±10 percent, as stated in Appendix C.1 of Design Specification APP-DT01-Z0-010, "Design Specification for Class 1E Regulating Transformers." While the input voltage can, during a transient, drop below the operating range of the transformer, it is expected that the transient will last only a few seconds, and a sustained low voltage below the operating range will be sensed by the degraded grid voltage relays and voltage restored upon their actuation. Based upon the above analysis, the inspectors concluded that adequate voltage would be available at the input of the regulating transformers to assure their correct operation in response to a loss of the associated inverter or degraded inverter output voltage.

c. Conclusion

The inspectors determined that adequate voltage would be available at the input of the regulating transformers to assure their correct operation in response to a loss of the associated inverter or degraded inverter output voltage.

10. Inverter and Regulating Transformer Sizing

a. Scope

The Class 1E 208/120 Vac IDS System receives its power from inverter assemblies that comprise a static transfer switch capable of transferring the voltage source from the inverter to an associated voltage regulating transformer through a make-before-break switch arrangement when the inverter is not available or the inverter voltage drops below predetermined values. Westinghouse Design Specification APP-DU01-Z0-001, "Design Specification for Class 1E Inverters, Static Transfer and Manual Bypass Switches for IDS System," defined the requirements for the design, manufacture, and testing of the Class 1E inverters and associated transfer static and manual bypass switches used in the Class 1E 208/120 Vac IDS system. The requirements for the voltage-regulating transformer were defined in Design Specification APP-DT01-Z0-010, "Design Specification for Class 1E regulating transformers." The inspectors reviewed the specifications for the inverter assemblies and regulating transformers to verify these components were properly sized and they would be capable of providing adequate voltage to the Class 1E 208/120 Vac system loads. The review included verification that specified design requirements were consistent with industry standards and NRC guidelines and requirements. The inspectors also confirmed that environmental conditions under which the components would be operating had been adequately outlined in the specification, and testing requirements assuring the capability of the component to perform under the specified environments, including voltage, loading, short-circuit current, temperature, radiation, relative humidity, and seismic environment,

had been specified. Lastly, the inspectors verified that the setpoint for inverter shutdown under low input voltage conditions was sufficiently low, as to not permit an inadvertent tripping of the inverter while the battery voltage approached its low limit, but was also sufficiently high enough to operate the required components when necessary.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The inspectors confirmed the sizing of the inverters was sufficient to meet the loading requirements under design basis events and the regulating transformers were adequately sized to provide back-up power to the inverters when the inverters were not available or capable to provide the required voltage to the Class 1E 208/120 Vac loads. The inspectors also confirmed the design and testing criteria stated in the specifications were appropriate and consistent with industry standards and NRC regulations.

c. Conclusion

The inspectors confirmed the sizing of the inverters was sufficient to meet the loading requirements under design basis events and the regulating transformers were adequately sized to provide back-up power to the inverters.

11. Battery Sizing

a. Scope

The inspectors reviewed the battery sizing calculations contained in Calculation APP-IDS-E0C-001, "Class 1E 250V DC Battery Sizing, Charger Sizing and Available Short Circuit Current," to verify that the size of the battery banks to be utilized in the IDS was adequate to provide power to the Class 1E loads under all system conditions.

There are four independent, Class 1E 250 Vdc Divisions: A, B, C, and D. Divisions A and D are each comprised of one 24-hour battery bank that provides power to the loads required for the first 24 hours following an event of loss of all ac power sources concurrent with a design basis accident (DBA), and the loss of one switchboard and one battery charger. Divisions B and C are each comprised of two battery banks (a 24-hour battery bank that provides power to the loads required for the first 24 hours following a of loss-of-all ac power sources concurrent with a DBA, and a 72-hour battery bank used for those loads requiring power for 72 hours following the same event. The sizing calculations reviewed include the calculations associated with the seven battery banks:

- IDSA-DB-1A/1B (Division A 24-hour Battery Bank),
- IDSB-DB-1A/1B (Division B 24-hour Battery Bank),
- IDSB-DB-2A/2B (Division B 72 hour Battery Bank),
- IDSC-DB-1A/1B (Division C 24-hour Battery Bank),
- IDSC-DB-2A/2B (Division C 72-hour Battery Bank),
- IDSD-DB-1A/1B (Division D 24-hour Battery Bank)
- IDSS-DB-1A/1B (Spare Battery Bank)

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The inspectors verified that the sizing calculations considered three DBA scenarios for battery loading conditions in order to determine the sizing of the battery in each division. A large break loss-of-coolant accident (LOCA) and the concurrent loss of ac power for the 72-hour battery banks is the worst-case loading scenario, and thus, it was used as the enveloping scenario utilized for the battery sizing calculation. The inspectors verified several basic factors that govern battery size including maximum system voltage, minimum system voltage, correction factors, and duty cycle. The minimum battery voltage is 210 Vdc and the maximum battery voltage is 280 Vdc. The inspectors verified that each IDS 24-hour battery bank was capable of supplying a dc switchboard bus load for a period of 24 hours without recharging as stated in AP1000 DCD Section 8.3.2.1.1.1. The inspectors also verified that each IDS 72-hour battery bank was capable of supplying a dc switchboard its assigned bus load for a period of 72 hours without recharging as required by the AP1000 DCD Section 8.3.2.1.1.1. Westinghouse opted to size all the batteries to the worst-case scenario, with the largest load being associated with a large break LOCA and concurrent loss of ac power event for the 72-hour battery banks, requiring a total of 27 plates with a corresponding manufacturer size battery of 2320 A-h, therefore, all seven batteries (24-hour and 72-hour batteries, plus the spare battery) are the same size. Based on the review of the battery sizing calculations, the inspectors concluded that the battery sizing calculations were adequate since they demonstrated that the battery banks would be able to supply their assigned loads under the worst-case scenario. The inspectors also verified that the analysis had been performed in accordance with IEEE 485-1997, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications," as committed to in the DCD, and included appropriate margins and correction factors.

c. Conclusion

The inspectors concluded that the battery sizing calculations were adequate since they demonstrated that the battery banks were able to supply their assigned loads under the worst-case scenario.

12. Battery Qualification

a. Scope

The inspectors reviewed the qualification test program for AP1000 24-hour and 72-hour Class 1E batteries outlined in Test Plan APP-DB01-VPH-001, "AP1000 Test Plan for Safety Related 250 VDC Batteries." The results of the qualification test program were documented in Reports APP-DB01-VBR-001, "Equipment Qualification Summary Report for Class 1E 250 VDC Batteries for Use in the AP1000 Plant;" APP-DB01-VBR-100, "AP1000 Class 1E 250 VDC Battery System Qualification Report: Qualification Report for Batteries with Type GN-29 Cells;" and APP-DB01-VTR-100, "AP1000 Class 1E 250 VDC Battery System Test Reports: Certification Test Reports for the Nuclear Environmental Qualification Testing of Enersys GN-29 Cells."

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The Westinghouse test program required that the battery be subjected to accelerated thermal aging and discharge cycling over its qualified life followed by the design basis seismic event. In addition, following the aging process, the test specimens were subjected to environmental testing to verify the equipment's ability to operate in postulated abnormal environmental conditions during plant operation. The test plan is summarized in the AP1000 DCD, Section 8.3.2.1.

The test plan assumes a qualified life of 20 years; the intervals at which the battery is tested (discharge cycling) during the qualification test are defined by the selected qualified life. The discharge cycling for the AP1000 battery qualification testing was performed in accordance with IEEE 450-2002, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications." IEEE 450 states that the performance test interval should not be greater than 25 percent of the expected service life (the capacity/performance test is performed every 60 months on a battery with a qualified life of 20 years). RG 1.129, which endorses IEEE 450, notes that the service test intervals should not be greater than 24 months.

The test plan identified the Type 3 modified performance test as the test to perform the discharge cycling of the batteries. A modified performance test is a test of the battery capacity/performance and the ability of the battery to satisfy the duty cycle (i.e., service test). Therefore, both the capacity and service test performed during the battery life, as approved in the AP1000 Technical Specifications (TS), would be enveloped in the modified performance test. The capacity/performance test should be performed as required in TS 3.8.7.6 with a frequency of 60 months until the battery reaches 85 percent of its qualified life after which the capacity test is performed annually if the capacity is less than 100 percent of the manufacturer's rating, or biannually if the capacity is more than a 100 percent of the manufacturer's rating. The service test should be performed as required in TS Surveillance Requirement (SR) 3.8.1.3 with a frequency of 24 months. Since the lowest time interval of the SRs for the two tests is 24 months, the modified performance test should be performed every 24 months in order to comply with both of the TS SRs. The test plan outlined the Type 3 modified performance test method at intervals representative of the AP1000 surveillance test requirements of the batteries with a 10 percent margin in the number of discharge cycles. This establishes the margin for the expected life of the battery. This approach results in a total of 16 modified performance tests (a factory acceptance test, a baseline/pre-aging test, 12 modified performance tests that simulate the cycle aging of the battery, an abnormal events test, and a post-seismic test). Thus, the test magnitude/duration (modified performance test versus service and performance tests) and test interval envelop the AP1000 and industry cycling requirements.

The inspectors determined that although the batteries needed to successfully undergo 16 modified performance tests to have a qualified life of 20 years, the batteries only completed 12 modified performance tests equivalent to a qualified life of 16.5 years. An additional 2.2 years of qualified life was added due to: 1) accelerated thermal aging above ≥100 degrees Fahrenheit (37.8 degrees Celsius) during 9 heat ups and 9 cool downs, and 2) natural aging during the test duration at 77°F (25°C). Thus, the total

qualified life for the batteries is 17 years, which includes a margin of 10 percent consistent with the guidance in IEEE 323. However, the qualified life is inconsistent with the information in the AP1000 TS SR.

The inspectors determined that since the qualified life achieved during the qualification testing is not 20 years (qualified life assumed to determine TS SR intervals), the license holders and applicants utilizing this qualification for the AP1000 Class 1E batteries would need to submit a license amendment correcting the TS SR frequencies corresponding to a 17-year qualified life. Westinghouse informed the NRC inspectors, and further documented the issue in Corrective Action Prevention and Learning report (CAPAL) 100357583, that they plan to repeat the qualification testing in an attempt to achieve a 20-year qualified life. Therefore, this issue is considered an unresolved item pending the completion of the subsequent qualification testing that Westinghouse is intending to complete: Unresolved Item 99901467/2016-201-02.

c. Conclusion

The inspectors determined the currently established qualified life of the IDS Class 1E batteries is 17 years. However, the qualified life is inconsistent with the information in the AP1000 TS SR and the license holders and applicants utilizing this qualification for the AP1000 Class 1E batteries would need to submit a license amendment correcting the TS SR frequencies corresponding to a 17-year qualified life. Therefore, this issue is considered an open item pending the completion of the subsequent qualification testing that Westinghouse is intending to complete: Open Item 99901467/2016-201-02.

13. Battery Hydrogen Evolution

a. Scope

The inspectors reviewed the two methods utilized to calculate the hydrogen evolution rates of the IDS system batteries, as documented in Calculations APP-IDS-E0C-005," Hydrogen Evolution Rates of IDS System," (Calculation based on EPRI EL-5036), and APP-VBS-M3C-001, "System Design Calculation for VBS System," (Calculation based on IEEE Standard 484).

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

AP1000 DCD, Section 8.1.4.3, states that the Class 1E batteries, as part of the Class 1E dc system, are designed in conformance with several IEEE standards including IEEE 484-1996, "IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications." This standard is endorsed by NRC RG 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants." Section 5.4 of IEEE Standard 484-1196 states that the battery area shall be ventilated, either by a natural or mechanical ventilation system, to prevent accumulation of hydrogen to less than 2 percent of the total volume of the battery area.

The inspectors observed that Westinghouse performed two separate calculations for determining the hydrogen evolution of the batteries as documented in APP-IDS-E0C-005," Hydrogen Evolution Rates of IDS System," (Calculation based on EPRI EL-5036), and APP-VBS-M3C-001, "System Design Calculation for VBS System," (Calculation based on IEEE Standard 484). The inspectors determined that the first method utilized by Westinghouse in APP-IDS-E0C-005 was less conservative than the battery manufacturer's (Enersys) method specifically designed for the GN-29 batteries and presented in Enersys Publication US-FL-IOM-AA. Upon discussion with Westinghouse staff, Westinghouse issued CAPAL 100429799 stating that the methodology utilized in Calculation APP-IDS-E0C-005, will be revised to reflect the more conservative Enersys methodology outlined in Enersys publication US-FL-IOM-AA, "Safety, Storage, Installation, Operation & Maintenance Manual Flooded Lead-Acid Batteries C, D, E, F and G."

Notwithstanding the above, Calculation APP-VBS-M3C-001 follows the methodology and assumptions discussed in IEEE 484-1996 with respect to prevention of hydrogen accumulation to less than 2 percent of the total volume of the battery area. The calculation resulted in a hydrogen generation rate of 6.456 ft^3/min at 120°F maximum abnormal temperature with a required ventilation rate of 322.8 cfm. This second method is more conservative than the first method discussed above; therefore, it was the methodology selected by Westinghouse to size the heating, ventilation, and air conditioning (HVAC) system exhaust for the battery room. Since the selected methodology conforms to the guidance in IEEE Standard 484-1996 as stated in the AP1000 DCD, the inspectors determined this to be acceptable.

c. Conclusion

The inspectors found that Westinghouse properly calculated the maximum hydrogen evolution rates for the IDS system batteries.

14. Verification of VBS System Design Calculation for Class 1E DC Equipment

a. Scope

The inspectors reviewed Calculation APP-VBS-M3C-001, "System Design Calculation for VBS System." This calculation pertains to HVAC heating and cooling requirements for the equipment served by the Nuclear Island Nonradioactive Ventilation System (VBS) located in the AP1000 Auxiliary Building. The inspectors assessed whether the HVAC system was properly sized to support Class 1E dc equipment loads during operational modes, and the inspectors assessed the impact of a failure of the HVAC on Class 1E dc equipment during accident conditions.

The inspectors reviewed Calculation APP-1200-VPC-001, "Base Model for AP1000 Auxiliary Building Room Heat-Up Analysis Using GOTHIC." This calculation examines the heat-up rate of the equipment rooms in the AP1000 Auxiliary Building for use in the AP1000 Auxiliary Building EQ analysis. The inspectors assessed whether the maximum temperatures calculated for abnormal and accident conditions in the Class 1E dc equipment rooms would be enveloped by the ongoing equipment qualification analysis program.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

Calculation APP-VBS-M3C-001 determined the room heating and cooling loads for Class 1E electrical equipment rooms served by VBS during normal plant operations and abnormal plant conditions, including a loss-of-offsite power and cold shutdown. The calculation determined VBS equipment sizing based on general requirements for HVAC systems found in EPRI TR-016780-V3R8, "Advanced Light Water Reactor Requirements Utility Requirements Document," and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook-Fundamentals, 2005.

The acceptance criteria required the VBS air handling units be sized at 15 percent higher than the calculated cooling requirements per EPRI TR-016780-V3R8. The inspectors verified that the calculations used appropriate methods to determine room heating and cooling loads for Class 1E dc equipment rooms and that the VBS equipment was sized accordingly.

Westinghouse used Generation of Thermal-Hydraulic Information for Containment (GOTHIC) software to analyze room heat-up rate for use in the AP1000 Auxiliary Building EQ analysis. Calculation APP-1200-VPC-001 developed several GOTHIC cases to confirm or challenge the equipment qualification temperature limits specified in Calculation APP-GW-VP-030, "AP1000 Environmental Conditions (for Equipment Qualification)." The calculation analyzed the Auxiliary Building heat-up effect on Class 1E equipment in the Auxiliary Building for a loss of HVAC and loss of all ac power abnormal conditions. Components located in the Auxiliary Building rooms that may exceed their equipment qualification temperature design limits as a result of these events were evaluated. The results in the calculation concluded that there are no safety-related components whose qualification would be invalidated by temperature changes in the Auxiliary Building due to loss of ac power or loss of non-safety HVAC events.

The inspectors verified that the GOTHIC Auxiliary Building room heat-up analysis demonstrated that the safety-related equipment located within the 250 Vdc battery rooms, Class 1E dc equipment rooms, Class 1E electrical penetration rooms, and Class 1E instrumentation and control rooms would remain below their qualification limits during adverse condition under abnormal plant conditions (loss of HVAC and a loss of all ac power).

c. Conclusions

The inspectors concluded the approach to sizing the HVAC system to support Class 1E dc equipment loads during operational modes was adequate. The inspectors also concluded that for abnormal conditions that involve a loss of HVAC and/or loss of ac power, the maximum temperatures calculated in the Class 1E equipment rooms would be enveloped by the on-going equipment qualification analysis program.

15. Verification of Class 1E 250VDC Battery Room Temperatures

a. Scope

The inspectors reviewed Calculation APP-VBS-M3C-005, "1E Battery Room Cooling Analysis," which evaluates Class 1E 250 Vdc battery performance during accident conditions. The inspectors assessed whether the Class 1E batteries would remain operable after a loss of HVAC and/or loss of ac power.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

The equipment qualification minimum temperature for the Class 1E battery rooms is identified in Calculation APP-GW-VP-030, "AP1000 Environmental Conditions (for Equipment Qualification)." The bounding conditions considered for the cooling analysis is a long-term loss of HVAC. The acceptance criteria for the battery room temperatures is that the battery rooms should not fall below 60°F for 72 hours with no heating available.

Calculation APP-VBS-M3C-005 modeled the battery room cooling analysis as an unsteady-state heat transfer problem to calculate heat transfer out of the battery room. The Division A Class 1E Battery Room and Division C Class 1E Battery Room 2 were selected for the analysis as Westinghouse determined these rooms would cool at the fastest rate. The results of the calculation determined that the Class 1E Battery Room temperatures will not fall below their minimum qualification temperature for greater than 130 hours after the loss of HVAC during worst-case cold temperature conditions.

c. Conclusions

The inspectors concluded that the Class 1E 250 Vdc battery room cooling analysis adequately demonstrates that the battery room temperatures will stay above the minimum design temperatures required to meet their environmental design requirements during a loss of HVAC, and therefore, the Class 1E batteries would remain operable.

16. Software Verification & Validation

a. Scope

The inspectors reviewed Westinghouse's implementation of quality activities associated with the use of design analyses computer software used in the AP1000 Class 1E dc equipment systems design to verify compliance with the regulatory requirements of Criterion III, "Design Control," of Appendix B to 10 CFR Part 50.

The inspections reviewed Westinghouse Procedure QS 02.07, "Computer Software," which establishes the requirements for the documentation, review, verification, validation, approval, and control of computer applications that could impact nuclear safety. The inspectors assessed whether software used in the development and validation of Class 1E dc systems was verified with the appropriate design analysis for each application.

b. Findings and Observations

No findings of significance were identified by the inspectors associated with this review.

Westinghouse utilized several software applications in the design and analyses of AP1000 Class 1E dc systems. The inspectors reviewed the software verification and validation performed by Westinghouse associated with the following software applications.

Westinghouse used Electrical Transient Analyzer Program (ETAP) V12.6.5N to perform the design and analysis of the Class 1E power systems for the AP1000 plant design. The ETAP program modules, qualified for nuclear use, were used to perform the following Class 1E systems analyses: load and short-circuit (ac/dc), battery discharge and sizing, protection devices, harmonics, transformer, motor acceleration, transient stability, transmission lines, and cable sizing. The ETAP software was procured as safety-related.

Westinghouse used EL-105, Version 00 Level 00, a MathCAD template used for the development and verification of Class 1E battery and charger sizing, and available short-circuit current. EL-105 implements the battery and charger sizing and available short-circuit current calculation criteria established in Westinghouse Calculation ETP 110.1.1-0, “Battery Sizing, Battery Charger Sizing, and Available Short Circuit Current.” The calculation follows IEEE methodology for sizing and calculating the short-circuit currents. Westinghouse validated the software by reproducing a sample case for the IEEE 485 battery sizing portion. The results of EL-105 were then compared with those from the IEEE sample problem. The battery charger size and short circuit calculation for the battery and charger were then manually calculated and compared against the EL-105 output.

Westinghouse used Microsoft Excel 2002, Westinghouse V2.4 Nuclear System Add-in for Excel 7+, to analyze Class 1E battery room temperatures following a loss of HVAC and loss of ac power. The analysis consisted of thermo-hydraulic hand formulas which were then translated into an Excel spreadsheet for computation. The results of the Excel calculation were checked by review of the calculation methods, assumptions, input data, references, and the mathematics using Westinghouse's 3-pass verification method. The accuracy of the numerical results were verified using the formulas and inputs shown in the calculation printout and the results were re-calculated independent of the spreadsheet.

Westinghouse used GOTHIC Version 7.2B to analyze room heat-up rate for use in the AP1000 Auxiliary Building equipment qualification analysis. The analysis was conducted by compiling heat load input values and values for the geometry for each auxiliary building room were compiled into "Master Input" Microsoft Excel spreadsheet files which were used as input to the GOTHIC program. GOTHIC simulations generated output in the form of a temperature history for each auxiliary building room and these results were used to determine if AP1000 auxiliary building rooms meet the room temperature limits for a loss of ac power and/or loss of HVAC events. The background, methods, analysis inputs, results and conclusions were verified using Westinghouse's 3-pass verification method.

c. Conclusions

The inspectors concluded that Westinghouse implemented adequate processes for verifying and validating computer software used in the design of Class 1E equipment systems through testing and analysis. The inspectors determined that Westinghouse established appropriate measures to verify the suitability of the computer software used to perform calculations used to design and analyze AP1000 Class 1E equipment systems.

17. Table of Items Opened/Closed and associated ITAAC

Nonconformance/Unresolved Item Number	Open/Closed	Finding Type	Related ITAAC
99901467/2016-201-01	Open	NON	2.6.03.08
99901467/2016-201-02	Open	Unresolved Item	N/A
99900404/2011-201-07	Closed	Open Item	N/A

ATTACHMENT

1. EXIT MEETING

On December 20, 2016, the NRC inspection team conducted an exit meeting with WEC management and staff and discussed the results of the inspection.

NAME	ORGANIZATION	Attended Entrance Meeting	Attended Exit Meeting
Ron Wessel	Westinghouse	X	X
Curtis Castell	Westinghouse	X	X
Christopher Roseman	Westinghouse	X	X
Michael Detrick	Westinghouse	X	X
Walter Drzal	Westinghouse		X
David Lucas	Westinghouse	X	X
Sunil Kabra	Westinghouse	X	
Charles Fisher	Westinghouse	X	
Gaurav Pant	Westinghouse	X	
Pat Sheldon	Westinghouse	X	
Frederick Willis	Southern Nuclear	X	
John Ewald	Westinghouse	X	
Jeffrey Jacobson	NRC	X	X
Jermaine Heath	NRC	X	X
Guillermo Crespo	NRC	X	X
Aniello Della Greca	NRC contractor	X	X
Tania Martinez-Navedo	NRC	X	X
Terry Jackson	NRC		X

2. List of Abbreviations Used in Report

A	Ampere
ac	alternating current
AOV	air operated valves
CAPAL	corrective action prevention and learning report
CB	circuit breaker
CDI	commercial grade dedication instruction
CFR	*Code of Federal Regulations*
DBA	design basis accident
dc	direct current
DCD	design control document
EDV	engineering design verification
EMI	electromagnetic interference
ETAP	Electrical Transient Analyzer Program
GOTHIC	Generation of Thermal-Hydraulic Information for Containment
HVAC	heating, ventilation, and air conditioning
IDS	Class 1E dc and Uninterruptible Power Supply System
IEEE	Institute of Electrical and Electronics Engineers
ITAAC	inspections, tests, analyses, and acceptance criteria
LOCA	loss of coolant accident
MCC	motor control center
MCP	motor circuit protector
MOV	motor operated valve
QA	quality assurance
RG	regulatory guide
SOV	solenoid operated valves
SR	surveillance requirement
THD	total harmonic distortion
TOL	thermal overload
TS	technical specifications
UPS	uninterruptible power supply
V	Volt
VBS	Nuclear Island Nonradioactive Ventilation System

3. INSPECTION PROCEDURES USED

NRC Inspection Procedure 37805, “Engineering Design Verification Inspection.”

4. DOCUMENTS REVIEWED

Design Specifications

- APP-DD01-Z0-010, “Design Specification for Class 1E 250 VDC Distribution Panels for System IDS,” Rev. 5
- APP-DF01-Z0-001, “Design Specification for Class 1E Fused Transfer Switch Boxes,” Rev. 7
- APP-DK01-Z0-010, “Class 1E Motor Control Centers,” Rev. 9
- APP-DS01-Z0-010, “Specification for Class 1E 250 VDC Switchboards for System IDS,” Rev. 6

- APP-DT01-Z0-010, "Design Specification for Class 1E Regulating Transformers," Rev 8
- APP-DU01-Z0-001, "Design Specification for Class 1E Inverters, Static Transfer and Manual Bypass Switches," Rev. 7
- APP-EA01-Z0-001, "Specification for Class 1E AC Distribution Panels for IDS System," Rev. 7
- APP-EA03-Z0-001, "Design Specification for Class 1E Fuse Panels for IDS System," Rev. 7
- APP-IDS-E8-001, "Class 1E DC and UPS System Specification Document," Rev. 3, March 3, 2016
- APP-EY01-V7Y-001, "Archival of Mirion IPS-2402, EPA Conductor Parameters," Rev. 0, dated June 30, 2011
- APP-DK01-Z0-010, "Class 1E Motor Control Centers," Rev. 9, dated August 2, 2016
- APP-PV01-Z0-001, "3" and Larger Motor Operated Gate and Globe Valves, ASME Boiler and Pressure Vessel Code Section III, Class 1, 2, and 3," Rev. 9, dated May 11, 2016
- APP-EY01-Z0-001, "Electrical Penetration Assemblies," Rev. 7 dated November 7, 2016
- APP-EY01-Z0D-010, "Specification Datasheet for Class 1E Power and Control Electrical Penetration Assemblies," Rev. 2, dated January 15, 2016
- APP-GW-M1-003, "HVAC System Design Criteria," Rev. 2," dated January 8, 2016
- Advanced Light Water Reactor Requirements Document Vol. III, Utility Requirements for Passive Plants, Chapter 9, Section 8 Heating, Ventilating and Air Conditioning System, Rev. 8, Issued 1999, Prepared for EPRI.

<u>Calculations</u>:

- APP-IDS-EOC-001, "Class 1E 250V DC Battery Sizing, Charger Sizing and Available Short Circuit Current," Rev. 4, September 30, 2016
- APP-IDS-EOC-002, "Class 1E DC and UPS (IDS) Inverter and Regulating Transformer Sizing," Rev. 3, May 25, 2016
- APP-IDS-EOC-004, "IDS Power Cable Sizing and Voltage Drop Analysis," Rev. 3, October 18, 2016
- APP-IDS-EOC-009, "IDS Powered Air and Solenoid Operated Valves, Plant Monitoring System Cabinets and Switchgear Cable Lengths," Rev. 2
- APP-IDS-EOC-010, "Coordination Study - Class 1E 208/120V AC System," Rev. 1, November 10, 2016
- APP-IDS-EOC-011, "Class 1E (IDS) 250V DC System - Coordination Study," Rev. 3, November 10, 2016
- APP-IDS-EOC-012, "Class 1E 250V DC System Arc Flash/ Incident Energy Calculation," Rev. 0, February 23, 2016
- APP-IDS-EOC-015, "IDS MCC Power Fuse RG1.106 Compliance," Rev. 0
- APP-IDS-EOC-016, "AP1000 IDS Motor Circuit Protector Sizing," Rev. 0
- APP-IDS-EOC-017, "IDS MCC TOL Requirements per IEEE741," Rev. 0
- APP-ZAS-EOC-001, "AC Electrical System Load Flow, Short Circuit and Motor Starting Calculation," Rev. 0, September 5, 2014
- APP-IDS-E0C-001, "Class 1E 250V DC Battery Sizing, Charger Sizing and Available Short Circuit Current," Rev. 4, September 30, 2016
- APP-IDS-E0C-005," Hydrogen Evolution Rates of IDS System," Rev. 1, July 8, 2014

- APP- APP-IDS-E0C-011, “Class 1E (IDS) 250V DC System – Coordination Study,” Rev. 3, dated November 10, 2016.
- APP-IDS-E0C-014, “Verification of IDS Low Voltage Class 1E Safety-Related Electrical Penetrations,” Rev. 0, dated November 10, 2016
- APP-IDS-E0C-008, “IDS Powered Motor Operated Valve and IDS System Cable Lengths,” Rev. 2, dated January 9, 2014.
- APP-IDS-EOC-004, “IDS Power Cable Sizing and Voltage Drop Analysis,” Rev. 3 dated October 18, 2016.
- VBS-M3C-001, “System Design Calculation for VBS System,” Rev. 6, October 12, 2016
- APP-GW-VP-030, “AP1000 Environmental Conditions,” Rev. 6 dated January 16, 2016
- APP-GW-G1-002,”AP1000 Equipment Qualification Methodology,” Rev.5, dated October 19, 2016
- APP-VBS-M3C-005, “1E Battery Room Cooling Analysis,” Rev.0
- APP-1200-VPC-001, “Base Model for AP1000 Auxiliary Building Room Heat-Up Analysis Using GOTHIC,” dated August 2016
- APP-VBS-M3C-001, “System Design Calculation for VBS System,” Revision 6, dated October 12, 2016

<u>Drawings</u>:

- APP-IDS-E3-001, “Class 1E DC System Station One Line Diagram Divisions A & C,” Rev. 2, March 3, 2016
- APP-IDS-E3-002, “Class 1E DC System Station One Line Diagram Divisions B & D & Spare,” Rev. 2, March 3, 2016
- APP-IDS-E3-003, “Class 1E UPS System Station One Line Diagram Divisions A, B, C, & D,” Rev. 2, March 3, 2016
- APP-IDS-E3-004, “One Line Meter & Relay Diagram/Spare Class 1E Battery Bank and Charger,” Rev. 1, March 4, 2016
- APP-IDS-E3-005, “Class 1E DC System One Line Meter & Relay Diagram Div. A - 24 Hour Battery Bank,” Rev. 1, March 4, 2016
- APP-IDS-E3-006, “Class 1E DC System One Line Meter & Relay Diagram Div. B - 24 Hour Battery Bank,” Rev. 1, March 4, 2016
- APP-IDS-E3-007, “Class 1E DC System One Line Meter & Relay Diagram Div. B - 72 Hour Battery Bank,” Rev. 1, March 4, 2016
- APP-IDS-E3-008, “Class 1E DC System One Line Meter & Relay Diagram Div. C - 24 Hour Battery Bank,” Rev. 1, March 4, 2016
- APP-IDS-E3-009, “Class 1E DC System One Line Meter & Relay Diagram Div. C - 72 Hour Battery Bank,” Rev. 1, March 4, 2016
- APP-IDS-E3-010, “Class 1E DC System One Line Meter & Relay Diagram Div. D - 24 Hour Battery Bank,” Rev. 1, March 4, 2016
- APP-IDS-E3-011, “Class 1E UPS System One Line Meter & Relay Diagram Division A,” Rev. 1, March 4, 2016
- APP-IDS-E3-012, “Class 1E UPS System One Line Meter & Relay Diagram Division B,” Rev. 1, March 3, 2016
- APP-IDS-E3-013, “Class 1E UPS System One Line Meter & Relay Diagram Division C,” Rev. 1, March 3, 2016

- APP-IDS-E3-014, “Class 1E UPS System One Line Meter & Relay Diagram Division D,” Rev. 1, March 3, 2016
- APP-IDSA-E3-DD101, Panel Schedule IDSA-DD-1, 250 VDC Distribution Panel Auxiliary Building, Rev 3, December 18, 2014
- APP-IDSB-E3-DD101, Panel Schedule IDSB-DD-1, 250 VDC Distribution Panel Auxiliary Building, Rev 3, December 18, 2014
- APP-IDSC-E3-DD101, Panel Schedule IDSC-DD-1, 250 VDC Distribution Panel Auxiliary Building, Rev 3, December 18, 2014
- APP-IDSD-E3-DD101, Panel Schedule IDSD-DD-1, 250 VDC Distribution Panel Auxiliary Building, Rev 3, December 18, 2014
- APP-IDSA-E3-DS101, “Class 1E 250 VDC Switchboard IDSA-DS-1 Auxiliary Bldg., Sheet 1 of 2,” Rev. 0, December 9, 2011
- APP-IDSA-E3-DS102, “Class 1E 250 VDC Switchboard IDSA-DS-1 Auxiliary Bldg., Sheet 2 of 2,” Rev. 0, December 9, 2011
- APP-IDSB-E3-DS101, “Class 1E 250 VDC Switchboard IDSB-DS-1 Auxiliary Bldg., Sheet 1 of 2,” Rev. 0, December 9, 2011
- APP-IDSB-E3-DS102, “Class 1E 250 VDC Switchboard IDSB-DS-1 Auxiliary Bldg., Sheet 2 of 2,” Rev. 0, December 9, 2011
- APP-IDSB-E3-DS201, “Class 1E 250 VDC Switchboard IDSB-DS-2 Auxiliary Bldg., Sheet 1 of 2,” Rev. 0, December 9, 2011
- APP-IDSB-E3-DS202, “Class 1E 250 VDC Switchboard IDSB-DS-2 Auxiliary Bldg., Sheet 2 of 2,” Rev. 0, December 9, 2011
- APP-IDSC-E3-DS101, “Class 1E 250 VDC Switchboard IDSC-DS-1 Auxiliary Bldg., Sheet 1 of 2,” Rev. 0, December 9, 2011
- APP-IDSC-E3-DS102, “Class 1E 250 VDC Switchboard IDSC-DS-1 Auxiliary Bldg., Sheet 2 of 2,” Rev. 0, December 9, 2011
- APP-IDSC-E3-DS201, “Class 1E 250 VDC Switchboard IDSC-DS-2 Auxiliary Bldg., Sheet 1 of 2,” Rev. 0, December 9, 2011
- APP-IDSC-E3-DS202, “Class 1E 250 VDC Switchboard IDSC-DS-2 Auxiliary Bldg., Sheet 2 of 2,” Rev. 0, December 9, 2011
- APP-IDSD-E3-DS101, “Class 1E 250 VDC Switchboard IDSD-DS-1 Auxiliary Bldg., Sheet 1 of 2,” Rev. 0, December 9, 2011
- APP-IDSD-E3-DS102, “Class 1E 250 VDC Switchboard IDSD-DS-1 Auxiliary Bldg., Sheet 2 of 2,” Rev. 0, December 14, 2011
- APP-IDSA-E3-DK101, “One Line Diagram Class 1E 250 VDC MCC IDSA-DK-1 Auxiliary Bldg., Sheet 1 of 3,” Rev. 2, March 3, 2016
- APP-IDSA-E3-DK102, “One Line Diagram Class 1E 250 VDC MCC IDSA-DK-1 Auxiliary Bldg., Sheet 2 of 3,” Rev. 2, March 3, 2016
- APP-IDSB-E3-DK101, “One Line Diagram Class 1E 250 VDC MCC IDSB-DK-1 Auxiliary Bldg., Sheet 1 of 3,” Rev. 2, March 3, 2016
- APP-IDSB-E3-DK102, “One Line Diagram Class 1E 250 VDC MCC IDSB-DK-1 Auxiliary Bldg., Sheet 2 of 3,” Rev. 2, March 3, 2016
- APP-IDSC-E3-DK101, “One Line Diagram Class 1E 250 VDC MCC IDSC-DK-1 Auxiliary Bldg., Sheet 1 of 3,” Rev. 2, March 3, 2016
- APP-IDSC-E3-DK102, “One Line Diagram Class 1E 250 VDC MCC IDSC-DK-1 Auxiliary Bldg., Sheet 2 of 3,” Rev. 2, March 3, 2016
- APP-IDSD-E3-DK101, “One Line Diagram Class 1E 250 VDC MCC IDSD-DK-1 Auxiliary Bldg., Sheet 1 of 3,” Rev. 2, March 3, 2016

- APP-IDSD-E3-DK102, “One Line Diagram Class 1E 250 VDC MCC IDSD-DK-1 Auxiliary Bldg., Sheet 2 of 3,” Rev. 2, March 3, 2016
- APP-IDSA-E3-EA101, “Panel Schedule IDSA-EA-1 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSA-E3-EA201, “Panel Schedule IDSA-EA-2 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSA-E3-EA401, “Panel Schedule IDSA-EA-4 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSB-E3-EA101, “Panel Schedule IDSB-EA-1 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSB-E3-EA201, “Panel Schedule IDSB-EA-2 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSB-E3-EA301, “Panel Schedule IDSB-EA-3 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSB-E3-EA401, “Panel Schedule IDSB-EA-4 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSB-E3-EA501, “Panel Schedule IDSB-EA-5 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSB-E3-EA601, “Panel Schedule IDSB-EA-6 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSC-E3-EA101, “Panel Schedule IDSC-EA-1 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSC-E3-EA201, “Panel Schedule IDSC-EA-2 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSC-E3-EA301, “Panel Schedule IDSC-EA-3 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSC-E3-EA401, “Panel Schedule IDSC-EA-4 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSC-E3-EA501, “Panel Schedule IDSC-EA-5 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSC-E3-EA601, “Panel Schedule IDSC-EA-6 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSD-E3-EA101, “Panel Schedule IDSD-EA-1 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSD-E3-EA201, “Panel Schedule IDSD-EA-2 208Y/120VAC Distribution Panel Auxiliary Bldg.,” Rev. 2, December 18, 2014
- APP-IDSD-E3-EA401, “Panel Schedule IDSD-EA-4 Class 1E Fuse Panel Auxiliary Bldg.,” Rev. 0, May 21, 2015
- APP-IDSA-E5-DC102, “Combined Wiring Diagram MCC 1E Charger IDSA-DC-1 Sheet 2 of 3,” Rev. 1, dated November 3, 2016
- APP-IDSA-E5-DC103, “Combined Wiring Diagram MCC 1E Charger IDSA-DC-1 Sheet 3 of 3,” Rev. 0, February 6, 2015
- APP-VBS-M6-005, “Piping and Instrumentation Diagram NI Nonradioactive Ventilation System,” Rev.8, dated September 27, 2016
- APP-VBS-M6-006, “Piping and Instrumentation Diagram NI Nonradioactive Ventilation System,” Rev.7, dated November 18, 2015
- APP-1210-P3-001, “Auxiliary Building Equipment Location Plan EL 66’-6,” Areas 1&2, Rev. 2, dated April 21, 2015

- APP-1220-P3-001, “Auxiliary Building Equipment Location Plan EL 82’-6,” Areas 1&2, Rev. 2, dated April 22, 2015

Engineering & Departure Change Requests (E&DCRs):

- E&DCR No. APP-DK01-GEF-014, “DK01 Class 1E MCCs 250A to 200A Fuse Change,” Rev. 0, May 15, 2014

Modifications, Design Changes, and Design Change Proposals:

- APP-GW-GEE-5086, “Electrical Protection of Electrical Penetration Assemblies associated with Core I&C Systems,” Rev. 0 dated: August 7, 2015
- APP-GW-GEE-4883, “Design Changes to Address Heatup of Auxiliary Building Rooms following Loss of HVAC or Loss of all A/C Power,” Rev 0, dated June 13, 2016

Purchase Orders:

- APP-EY01-Z5-011, “Appendix 3.0 Technical and Quality Purchase Agreement Requirements Electrical Penetration Assemblies – Domestic Projects,” Rev. 0, dated March 3, 2012
- APP-PV01-Z5-003, “Appendix 3: Technical and Quality Requirements for the Procurement of PV01 Motor Operated Gate and Glove Valves for Domestic Projects,” Rev. 3 dated May 22, 2013

Correction Action Documents:

- CAPAL 100429739, Cable Identification in Figure E of calculation APP-IDS-EOC-014, dated November 15, 2016
- CAPAL 100430098, Change in conductor size not properly protected by fuse shown in Calculation APP-IDS-EOC-011, dated November 17, 2016
- CAPAL 100357583, “Battery Surveillance Technical Specification Errors/Enhancements,” existing CAPAL
- CAPAL 100429799, “APP-IDS-E0C-005 Hydrogen Evolution Equation,” dated November 17, 2016

Miscellaneous:

- APP-GW-VP-030, “AP1000® Environmental Conditions,” Rev. 6, January 8, 2016
- APP-IDS-EOC-014, “Verification of IDS Low Voltage Class 1E Safety-Related Electrical Penetrations,” Rev. A, March 8, 2016
- APP-EY01-V7Y-001, “Archival of Mirion IPS-2402, EPA Conductor Parameters,” Rev. 0 dated May 15, 2014
- APP-G1-E1-002, “Wire and Cable Design Criteria,” Rev. 0 dated November 19, 2010.
- Commercial Dedication Instruction CD-4324, “AP1000 Commodity Code EA01, AC Distribution Panel,” Revision 5, dated June 24, 2016
- APP-DB01-VBR-001, “Equipment Qualification Summary Report for Class 1E 250 VDC Batteries for Use in the AP1000 Plant,” Rev. 0

- APP-DB01-VBR-100, "AP1000 Class 1E 250 VDC Battery System Qualification Report: Qualification Report for Batteries with Type GN-29 Cells," Rev. 0, August 23, 2013
- APP-DB01-VBR-101, "AP1000 Class 1E 250 VDC Battery System Qualification Report: Addendum to the Qualification Report ENS # 208 for Batteries with Type GN-29 Cells," Rev. 0, February 18, 2016
- APP-DB01-VTR-100, "AP1000 Class 1E 250 VDC Battery System Test Reports: Certification test Reports for the Nuclear Environmental Qualification Testing of Enersys
GN-29 Cells," Rev. A, May 31, 2013

<u>Software V&V</u>

- QS 02.07, Computer Software, Rev. 05.01, dated March 31, 2016
- Qualification EL-100, Electrical Transient Analyzer Program (ETAP), Version 12.6.5NE, dated September 29, 2015
- ETAP-CL-12.6.5N, "ETAP Certification Letter," dated February 14, 2015
- RECA-Summary-1265N, ETAP Reported Errors and Corrective Action Summary, Rev.0
- Qualification EL-105, Charger Sizing, and Available Short Circuit Current Version, Version 00/Level 00, Rev. 0, dated September 4, 1998
- Qualification EL-105, Charger Sizing, and Available Short Circuit Current Version, Version 00/Level 00, Rev. 1, dated March 12, 2007
- AP1000 DCD Rev 19 Section 2.7, "HVAC Systems," dated June 13, 2011