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FACILITY NAME: Oyster Creek Nuclear Generating Station

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Areas Inspected: Announced team inspection by regional and contract personnel to review the functionality of the electrical distribution system.

Results: Refer to the Executive Summary.

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EXECUTIVE SUMMARY

During the period between May 4 and June 5, 1992, a Nuclear Regulatory Commission (NRC) inspection team conducted an electrical distribution system functional inspection (EDSFI) at the Oyster Creek Nuclear Generating Station to determine if the electrical distribution system (EDS) was capable of performing its intended safety functions, as designed, installed and configured. A second objective of the inspection was the assessment of the licensee's engineering and technical support for EDS activities.

Based upon the sample of design drawings, studies and calculations reviewed and equipment inspected, the team's conclusions were that the electrical distribution systems at Oyster Creek was capable of performing its intended functions. In addition, the team concluded that the engineering and technical support staff provided adequate support for the safe operation of the EDS at the plant.

Several strengths were identified, including measures taken to assure reliable offsite power, such as periodic grid stability studies. The emergency diesel generators and their dedicated support systems were determined to be adequately designed, well maintained and historically reliable. The licensee's program for the control of maintenance and test equipment was very effective with quality procedures, accurate calibrations, and knowledgeable technicians. The team concluded that the licensee's self assessment program was extensive and was enhanced by good root cause analyses. In general, technicians and engineers were very knowledgeable in their respective areas of expertise.

The team identified several safety-related components which the licensee had failed to include in programs to functionally test to assure that they would perform satisfactorily in service. This violation, cited in Appendix A, involved the battery main breakers, the static battery chargers, the rotary battery chargers, and the rotary inverter. Another violation, which involved calculation errors, was not cited due to minor safety significance and licensee corrective actions.

The team identified several weaknesses in the licensee's knowledge of the design bases of the EDS. Licensee analyses had not demonstrated that MCC control circuits could supply adequate voltage to their safety-related loads. Several other cases were also identified where the ac voltage analyses were not completed to the terminals of safety-related equipment. This weakness was also evident for dc circuits as the team identified that the licensee did not have voltage drop calculations for the safety-related 125 Vdc system. A similar weakness was identified with respect to the HVAC systems designed, in part, to limit the maximum temperatures in rooms containing safety-related EDS equipment. This weakness was indicated by deficiencies in alarms and weaknesses in procedural guidance to operators.

The team's findings are listed in Attachment 1 along with the sections of the report in which the items are discussed. Other observations are contained in the body of the report.

1.0 INTRODUCTION

During recent inspections, the Nuclear Regulatory Commission (NRC) staff observed that, at several operating plants, the functionality of safety related systems had been compromised by design modifications affecting the electrical distribution system (EDS). The observed design deficiencies were attributed, in part, to improper engineering and technical support. Examples of these deficiencies included: unmonitored and uncontrolled load growth on safety related busses; inadequate review of design modifications; inadequate design calculations; improper testing of electrical equipment; and use of unqualified commercial grade equipment in safety related applications.

In view of the above, the NRC initiated electrical distribution system functional inspections (EDSFI). The objectives of these inspections were to assess: (1) the capability of the electrical distribution system's power sources and equipment to adequately support the operation of safety related components and (2) the adequacy of the engineering and technical support in this area.

To achieve the first objective, the team reviewed calculations, design documents and test data, paying particular attention to those attributes which ensure that quality power is delivered to those systems and components that are relied upon during and following a design basis event. The review covered portions of onsite and offsite power sources and included the 230 kV and 34.5 kV offsite power grids, main transformers, unit startup and auxiliary transformers, 4.16 kV normal and emergency busses, emergency diesel generators, 480 V safety related unit substations and motor control centers, station batteries, battery chargers, inverters, 125 Vdc safety related busses, and the 120 Vac vital distribution system.

The team verified the adequacy of the emergency onsite and offsite power sources for the EDS equipment by reviewing regulation of power to essential loads, protection for calculated fault currents, circuit independence, and coordination of protective devices. The team also assessed the adequacy of those mechanical systems which interface with and support the EDS. These included the diesel start system, lube oil, and the cooling and heating systems for the emergency diesel generators and for the electrical distribution equipment.

A physical examination of selected EDS equipment verified the equipment configuration and rating. In addition, the team reviewed maintenance, calibration and surveillance activities for selected EDS components.

The capabilities and performance of the engineering and technical support organizations for the electrical distribution system area were also evaluated. Particular attention was given to their resolution of identified non-conformances and their involvement in the design and operations issues.

The inspection considered conformance to General Design Criteria and other regulatory requirements as well as the licensee's commitments contained in applicable portions of the plant's Technical Specifications, the Final Safety Analysis Report and appropriate safety evaluation reports.

Section 2.1 of this report provides a general description of the Oyster Creek electrical systems. The details of the specific areas reviewed, the team's findings and the applicable conclusions are described in Sections 2 through 5.

2.0 ELECTRICAL DESIGN

To assess the adequacy of Oyster Creek's electrical design, the team reviewed the features and components of the electrical distribution system (EDS) included within the scope of the inspection. The design was evaluated for compliance with specifications, industry standards, and regulatory requirements and commitments. The documents were reviewed for accuracy and conformance with accepted engineering practices.

The scope of the review included drawings, design calculations, and studies associated with:

1. The ac and dc systems loading, including steady-state and transient load profiles of diesel generators and batteries, under normal and abnormal operating conditions;

2. Voltage regulation during normal and degraded grid conditions;

3. Voltage regulation during sequencing of engineered safeguards equipment onto the preferred power supply and onto the emergency diesel generators;

4. Short circuit and ground fault detection and protection, including selection and coordination of overload protective devices for ac and dc electrical equipment;

5. Ratings of EDS equipment, such as switchgear and transformers, batteries and battery chargers, and emergency diesel generators;

6. Sizing of cables for fault withstand capability, and voltage drop during steady-state and transient conditions;

7. Protection of electrical containment penetrations,

The team also reviewed procedures and guidelines governing the EDS design calculations, design control, and plant modifications.

The team's findings are described in the paragraphs below.

2.1 Offsite Power and Grid Stability

The Oyster Creek Nuclear Generating Station (OCNGS) design generation capacity is 687.6 MVA of power at 24 kV. This power is transmitted from the main generator to two main transformers (M1A and M1B) and one auxiliary transformer through an isolated-phase bus duct. The two main transformers step up the voltage from 24 kV to 230 kV and transmit it to two 230 kV switchyard busses. The 230 kV busses are connected through transformers to two 34.5 kV busses in the switchyard. The 230 kV and 34.5 kV busses make up the OCNGS transmission and switching system. This includes three transmission lines from the 230 kV busses and 5 transmission lines from the 34.5 kV busses. A pair of combustion turbines located near the switchyard provide grid peaking power. The combustion turbines are also connected to the 230 kV busses through separate 13.8 kV to 230 kV transformers.

The auxiliary transformer receives power directly from the main generator and steps down the 24 kV generator voltage to feed two 4160 V busses, 1A and 1B. During normal operation, site power is provided from the auxiliary transformer to the 1A and 1B 4160 V busses. During startups, shutdown or emergencies, site power is provided through two startup transformers, S1A and S1B. The startup transformers step down their 34.5 kV supply, from the OCNGS switchyard, to 4160 V and supply the 1A and 1B busses. If both 34.5 busses were unavailable during an event, the startup transformers could receive power directly from one offsite line through the manual operation of pole mounted disconnect switches. The team confirmed that each startup transformer had sufficient capacity to carry all emergency loads.

The team noted that when the plant auxiliary power is being provided by the startup transformers, induction voltage regulators connected to the 34.5 kV side before the startup transformers automatically accommodate voltage fluctuations in the subtransmission network. In addition, each 34.5 kV bus is provided with a capacitor bank as a provision to enhance the system voltages and power factor, with adjustments made remotely/locally under the direction Jersey Central Power & Light (JCP&L) load controller. The licensee had performed a series of system analyses under various operating and system fault conditions. These conditions included contingencies involving the 230 kV transmission and 334.5 kV subtransmission systems. The transient stability studies completed earlier simulated the loss of OCNGS and the largest unit in the New Jersey network. The studies included three phase faults with primary and delayed relay clearing and single phase to ground faults with delayed clearing. Additionally, a 1979 load growth study done by JCP&L examined the system overloads and voltage problems due to the loss of OCNGS and the worst case transmission line in JCP&L system. This study concluded that no OCNGS transient instability or system transient instability problem could occur. The team identified no deficiencies in the studies.

The team found evidence that JCP&L periodically had conducted studies to determine anticipated operating conditions within the Southern Jersey of JCP&L for the summer peak to assure that the system was capable of handling the loads and maintaining the required voltage. The team reviewed the 1989 summer peak projection reliability study and concluded that system could maintain the grid system voltages as required with contingency plans for load shedding, if required. The load shedding could be accomplished automatically based on system voltages or by load dispatcher manual action. The team reviewed the 230 kV grid system voltage historical data for the previous two years and confirmed that the voltages available enveloped the assumptions in the licensee's degraded voltage study. The measures taken by the licensee to assure reliable offsite power, including periodic grid stability studies, are considered a strength.

The team questioned the reliability of switchyard breakers and protective devices. During walkdowns, the team observed that switchyard breakers had only one trip coil, vice two independent trip coils as more commonly found at nuclear stations, and only one dc control power system for the protective devices in the switchyard. The licensee stated that this was the original design for the plant. Based on the maintenance history of the breakers and the absence of significant failures, the team had no further questions concerning the design of the switchyard breakers.

The single dc control power system for the switchyard consists of a battery sized to provide 48 hours of operation and a battery charger sized to handle all loads while recharging the battery. The 48 hour battery rating was selected by JCP&L to provide control power for a sufficient period to allow charger maintenance or repair. The team identified that no periodic maintenance was performed on the battery other then periodic voltage readings and monthly specific gravity readings. The absence of a program to periodically test the battery to verify its continued ability to provide power for its design period is an area of potential concern. The team noted that the loss of control power to any switchyard breaker would be indicated in the OCNGS control room and also annunciated at the load dispatcher control room.

2.2 Bus Alignment During Startup, Normal, Abnormal and Shutdown Operation

The medium voltage class 1E EDS at OCNGS includes two 4160 volt emergency switchgear busses (1C and 1D), four class 1E 460 volt unit substations (1A2, 1A3, 1B2 and 1B3), 460 volt safety class Motor Control Centers (MCCs), and vital 460V MCCs (1A2 and 1B2). The 4160 volt system is a low resistance (2 ohm) grounded wye, developing approximately 1000 amperes for ground faults. The 480/277 volt system (the low voltage EDS design specifies a 4160 - 480/277V transformer and a 460V unit substation bus) is a solidly grounded wye.

The two 4160 volt emergency busses are designated 1C and 1D and are normally aligned with non-safety 4kV busses 1A and 1B, respectively. During normal station operations, busses 1A and 1B are supplied via the station unit auxiliary transformer (a three winding 24000V - 4160/2400V, 4160/2400V transformer) rated 18/24/30 MVA, and 8.24 per cent and 8.27 per cent impedance, H-X and H-Y windings, each on its 9 MVA base (the secondary windings are rated 9/12/15 MVA).

During station start-up and shutdown, the 4kV busses 1A and 1B are supplied via two 34.5/4.16kV station start-up transformers, each two winding, rated 12/16/20 MVA, and each approximately 6.10 per cent impedance on the its 12 MVA rating. Each start-up transformer is specified and dedicated to one "normal" 4160 volt bus. In addition, start-up transformer SA, besides providing power to 4160V bus 1A, also feeds a 4160kV dilution plant switchgear bus. During abnormal conditions, such as the deenergization of the auxiliary transformer, an automatic fast transfer is available to the respective startup transformer (see section 2.3).

A station modification, effected in the 1980/81 time period, added voltage regulators at the 34.5kV switchyard to improve the stations voltage profile. These regulators were designed and installed to maintain the voltage, at busses 1A and 1B, between 4200 and 4300 volts. This addition was in part a result of the station's degraded grid studies.

The team reviewed the applicable station procedures and electrical lineups and determined that they were acceptable and in conformance with the OCNGS FSAR.

2.3 Bus Transfer Schemes

The OCNGS design provides for the automatic fast transfer of 4 kV busses 1A and 1B to alternate sources, without becoming deenergized, upon the loss of the normal power supply, the unit auxiliary transformer. The alternate power supplies to 4 kV busses 1A and 1B are startup transformers S1A and S1B, respectively.

The bus transfer scheme opens the unit auxiliary transformer breaker which, via its "b" contact, initiates the closure of the startup transformer supply breaker to the respective bus. The objective of the design is to limit the time that the bus being transferred is disconnected from both sources to a maximum of approximately 7 cycles.

The licensee had conducted an analytical study concerning the fast transfer feature. The 7 cycles total dead time calculated in this study was based on 5.2 cycles nominal dead time with no arcing plus a tolerance of 1.3 cycles and 0.5 cycles margin for class 1E application. During high level electrical faults, arcing for a duration of 1.6 cycles was considered in establishing the total dead time. The total dead time was 5.4 cycles based on 3.6 cycles nominal dead time plus a tolerance of 1.3 cycles and 0.5 cycles margin for class 1E applications. In this study the licensee considered worst case loading and average historical voltage condition on the 4160V busses. The team reviewed this study and other related analyses and determined the calculated 7 cycle transfer time to be acceptable and adequately supported.

2.4 4160 V/480 V ac Class 1E Systems

The OCNGS EDS includes two 100 per cent capacity emergency diesel generators (EDGs) to supply emergency power to the 4160 volt emergency busses 1C and 1D within 20 seconds of a loss of bus voltage. The EDGs, the class 1E EDS, and the safety class loads were configured and connected to form two redundant and independent trains to ensure that at least one path of required power was available to safety-related components and systems for all station design basis conditions. The EDGs have a continuous rating of 2500 kW at 0.8

power factor and 4160 volt. Each EDG has an output breaker switchgear bus located in its respective diesel building. The connection from this bus to the emergency 4.16kV busses (1C and 1D) is via two single conduct.. 500 MCM cables (per phase) routed in dedicated duct bank and conduit from the diesel building to the 4.16 kV switchgear area in the turbine building. This cable is solidly terminated at both ends of the 4kV switchgear (i.e., at the DG switchgear and at the 4 kV emergency switchgear).

All 460 volt unit substation busses at OCNGS are supplied from the 4.16kV emergency switchgear busses 1C and 1D. Three unit substations are connected to eac bus;, one of the three (unit substation busses 1A3 or 1B3) feed non safety loads; the othe two (1A1 and 1A2 or 1B1 and 1B2) feed class 1E loads, with some exceptions. For those cases where non-1E loads are supplied from class 1E distributio a qualified isolation device has been provided. The capability to effect cross tie connections between busses of opposite trains does exist at OCNGS; however, these ties are administratively controlled and are normally opened and/or the circuit breakers in the tie path are physically racked out.

The class 1E 460 volt unit substations provide power to safety class loads including large motors (125 hp up to and including 300 hp), 460 volt class 1E Motor Control Centers (MCCs), vital Motor Control Centers (which supply low voltage class 1E components and systems), 480-208/120V distribution and lighting transformers, and 460-120V regulating transformers.

The team reviewed cable sizing for the class 1E 4160V and 460V EDS. Since the historical design basis for cable sizing was not available, the team reviewed present licensee engineering procedures and standards for new cable sizing. Also, a representative sample of the original cable sizing population was reviewed to confirm that circuit ampacities, as compared to the most recent station design loads and circuit installation configuration, were adequate. With regard to current engineering design at OCNGS, several design modifications were reviewed to verify the implementation of cable sizing procedures and installation. The review of selected safety category modifications demonstrated that cable requirements had been properly evaluated.

The team also reviewed and compared load flow analysis results with installed equipment nameplate data, recorded during station inspections and walkdowns. In all cases, the nameplate data was concluded to exceed analyzed load requirements with adequate margin.

The team also reviewed connected loads versus loads calculated in the load flow studies. Specifically, the team reviewed controls/monitoring for loading on unit substation 1B2, since the connected load was substantially in excess of the substation transformer rating (2300kVA versus greater than 2900kVA connected load). The licensee provided information describing a high current alarm provision for the unit substation, set at 272 amperes (approximately 2000kVA) monitoring the feeder current to the unit substation transformer. Based on a review of this information, the team concluded the design to be adequate.

System requirements were also compared to equipment specification performance ratings. Good agreement was found between performance requirements and ratings, but the team noted that there was little or no margin in the design concerning momentary short circuits at the 4 kV switchgear (see section 2.7).

The team also reviewed voltage drop analysis studies, performed for the Class 1E Electrical Distribution System at Oyster Creek for running and starting conditions and from offsite (start-up transformers) or from the unit auxiliary transformers. These studies were performed for degraded grid conditions and worst case load flows.

The team identified two areas of weakness involving the area of voltage drop analyses. The first area of weakness involved the analyses of MCC control circuits. The analyses assumed a maximum voltage drop in control wiring for any safety-related starter circuit to be 3 volts; however, no documentation was available to demonstrate how this assumption was implemented or controlled. In addition, specific examples were identified in the plant design where subsequent control circuit modifications had not been reanalyzed at that time to verify that the 3 volt assumption had not been obviated by the change. The identified examples involved Appendix R modifications made to control circuits in the 1985/86 time frame, which added relays and contacts to the starter circuits so that control could be transferred to an alternate shutdown panel. Also the licensee indicated that interposing relays provided as part of the Appendix R change had not been analyzed as part of the design modification package. The team also noted that the methodology used in the MCC control circuit voltage analyses did not appear to address control transformer impedances. Since control transformer sizes range from 75va to 400va, the voltage drop across smaller rated transformers could affect available voltage at control circuit contactor coils. Also, a review of a sample of motor control center control circuits identified safety components in these circuits (e.g., auxiliary relays, solenoid operated valves, squib firing devices, etc.) which had not been addressed in the control circuit analysis. Adequate voltage had not, therefore, been analyzed to be available to these safety devices to fulfill their design bases. The ability of MCC control circuits to supply adequate voltage to all safety-related components is an unresolved item (50-219/92-80-02).

The second area of weakness identified by the team involved omissions in voltage analyses such that adequate voltage for several safety-related ac components had not been demonstrated. For example, one safety class 460V MCC (1B24) had been omitted from the calculation for degraded grid conditions, thus precluding assurance that adequate voltage would be available to the class 1E loads served by this MCC. Also, several cases were identified, based on a sample of safety components, where the voltage analyses were not completed to the terminals of safety equipment. As an example, control room panel 11R, which is fed from 120V ac panel VACP-1 serves safety class loads SOV 1059, SOV 1060, and MOD DM 826-042 and -043. In the calculation, the voltage analysis criteria defined the minimum required voltage as 106.5 at distribution panel VACP-1; however, there was no assurance, based on the analysis reviewed, to demonstrate that the identified minimum required voltages at the equipment terminals (103.5V) would be available. The adequacy of voltage to safety-related ac components is an unresolved item (50-219/92-80-03).

The team also determined that the starting of a Reactor Feed Pump (RFP) motor on the station auxiliary unit transformer had not been fully analyzed. The concern was that a protracted motor start, as a result of low unit system voltage, could induce a spurious Loss of Offsite Power (LOOP) event initiated by the degraded grid protective relays which are set at approximately 3670V with a ten second time delay. The licensee's analysis of the RFP motor starting was performed for the case of the start-up transformer which concluded that motor starting times on the order of 12.5 seconds were possible under certain station conditions. The team noted that starting a RFP on the auxiliary transformer was a credible station event, that the auxiliary transformer had an impedance approximately 50 percent greater than the start-up transformer, and that the resulting voltage swing was not regulated. Based on these factors, the team concluded that the starting of the RFP on a unit auxiliary transformer had not been fully analyzed. This item is unresolved (50-219/92-80-04).

During the team's review of one licensee analysis (GPU Calculation no. C1302-730-5350-003, Rev. 0, "Voltage Drop Calculation for Generic Letter 89-10, Sup. 3 MOV's at Oyster Creek," dated 2/11/92), two cases were identified in which valve bus voltages had been incorrectly selected from a previously prepared Oyster Creek analysis of distribution voltages. In the interim between the preparation of the original voltage analysis and the more recent calculation (identified above), two MOVs had been reassigned (as a result of Appendix R analysis) to new MCC busses. The failure to identify the correct bus voltage in these two cases was of minor safety significance because the voltages used in the calculation (from the wrong bus) were more limiting than the correct voltages. The licensee committed to correct the calculation and to review all other loads reassigned in the same modification. Due to its minor safety significance and the licensee's corrective action, this item meets the criteria of the NRC Enforcement Policy (10 CFR 2, Appendix C, VII B(1)) and is not being cited.

The team also reviewed the station distribution system voltage for "light" or refueling load conditions and the possibility of overvoltages at safety-related busses and equipment. The team noted that the voltage from the start-up transformers was regulated at approximately 4300V maximum and that there was a high voltage alarm in the OCNGS main control room. The team concluded the design for overvoltage at Oyster Creek was acceptable.

2.5 Emergency Diesel Generator

The team reviewed the EDG design loading calculations and concluded the capability and ratings of the EDGs to be adequate. The team noted that the EDG cold starting load limitation was not clearly defined in the licensee's analyses and, in one case (Calculation 5350-008), specifically omitted. Even though the loading requirements identified were well within the EDG rating, this limitation is necessary to properly evaluate future load additions. The EDG must operate for three minutes at the cold engine rating before the hot engine rating is available, so as to insure that the turbocharger is off the engine gear train and is being driven by the exhaust gas. The team concluded this item to be a weakness in documentation and not a safety concern.

It was noted that no phase-to-phase fault protection for the diesel generator output breakers was provided. Therefore, during testing, there is a possibility that the generator could be damaged as a result of a bus fault. The team identified that the cable connecting the EDG switchgear to the 4160 volt bus 1D (1C is similar) did not have circuit breaker protection. Therefore, a failure in this cable would preclude the supply from both the start-up transformers and from the dedicated EDG. The team reviewed the cable testing program and noted that the test frequency of this cable was every third refueling outage. Surveillance and testing procedures for the emergency diesel generators and the results of the two most recent surveillance tests and setpoint calibrations were also reviewed by the team. The team found the diesel generator surveillance tests and the verification of set points to be adequate.

Protective relaying for the EDGs was reviewed by the team and in general determined to be adequate. The diesel generator units are high resistance grounded through a 10kVA, 4160-240V grounding transformer and a 6 ohm resistor. The protective relaying includes an (81) frequency relay (set at approximately 56 hertz) as a means of protecting the diesel from overloads. Other EDG protection includes a loss of excitation relay (40), a loss of field relay (64), a ground fault protection relay (59), a reverse power protection relay (67) and a voltage and phase sequence monitoring relay (47). For a LOOP or a LOCA, all diesel generator protection is bypassed except for differential, overspeed and undervoltage. The latter is configured in a two out of three logic consistent with Regulatory Guide 1.9 criteria. The team determined the EDG protection features to be adequate.

2.6 EDG Load Sequencing

The team inspector reviewed the load sequencing as part of the review of the diesel generator loading studies and unit substation loading studies (see section 2.4). The team also reviewed the applicable elementary diagrams and the control logics. The accuracy of the sequence timing relays was reviewed. The team identified no design deficiencies; the time intervals between loads were found to be of sufficient size as to preclude any overlapping problem. The team also reviewed the applicable surveillance test procedure and confirmed that it adequately verified the proper sequencing of emergency loads onto the EDG for the design basis accident scenarios.

2.7 AC System Short Circuit Study

The team reviewed the licensee's design calculations (1986) which address short circuit currents at the 4160V and 460V distribution equipment. The team reviewed the short circuit analysis for the class 1E 460V distribution equipment and confirmed the design and ratings of equipment to be adequate. The licensee's technical report had determined that there was little or no margin at the 4 kV bus level with respect to the maximum short circuit current. The team noted that a subsequent plant modification, which added voltage regulators to the 34.5 kV switchyard to assure a minimum voltage at the 4 kV busses of 4200-4300 volts from the start-up transformers, represented a potential increase in fault current at the 4 kV switchgear. The licensee committed to reanalyze the calculation of maximum short circuit at the 4 kV switchgear. Based on the licensee's commitment and conservatisms identified in the original calculations (e.g., cable impedances were neglected), the team had no further questions.

2.8 AC System Protection and Coordination

The team reviewed coordination and protection studies performed by the licensee for the 4160 kV and 460V class 1E systems. The team determined the set point calculations at OCNGS to be, in general, adequate. The team also reviewed recent examples of inspection and service performance reports for EDS components. These examples included the inspection, cleaning, and testing of safety-related 4 kV breakers, 460V breakers and 460V motor controllers. The team concluded the inspection, testing and servicing of circuit breakers, including over current protective settings, to be adequate.

2.9 Electrical Penetration Protection

The team reviewed the design and analysis of electrical containment penetrations at OCNGS. Documents reviewed included licensee design calculations, Oyster Creek Systematic Evaluation Program, Topic VIII-4, and the NRC "Safety Evaluation Report Related to the Full Term Operating License for OCNGS" (NUREG-1382). The team determined that the electrical penetration design at OCNGS was adequate and that medium voltage penetrations were protected, by primary circuit protective devices, for faults inside containment.

2.10 120 Vac Vital System

The 120 Vac system supplies power to instrumentation panels and reactor protection system panels. The reactor protection system panels are powered by two redundant and independent 120 Vac, 60 Hz, single phase power systems. Each system consists of a two unit motor generator (MG) sets which receives its power from vital MCCs 1A2 and 1B2. They are protected by two electrical protection assemblies (EPAs). Power to instrument panel IP4 and vital ac power panel VACP-1 is supplied from two redundant sources through an auto transfer switch. Also, a continuous instrument panel CIP-3 is powered by a battery-backed, rotary inverter (uninterruptible power) and redundant vital ac through an auto transfer switch.

2.10.1 Inverter Rating

The team reviewed the worst case loading for the continuous power motor generator set inverter unit. This unit has a synchronous generator with a rating of 18.75 KVA, an ac induction motor with a rating of 25 HP and a dc motor with a rating of 25 HP. The maximum loading on the inverter was found to be less than the rating of the inverter. No unacceptable conditions were noted during this review

2.10.2 Voltage Drop Study

The team reviewed the licensee's voltage drop analysis (calculation No. 3431-40-2B, dated July 7, 1980) to determine the voltages at the safety-related power distribution panels with the grid voltage at its second level under voltage trip point and the plant at full load. The results of this analysis indicated that voltage levels at the 120V distribution panels were above the minimum acceptable voltage except for panel No. 3, where the voltage was less than (1.73%), the minimum required voltage of 103.5. The licensee had corrected this by changing the tap set point on the transformer IT3 to get an acceptable voltage of 104.4V. The team noted that the licensee did not have any calculations to show the minimum voltage available at the component level. Refer to section 2.4 for further discussions.

2.10.3 Protection and Protection Coordination

The team reviewed the licensee's design calculations to determine the maximum level of interrupting duty fault current and the protective devices utilized to interrupt these fault currents. The review indicated that breakers immediately upstream of their respective assumed fault (seven fault levels at various distribution levels fed from MCC 1A2 and 1B2 were reviewed) have a higher interrupting rating than the available maximum short circuit fault current. The review also indicated that MCC-1A2 and -1B2 breakers were not coordinated with downstream breakers for all fault cases. The licensee showed evidence of breaker trip unit modifications (changed long time delay instantaneous to long time delay - short time delay) that addressed proper coordination. The team found this acceptable. The team noted that the coordination of breakers downstream of auto bus transfer switch and the impact of loss of connected loads had been reviewed and accepted by the NRC during the Systematic Evaluation Program (NUREG-0822) and the IE Bulletin 79-29 review.

The team noted that instruments powered from instrument panel IP4 and continuous instrument panel CIP-3 had no redundant instrumentation. The potential concern involved the impact of the loss of the instruments during a LOOP/LOCA scenario until power was restored by the diesel generator. The licensee stated that alternate instruments were available at the control room panels which were powered by the RPS bus and also backed up by a class 1E dc source. Based upon the review of the alternate instruments and the NRC acceptance of the existing design during the Systematic Evaluation Program (NUREG 0822), the team had no further questions.

A review of the reactor protection system 25 KVA supply transformer "PS-1" tap setting showed that the tap settings were adequate to assure the voltage at the terminals of the field devices were within ± 10% of nominal voltage. Also, the present electrical protection system undervoltage and overvoltage setpoints were determined to be adequate to protect the RPS equipment for undervoltage and overvoltage conditions.

2.11 125 Vdc Class 1E System

The 125 Vdc class 1E system consists of two separate and redundant safety-related battery busses. Each battery bus (B and C) is served by its own 125 Volt, 60 cell, lead antimony (for battery B) and lead calcium (for battery C) battery banks and battery charging equipment. Battery B has an MG set as the dedicated charger and a static charger as a standby unit. Battery C has two static chargers. During normal operations, the battery chargers maintain each station battery in a fully charged state by the float charge. Load centers B and C supply the Division B and Division A safety-related loads, respectively. Battery system A and its chargers supply the non-safety-related loads. There is no automatic transfer or manual transfer between two divisions of dc power. A separate battery and battery charging system is utilized for each diesel generator.

2.11.1 Battery Charger and Battery Capacity

The team reviewed the licensee's battery sizing calculation for battery B and diesel generator battery EDG-2. Battery B is sized for a worst case loading which is loss of all ac circuits, subsequent to a LOCA. The design duty cycle for battery B was found to be 3 hours. Based on the licensee's battery B sizing calculation, the battery has a design margin of 35.8% for a design temperature of 77°F. For the EDG-2 battery, the design margin had been analyzed to be 28.2%. The team concluded that the battery systems had adequate design margin to account for any temperature changes and load changes. The team verified that the sizing calculation was consistent with IEEE Standard 485, "Recommended Practice for Sizing Large Storage Batteries for Generating Stations and Sub Stations." The battery B and EDG-2 battery banks were installed in 1986 and 1990, respectively, and have a life of 20 years and 8 years, respectively. The team concluded that batteries had ample capacity and were sized adequately. The team identified one potential concern with respect to the EDG batteries; this item is discussed in section 3.1.

The battery charger B and DG battery charger B design ratings were also reviewed. The team noted that the licensee had not developed any sizing calculations for the battery chargers. However, the loading on the battery B MG set and static charger were found to be well below the design ratings. The EDG battery charger is rated to provide the charging current for the battery from a full discharge. However, the EDG battery charger is not designed to handle the in-rush current from a diesel start (diesel is started by two starter motors). The battery charger is bypassed by a starting relay during a diesel start. The team did not identify any unacceptable conditions.

2.11.2 Voltage Regulation

The team noted that the licensee did not have any voltage drop calculation for the 125 Vdc system. The team requested the licensee to evaluate voltages available at certain safety-related components such as the 4 kV breaker closing and tripping coils, ADS valves, and solenoids. The licensee was not able to provide this information during the inspection. The adequacy of voltage to safety-related dc components is an unresolved item (50-219/92-80-05).

2.11.3 Short Circuit Current Duty

The team reviewed the licensee's short circuit design calculations to determine the short circuit fault current level and the plant breaker interrupting rating. The review indicated that except for 125 Vdc panel D, the available short circuit current was less than the dc interrupting rating of the breakers and was found to be acceptable. The team determined that the potentially deficient breakers had been replaced subsequent to the 1986 calculation with breakers with higher, acceptable interrupting rating.

The team observed that the battery charger short circuit contribution from the MG set was taken conservatively as 75% of the charger rating. However, for the static charger, the short circuit contribution was taken as 125% of rated full load current, which was not necessarily conservative. Considering that the battery charger control elements are silicone controlled rectifiers (SCRs), such current limiting control would not be effective until the first zero crossing of the ac supply current waveform was reached. This may take more than half a cycle (8 ms) depending on the ac supply circuit time constant (X/R) ratio. This is of concern because small frame welded case feeder circuit breakers will attempt to interrupt bolted fault currents in less then 9 milliseconds. Thus, the initial battery charger short circuit contribution (potentially above 500% of full load current), combined with the battery contribution, could exceed the molded case circuit breaker interrupting duty ratings. Due to the uncertainty in the short circuit contribution of the static charger, the adequacy of the safety-related dc molded case breakers to protect their associated circuits from a short circuit is an unresolved item (50-219/92-80-06).

2.11.4 Protection Coordination

Protective coordination was reviewed to assure that faulted/overloaded electrical equipment were isolated with minimal system supply interruptions. The team reviewed the licensee's design calculations that addressed A/B battery charger input/output breakers incorrect trip settings. The present settings had been raised to accommodate inrush currents and were found to be acceptable. The team also reviewed the calculations that addressed miscoordination of main breakers B with downstream breakers. The analysis had recommended that the magnetic trip setting of the main breaker be increased for better coordination. The licensee had written a work order to implement the new settings. Furthermore, the team noted that the licensee has also identified miscoordination of breakers at dc panels DC-1 and 2, DC-F and panel D with supply breakers. The licensee stated that the corrective actions were not yet completed and were still being reviewed by engineering. Since the lack of coordination resulting from a fault would not impact the redundant 125 Vdc system, the team concluded that this condition did not represent a safety concern.

2.12 Conclusion

Based on the sample review of OCNGS EDS design attributes, the team concluded that, with the exception of the specific findings noted above, the EDS design was generally adequate and no safety concerns existed. The team considered the measures taken to assure reliable offsite power, such as periodic grid stability studies, to be a strength. The omission of the switchyard control power battery from any testing program, however, could prevent detection of unexpected reductions in the time available to make control power system repairs.

Station electrical bus lineups and procedures were determined to be in conformance with the FSAR, and electrical bus fast transfer time was acceptable and adequately supported. Knowledge of the OCNGS design basis was found to be weak in the case of voltage at the terminals of safety-related components. This absence of analysis and documentation affected both ac and dc devices.

The design loading calculations for each EDG showed the loading requirements to be within the EDG rating. The EDG protection features were acceptable and the sequence loads were sufficiently separated to preclude inadvertent overlapping.

The ac short circuit analyses showed the design and ratings of equipment to be adequate. but there was little or no margin at the 4 kV bus level. Also determined to be adequate were ac and dc protection and coordination, electrical penetration protection, and battery capacities.

3.0 MECHANICAL SYSTEMS

In order to verify the loading on the EDGs, the team reviewed the power demands of major loads (selected pumps) and the translation of mechanical into electrical loads used as input into the design basis calculations. To determine the ability of the mechanical systems to support the operation of the EDGs during postulated design basis accidents, the team reviewed sample documentation and conducted walkdowns of the fuel storage and transfer system, diesel starting system, lube oil and jacket water systems, and the service water system. The team also reviewed the heating, ventilation and air conditioning (HVAC) systems that ensure an adequate operating environment for the safety related equipment in the diesel generator building, the switchgear room, the cable spreading room, and the battery rooms.

3.1 Power Demands for Major Loads

The team reviewed the accuracy of the power demands for the major loads on the EDGs. The loads on the vital bus had been revised by the licensee from the original automatic loading schedule. Consequently, only one core spray booster pump starts automatically. The team noted that the FSAR had not yet been revised to reflect this modification.

The team identified that the original emergency service water pump horsepower requirements were in excess of the pump nameplate rating. The team noted, however, that the licensee had reduced the pump lift through adjusting the impeller clearance for all pumps. Field testing had demonstrated that the 300 HP motor rating was not exceeded. The hydraulic power requirements of the safety pumps were verified and matched with the corresponding pump motor nameplate ratings. The team concluded that the major loads had been adequately assessed and did not exceed the EDG continuous rating.

3.2 Diesel Generator and Auxiliary Systems

The team found the material condition of the EDGs and their associated auxiliary systems to be excellent. The EDG building was clean and well maintained. The team verified the common bulk fuel storage supply, the fuel oil system, engine cooling system, lube oil system, air intake and protective devices to be consistent with the applicable design documents. Adequacy of the fu[illegible] storage capacity was verified based on the fuel consumption required to carry the major loads during a LOCA and LOOP.

3.3 Heating, Ventilation, and Air Conditioning

The HVAC systems were found to be in good condition and consistent with the original design criteria laid out for the operational requirements of the safety related switchgear, cable spread and battery rooms. The team identified an area of weakness concerning the control of temperature in 4160 V switchgear rooms 1C and 1D and in the 460V switchgear rooms.

The team noted that the 4 kV switchgear room ventilation fans were not powered from a safety-related source. Also, there were no high temperature alarms for the 4 kV switchgear rooms, although loss of air flow alarms were provided. Design basis accident analyses assumed initial 4 kV switchgear room temperatures of not more than 104°F. The loss of air flow alarm response procedure instructed the operators to evaluate the need for temporary ventilation, but gave no guidance on what temperatures were acceptable or not acceptable.

The 460V switchgear rooms did have high temperature alarms, but the team identified that the setpoint was 105°F which was above the 104°F design basis value. The alarm response procedure was similar to that provided for loss of air flow to the 4 kV switchgear rooms. The team identified that there was no guidance for maximum allowable room temperature or limits on the duration of temperatures greater than the design basis. The licensee acknowledged the teams concerns and committed to reduce the 460V switchgear rooms high temperature alarm procedure and to improve the guidance to the operators. This item is unresolved (50-219/92-80-07) pending implementation of measures to assure that the safety-related 4 kV and 460V switchgear room temperatures remain within design bases.

3.4 Battery Start Systems

The Emergency Diesel Generators are equipped with dual electric starting motor systems. Each starting motor operates independently, having its own starting solenoid and pinion gear. A starting attempt is interrupted after two seconds if both starter motor pinions are not engaged. A review of the performance history of the starting motors, replaced in 1972 and regularly tested, indicated that they had been very reliable and had performed without failure. Maintenance records and physical inspection showed no indication of abnormal wear on the individual components.

The starting motors are powered by the EDG batteries which are located in a reinforced concrete trench at ground elevation on either side of the engine. Each of the eight batteries (four per side) are enclosed in a compartment. Each compartment has a closure lid and openings on the side but no ventilation. The team raised the concern about the potential for hydrogen concentration build up in the battery compartments. Hydrogen gas is constantly generated during normal (float) operation at a low rate (0.06 cubic feet per hour) and the small, unventilated compartments have no hydrogen measurement capability. Hydrogen is generated at a much greater rate during battery charging, but the team noted that the applicable procedure required the enclosure lids to be open under those circumstances. The acceptability of the EDG battery compartment hydrogen gas concentration during normal operation is an unresolved item (50-219/92-80-08).

3.4 Diesel Motor Starter

The EDGs are started by a dual electric starting motor system. Two dc starter motors are connected in series and are supplied by a 125 Vdc, 450 ampere hour battery. The existing alarm setpoint assures that the motor starter has at least 112 Vdc available to the motor starter. The inrush current from the motor starter is approximately 1200 amperes and the rolling amperes between 400-700. According to the vendor specification, the number of cranking attempts possible by the battery with this starter is 156. The licensee stated that the design function of the diesel motor starter was to provide at least three starts. The team reviewed the component performance history and identified no failures with this starter. The team noted that bench tests such as resistance check, pinion test and solenoid test were performed to verify the performance of the starters in accordance with the vendor maintenance manual.

3.5 Seismic Qualification of Equipment

Safety-related components are located in buildings not designated as seismically qualified, with the exception of the Emergency Diesel Generator Building, which is qualified seismically and against tornado. The licensee had, however, performed seismic qualification of the block walls protecting the safety-related equipment. The team inspected the safety-related switchgear and battery rooms in the Turbine Building including battery room C, which was added as the result of Appendix R modifications. The 460V switchgear rooms in the Reactor Building and the battery rooms A and B in the Office Building were also inspected.

The team identified one deficiency as no evidence was found for the seismic qualification of the wall mounted electric heater in the battery room C. The heater (H-59-005) is installed above the safety-related C battery such that seismic qualification is required both for heater operability and for the operability of the C battery. The team identified no evidence of seismic qualification although the heater is listed in licensee documents as seismically qualified. The design and installation adequacy of the C battery room heater is an unresolved item (50-219/92-80-09).

3.6 Conclusion

The team found that the Emergency Diesel Generators including the support systems were adequately designed, well maintained, and historically reliable.

The team identified concerns in the areas of switchgear room HVAC, EDG battery hydrogen concentrations, and the seismic qualification of equipment.

4.0 ELECTRICAL DISTRIBUTION SYSTEM EQUIPMENT

The scope of this inspection element was to assess the effectiveness of the controls established by the licensee to ensure that the design bases for the electrical distribution system were maintained. This effort was accomplished through a physical inspection of the electrical equipment which verified that the as-built configuration corresponded to that specified in single-line diagrams and modification packages. In addition, the maintenance and test programs developed for electrical components as well as the controls established for plant modifications were reviewed to determine their technical adequacy. Inspection attributes for plant modifications included the design review process and the resulting safety evaluations to meet the requirements of 10 CFR 50.59.

4.1 Equipment Walkdowns

The team inspected various areas of the plant to verify the as-built configuration of installed equipment. Areas inspected included the switchyards, the EDGs, 4160V and 460V switchgears, 120 Vac and 125 Vdc systems, batteries, and the control room. Transformers, motor-generator sets, circuit breakers, pump motors, and protective equipment nameplate data were recorded. This data was collected to verify completeness and accuracy of the system calculations and applicable design drawings. Protective relay settings were also recorded and compared with the current calibration data.

The team found that the inspected equipment was installed in accordance with design drawings. The walkdown inspection suggested that adequate measures were in place to effectively control system configuration. Equipment inspected was well kept, with the surrounding areas generally clear of safety hazards. Several minor deficiencies were identified such as open fittings of cable conduits, exposed conductors of cut and retired cable, and debris in cable trays. The licensee addressed the items identified at the time of the inspection. Marinite board, originally installed to enhance cable separation and protection, was found in a number of cases to be loose, missing or damaged. The boards were not depicted on plant drawings and there was no program to inspect and repair damaged or dislodged sections. The licensee acknowledged the team's concern and committed to repair the identified board deficiencies, inspect OCNGS for similar deficiencies, and conduct periodic reinspections. Based on the licensee commitments, the team had no further questions.

The team questioned the licensee whether the middle portion of the switchyard where 230 kV buses stepdown to the 34.5 kV bus configuration are adequately protected by the lightning arrestors. The licensee review of the design revealed that all the overhead lines (230 and 34.5 kV) have been provided with the overhead shield wires and the S145 (34.5 kV) line and all transformers have lightning arrestors. The team concluded that the switchyards were adequately protected against direct strikes and surges.

4.2 Equipment Maintenance and Testing

The team reviewed various maintenance and testing procedures for the EDGs, 4 kV and 460V switchgear and unit substations, batteries, battery chargers, inverters, and protective relays. Licensee personnel were interviewed to ascertain their understanding of testing programs. The team also reviewed the controls to establish instrument setpoints during the calibration and testing process.

4.2.1 Class 1E Battery Testing

The Oyster Creek Technical Specification (TS) Surveillance 4.7.B requires that station batteries and diesel generator batteries be subjected to weekly, monthly, quarterly, yearly and refueling tests to verify the conditions of the 125 Vdc battery system. The team reviewed a sample of tests for train B. The service test and discharge or load test are performed by the licensee on a refueling/yearly basis. The service test is performed to verify that the battery capacity is adequate to supply loads in accordance with the design duty cycle. The discharge or load test is performed to assess the capacity of the batteries to detect any signs of degradation. A review of the service test for battery B indicated that the test met the design duty cycle loading requirements and end of life voltage requirements. The team identified that the duty cycle for EDG-2 battery had not been established. The TS section 4.7.B was not clear in that the duty cycle rating was not specified. The licensee committed to establish the EDG battery duty cycle and to submit the appropriate TS amendment request. On the basis of the licensee commitment, the team had no further questions.

A review of the load test, dated April 1991, conducted for battery B indicated that battery B had a capacity of 114.37%. A review of the load test for EDG-2 battery, dated May 1991, indicated that the battery had 104% capacity. The weekly and monthly surveillance tests for the plant and diesel batteries were found to be acceptable.

4.2.2 Relay Testing

The team reviewed procedures for testing of relays at OCNGS and some of the recent surveillance tests performed. Systems and equipment addressed included EDG protection, transformer protection, bus protection, undervoltage and overvoltage bus protection, and motor protection. Based on the documents and test records reviewed, the team concluded the relay testing at OCNGS to be adequate.

4.2.3 EDG Surveillance Testing

Surveillance and testing procedures for the emergency diesel generators and the results of the two most recent surveillance tests and set point calibrations were reviewed by the team. In addition, the team witnessed one monthly EDG surveillance test. The EDG surveillance tests and the verification of setpoints were acceptable.

4.2.4 Circuit Breakers

The team reviewed the maintenance and testing for both ac and dc safety-related circuit breakers. Circuit breaker maintenance and test procedures were reviewed for technical adequacy and compared with the vendor's operating and instruction manuals to ensure that proper maintenance and testing was being performed. In addition, licensee personnel involved in circuit breaker maintenance and testing were interviewed to assess their understanding of the testing and maintenance programs.

The team noted that the licensee had established generic procedures for the maintenance and testing of circuit breakers which provided instructions for both corrective and preventive maintenance such as inspecting, testing, adjusting, cleaning, and replacing parts subject to wear. From these generic procedures hundreds of Preventive Maintenance (PM) tasks were written for specific types of breakers.

The team reviewed a sample of completed Job Work Orders which contained the PMs for safety-related MCCs. During the PM, such tests as the individual pole overload tripping test and the instantaneous mag[illegible] tripping test are performed using the guidance in the generic procedure. However, the team identified that neither the generic procedure nor the PMs provided good acceptance criteria for testing breaker instantaneous trip elements. As a result, unacceptable instantaneous trip element data which were indicative of potential failures or degradation could potentially go undetected. The team considered this to be a weakness. In response to the teams concern, the licensee initiated actions to incorporate acceptance criteria in new and existing PMs for MCCs. The licensee stated that this revision would be made effective in approximately 400 PM task procedures.

The licensee trended the components in the maintenance program using the data maintained on history cards and the GMS-2 computer database. Since the installation of the GMS-2 system, history cards have not been maintained. GMS-2 was used as the primary source for retrieval of information, however, the system did not provide the capability to recall specific as-found data from more than one task at a time to monitor and trend such items as instrument setpoint drift.

The team identified that the two safety-related dc main breakers were not included in a routine testing and maintenance program. Results of a coordination study performed by the licensee indicated a need for adjustments to be made to the instantaneous trip and long time delay settings of these breakers. On October 11, 1986 a Work Request was written and maintenance as well as post-maintenance testing were performed in accordance with vendor recommendations on these breakers. However, the licensee failed to recognize the need for periodic testing of these breakers. As such, these breakers were not included in a testing program. Failure to establish adequate testing programs and procedures to assure that safety-related components will perform satisfactorily inservice is a violation of 10 CFR 50, Appendix B, Criterion XI (Violation 50-219/92-80-01).

The maintenance program for circuit breakers was found to be implemented adequately with the above exceptions. The circuit breakers were maintained reliably and periodic testing had been performed on the safety related 4160 Vac, 480 Vac, and molded case circuit breakers as well as the 125 Vdc breakers in accordance with vendor instructions. The team had no further questions in this area.

4.2.5 Offsite Power Sources, and Auxiliary Transformers

The team reviewed the switchyard major components preventive maintenance programs as their components are relied upon for the availability of the preferred power source for the OCNGS during startup, shutdown, and abnormal conditions. The preventive maintenance for the 230 and 34.5 kV switchyard including the auxiliary and startup transformers is done by JCP&L. The plant operation and maintenance staff are responsible to coordinate and facilitate this activity as outlined by applicable procedures and contractual agreement between them.

Diagnostic tests on the main generator output breakers, the main step-up transformers, the auxiliary transformer, and the startup transformers are generally performed every refueling outage. Preventive maintenance on other major components in the switchyard is usually performed every four years. The transformer diagnostic test includes complete insulation tests of windings and bushings, and an excitation current check. The oil sample test on these transformers is performed on a monthly basis. In addition, any abnormal conditions in the switchyard and near the transformers associated with offsite power are inspected by the licensee staff on a daily basis.

Based on the review of the switchyard maintenance program and a review of a sample of diagnostic checks and oil sample results, the team determined the preventive maintenance of major switchyard components to be acceptable.

4.2.6 Measuring and Test Equipment

The team reviewed the licensee's program for the control of measuring and test equipment (M&TE). The team reviewed the applicable procedures, walked down the calibration laboratory and storage area, tracked M&TE signed out for use in the field, and held discussions with the cognizant program personnel.

The team determined that the program documents were consistent and delineated a good program to assure that M&TE were adequately calibrated and controlled. The majority of M&TE used by the licensee was calibrated onsite by one of three technicians assigned to the calibration lab. Remaining M&TE were periodically sent to qualified vendors for calibration. The team reviewed a sample of "Controlled Test Equipment Discrepancy Investigation Records" used by the licensee for documenting the investigation and corrective action taken when "As Found" calibration results exceeded specified tolerances. These records documented the performance of evaluations to determine the impact of such M&TE on plant equipment. Also reviewed was the recall process for assuring the timely recalibration of equipment. The team noted that the licensee maintained a computer program, reviewed monthly, to determine which instruments or devices required calibration.

The team concluded that the licensee had a well developed and adequately implemented program for the control and calibration of M&TE. Applicable regulatory requirements, licensee commitments, and industry guides and standards were verified to be included in the program. Overall, the effectiveness of the licensee's M&TE program, as evident through quality procedures, accurate calibrations, and knowledgeable technicians, was considered a strength.

4.2.7 Other Electrical Equipment

The team noted that the licensee performed tests for 480 V MCC circuits (overload relay, breakers, contactors, etc.), visual inspection of battery charger M/G sets for degradation (including condition of brushes and lubrication), and meggering checks for M/G sets. Also, the licensee performed yearly tests on static charger input/output breaker time/current test. No other tests were performed on the battery chargers and rotary inverter M/G sets.

The team reviewed the RPS M/G set output breaker trip test. The test results were found to be acceptable, except the team noted that the EPAs 4 and 5 overvoltage as-found settings had been above the desired values. The licensee had adjusted the setpoint to the desired values. Subsequent tests confirmed that the as-left values were acceptable. The team reviewed the preventive maintenance tests performed in auto bus transfer switches. A megger test and operational checks were performed on a refueling interval. No unacceptable conditions were identified.

The team noted that the battery chargers (static and MG sets) and rotary inverters were not tested to verify functional capability. Failure to establish adequate testing programs and procedures to assure that safety-related components will perform satisfactorily in service is a violation of 10 CFR 50, Appendix B, Criterion XI (Violation 50-219/92-80-01).

4.3 Fuse Control

The team reviewed the licensee's fuse control program to verify that fuses provided adequate overcurrent protection for electrical systems and components and carry normal load currents without interruption. Fuse characteristics differ among manufacturers and classes. Therefore, proper evaluation, installation, and replacements are necessary to ensure appropriate circuit protection and coordination. A review of the licensee's methodology for controlling fuses was conducted and a plant walkdown was performed to verify that the installed fuses were in conformance with the as-built drawings.

The team identified that the licensee had no formal fuse control program nor a controlled fuse replacement list in place. Guidance for the replacement of fuses was contained in Operations Procedure 106, "Conduct of Operations." This procedure required that fuses be replaced with those of identical type, manufacturer, and rating (i.e., like for like) as specified in referenced drawings. Discussions with the licensee's operations, maintenance, and engineering staff personnel indicated a strong cognizance of the above requirement. The inspector reviewed the referenced drawings on a sampling basis and noted that fuse sizes were not specified. The licensee stated that these drawings had been superseded and a procedure change was initiated to reference the updated drawings. However, the team identified that these updated drawings also did not contain fuse sizes at the time of this inspection. Further discussions with licensee personnel indicated that if information could not be obtained from the removed fuse, the normal practice was to contact engineering to obtain the size and type of fuse for the installation. If a correct replacement fuse was not available, valid substitutions were specified by Procurement Engineering after a detailed evaluation. The team noted that all replacement fuses for safety-related equipment were processed through Procurement Engineering. Fuses were procured commercial grade and dedicated thereafter utilizing guidance provided in the EPRI Commercial Grade Item Joint Utility Task Group (CGI JUTG) report. This report provides guidance for evaluating performance standards and testing of fuses.

Originally installed fuses were verified for size and coordination in accordance with a document by the architect engineer. This verification was based on a sampling of circuits from panelboards, medium voltage switchgear power feeders, unit substation power feeders, MCC power feeders and control circuits, 125 Vdc trip circuits, and instrument power supplies. To address potential inadequacies of fuses and common deficiencies identified in NRC Information Notice 91-51, "Inadequate Fuse Control Programs," the licensee initiated a review the feasibility of implementing a fuse control program. At the time of the inspection the feasibility review had not been completed and the development of the fuse control program had not been initiated.

The team noted that the procedure for fuse control did not adequately specify required actions to maintain configuration control when replacing fuses with unreadable information or when an identical fuse was not available. Although it was determined that an informal methodology existed to issue a deficiency report and receive an engineering evaluation prior to installing a new fuse, not specifying these actions was considered by the team as a weakness.

Overall, the team determined the licensee's actions for fuse replacement to be adequate. Discussions with personnel demonstrated a good understanding of the requirements.

4.4 Relay Setpoint Control and Calibration

The team reviewed the licensee's program for controlling and calibrating protective relay setpoints. Relay calibration procedures and completed test records were reviewed to determine that relays were maintained and tested properly to assure equipment operation at design basis conditions.

Original relay setpoints for Oyster Creek were developed by JCP&L. The licensee maintained the current configuration of relay setpoints through the use of Relay Setting Sheets (RSN), which were the historical and unchanging record of relay setpoints. These RSNs were used in accordance with undervoltage and degraded voltage procedures to ensure proper protection and coordination of relays and circuit breakers for pump motors, high voltage transformers and busses, and generators. JCP&L was responsible for calibration of all relays in accordance with licensee procedures.

A sampling review of relay calculations and RSNs was performed. It was determined that the RSNs accurately reflected the setpoints specified in the calculations. In addition, several 4160 Vac protective relay settings were confirmed, by a field walkdown, to accurately reflect the information provided on the RSNs.

The team determined the licensee had an effective program in place for the control and calibration of relays. Procedures were determined to provide good instructions and details consistent with the technical specification requirements for undervoltage and degraded voltage relays.

4.5 Electrical Separation

The separation criteria for EDS cable were described in the FSAR and were later reviewed as part of the Systematic Evaluation Program (NUREG-0822). Significant cable routing modifications were performed as part of the actions taken at OCNGS to achieve compliance with 10 CFR 50, Appendix R. The team reviewed the original design criteria, the Appendix R modifications, and the current modification guidance with respect to electrical cable separation. A sample of modifications and cable raceways was physically inspected and conformance with the applicable requirements and licensee commitments was acceptable.

4.6 Conclusion

Based on plant walkdowns, the team concluded that the licensee had implemented adequate measures to effectively control system configuration and maintain equipment material condition. Maintenance and testing of EDS components was generally adequate, but the team identified several examples of safety-related components which were not adequately tested. These deficiencies are cited in Appendix A, Notice of Violation.

The control and calibration of M&TE was found to be strong. Some weaknesses in guidance were identified concerning fuse replacement, but the overall control of fuses was adequate. The licensee's program for the control and calibration of relays was effective. Conformance with applicable electrical separation requirements was acceptable.

5.0 ENGINEERING AND TECHNICAL SUPPORT

An evaluation was performed of the licensee's capabilities to provide acceptable engineering and technical support to the plant operations organization. For this purpose, the team reviewed organization and staffing, interfaces between the engineering organizations and the technical support groups responsible for the plant operations, and self assessment programs.

To address the licensee's performance in the engineering and technical support area, the review evaluated the implementation of programs and procedures and examined a sample of Quality Deficiency Reports (QDRs), Material Non-Conformance Reports (MNCRs), Deviation Reports (DRs), Licensee Event Reports (LERs), root cause investigation and corrective action programs, major, minor and temporary modification programs, and Quality Assurance (QA) audits.

5.1 Organization and Key Staff

The engineering and technical support for the Oyster Creek Nuclear Generating Station are provided primarily by the onsite Plant Engineering organization and by the Technical Functions Division of the corporate staff at Parsippany, New Jersey.

Plant Engineering, which is composed of approximately 50 engineers and engineering personnel, is divided into several groups representing disciplines such as electrical, mechanical, and instrumentation and controls. They report to the Plant Engineering Director and are responsible for the day to day activities at the plant. Also reporting to the Plant Engineering Director is the Plant Material Section which is responsible for the purchasing of all equipment and parts required for the operation of the plant. Engineering personnel is also available in all operations organizations and together with Plant Engineering provide the technical support and expertise necessary to support the smooth operation of Oyster Creek.

The Technical Functions organization is responsible for engineering and design of major modifications, the overall configuration control program, and the engineering and design standards. It is composed of the System Engineering, Engineering and Design, Projects, and Engineering Services Departments which report to the Vice President and Director of Technical Functions. The organization also includes a Site Director who facilitates the interfaces between Technical Functions and the site Plant Engineering through the Vice President and Director of Oyster Creek. Major undertakings and specialized expertise are provided through this organization.

System engineering functions at the site are provided by the plant engineering personnel. However, system knowledge is limited. Currently, the licensee is planning on establishing a system engineering group at the site to be composed of both corporate and plant engineers.

The team's evaluation of the staff's performance concluded that it was generally good with engineering and technical personnel knowledgeable of the respective disciplines. New calculations performed to address design changes or as a result of the current design basis reconstitution program were found to be generally good, conservative, and in conformance with the current standards. However, the team also observed some inconsistencies in the accuracy of earlier calculations. In addition, the team observed several examples where calculations that had been superseded in part or entirely were maintained in the current design basis without an annotation of their current status, thereby creating the potential for future design errors. As an example, the voltage drop calculation No. 13432.21, Revision 0, was provided for review, but only after discussion with the licensee regarding methodology used was it determined that the calculation had been superseded by more recent studies.

The licensee's decision to establish a site system engineering group was viewed by the team as a good initiative to improve technical support at the site.

5.2 Root Cause Analysis and Corrective Action Programs

To assess the effectiveness of the licensee's root cause analysis and corrective action programs, the team reviewed several licensee event reports (LER), quality deficiency reports, material non conformance reports, and deviation reports together with their resolution. In addition, the team reviewed the trending program conducted at the site.

At Oyster Creek, the administrative methods for identifying, documenting, reporting, reviewing, and correcting conditions adverse to quality are provided by Procedure No. 104, Control of Nonconformances and Corrective Actions. The procedure also establishes the method for implementing the GPUN administrative procedure 1000-ADM-7216.01, GPUN Corrective Action Programs and Processes. A review of selected MNCRs, QDRs, DRs and LERs concluded that the licensee s evaluation and, except as described below, disposition of the identified deficiencies were technically correct and demonstrated a good understanding of the applicable procedures.

For the conduct of root cause analyses the licensee, in March 1991, issued a Root Cause Standard which provides the necessary guidance, requirements and responsibilities. Analyses are usually initiated by a Deviation Report and categorized into four levels based upon risk and uncertainty. The standard was found to be comprehensive and to contain adequate charts and guidance for good, detailed evaluations. A sample of recent evaluations found them to be thorough and of generally good quality.

As indicated above, corrective actions were found to be appropriate to the finding. However, one instance was found when the corrective actions were incomplete in that they did not totally address the event. The issue pertains to the failure of an emergency diesel generator to start one hour after it had been shutdown for unrelated causes. As described in LER No. 89-019, dated September 11, 1989, the EDG's "failure to start was attributed to latent heat expansion of the engine... The added engine friction caused the starters to stall in the reduced voltage slow roll mode." In the case of the Oyster Creek EDGs, voltage plays an important role, since two electric starters operating in tandem are used to roll and start the engine. The starters are wired in series and use as source of power 125 Vdc dedicated batteries. During surveillance tests, series resistors temporarily reduce the applied voltage to roll the engine and check for hydraulic locks. The resistors are bypassed for fast start in case of an emergency.

The licensee, recognizing that the resistors would not be a factor during emergency starts, to increase the voltage to the starters circuit during surveillance tests reduced the series resistance. Appropriate post modification tests demonstrated the capability of the engine to restart after it had been shutdown and heat expansion had occurred.

The team concurred with the licensee's corrective actions. However, recognizing that reduced voltage to the starters could also be the result of battery degradation during emergency fast starts, asked the licensee whether any tests or analyses were available to demonstrate that an EDG would restart if the minimum voltage allowed by the Technical Specification (105 Vdc) was applied to the series starters with the engine already hot from a previous start. The licensee was not able to obtain test data from the engine manufacturer by the end of the inspection period and no analysis or tests were available at the site. Although the licensee indicated that the starters are tested regularly at the minimum voltage specified by the manufacturer (approximately 30 Vdc), the team did not consider these tests applicable to the concern since the starters were not loaded. Therefore, the ability of the EDGs to start at the minimum allowable battery voltage with the engine in a hot condition is unresolved (50-219/92-80-10).

The issue was not considered to present an immediate safety concern in that the EDG batteries were relatively new and, therefore, capable of providing full voltage. However, the licensee was requested to expedite the evaluation of the issue, since battery voltage cannot be accurately measured without isolation from the charger.

Tracking and trending of component failures is provided by the plant maintenance organization. Trending is limited to critical components and primarily to corrective maintenance. For this adequate instructions are provided to code failures and enter them in the appropriate data base. Although discussions with the licensee indicated that preventive maintenance was also addressed by the program, no instructions were available for dealing with the results of this maintenance. Thus, the inadequate performance of a transmitter or of a particular type of instrument (e.g., transmitter repeatedly found out of calibration) would not necessarily be recognized as a failure and trended for potential corrective action. The team concluded the licensee's current program to be adequate, but that trending of preventive maintenance problems represented an area for improvement.

5.3 EDS Operating Procedures

Procedures No. 2000-OPS-3024.10a, "Electrical Distribution - 4160 Vac - Diagnostic and Restoration Actions," and No. 2000-ABN-3200.36, "Loss of Off-Site Power," were reviewed to confirm that the operating instructions and administrative controls were adequate to ensure operability of the electrical distribution system under all plant operating conditions. The review included a walkdown of the control room and of applicable plant areas to ensure that the procedures were accurately written and to verify that the instructions could be accomplished using the installed equipment, instrumentation and controls. Operators were interviewed to ensure that they were familiar with the procedures and the plant equipment.

Based upon the sample review performed, the team concluded that the procedures contained a sufficient level of details to ensure that the objectives of the procedures could be satisfactorily accomplished. The operators interviewed were found to be familiar with the procedures and with the equipment, instruments and controls involved. Identification of control and distribution equipment was considered to be acceptable as was the readability of the instruments provided.

5.4 Self Assessment Program

The team reviewed the licensee's self assessment programs to ensure that safety issues were promptly identified and resolved in a timely manner. This review found the programs to encompass various engineering activities including safety systems functional inspections (SSFI), QA audits and surveillances, and various performance monitoring devices.

A review of the licensee's emergency electrical power distribution SSFI indicated excellent efforts by the inspection team covering electrical and mechanical design, surveillance and testing, operations and maintenance. The report documented numerous observations which were ultimately assembled into 17 recommendations covering all areas of review. At the time of the inspection, the licensee's findings had been either resolved or included in the plant tracking system awaiting resolution. However, the team also observed that self imposed schedules were not always kept. A review of the other SSFIs determined that they were of similarly high quality with significant findings. In the case of the core spray system SSFI, it was determined that the inspection recommendations had not been entered in the central tracking system. However, further discussions with the responsible organization concluded that the findings had been evaluated and their resolution was tracked separately by the responsible department.

The team evaluated the involvement of QA personnel in assessing the quality of engineering services and determined that engineering audits were routinely performed of both the site and the corporate support staff and involved a variety of engineering activities. These included design control, training, procedure maintenance, inservice testing, spare parts engineering, surveillance test programs, environmental qualification, control of design changes and modifications, setpoint control, plant performance monitoring, and operating experience assessment. The audit findings were summarized and tracked to completion by the QA organizations at the site and at the corporate offices, as applicable. The QA audits were found to be thorough, well organized and with good insight.

Based on the above, the team considered the licensee's self assessment program to be a strength.

5.5 Design Changes and Modifications

The team reviewed the area of plant design changes and modifications to ensure that changes to the plant were controlled and performed in accordance with approved licensee procedures and in conformance with the regulatory requirements.

The team noted that design changes and plant modifications were categorized into major and mini mods, depending upon cost and engineering impact. Several recent major and mini modifications affecting the electrical distribution system were reviewed for compliance with licensee and regulatory requirements. Adequacy of resolution of the identified problem was also evaluated. The packages were found to be well organized, thorough, and documented according with the applicable procedures. In all cases, the design had been evaluated for safety impact under 10 CFR 50.59. Applicable drawings were also reviewed to verify appropriate documentation of the design change and were found to be acceptable.

The team identified one item of potential concern involving Modification Design Description MDD-OC-212A, a modification of the core spay system. The modification was initiated to resolve two issues: reduction of the total emergency diesel generator loading and shut-down of the plant when the core spray system is inoperable. The scope of the modification entailed: (1) the installation of interlocks between the primary and back-up core spray booster pumps of the same electrical division to prevent the automatic starting of more than one booster pump; and (2) the swapping of core spray booster pump interlocks within the automatic depressurization system (ADS) to alleviate the Technical Specification restrictions with regard to core spray and ADS operability.

In describing the function of the ADS, the MDD stated that four of five ADS valves were required to open to achieve depressurization in the allowable time and that no single failure could cause more than one valve to fail to open upon initiation signal actuation. However, the team identified that the five ADS valves were equipped each with a single actuating solenoid coil and that control power to the solenoids was assured by means of an automatic throw-over scheme between redundant 125 Vdc sources. The power to the five solenoids was supplied by two sets of 20A circuit breakers, one each at dc power panels "D" and "F", respectively. Three solenoids were powered by one set and two by the other. To address single failure, the solenoids were individually protected by a set of two 10A fuses, one from each source.

To determine whether a single electrical fault could affect more than one ADS valve, the team requested for review the design details regarding trip coordination between breakers and fuses and available short circuit at the terminals of the fuses. This information was not available, but licensee preliminary calculations performed subsequent to the information request indicated that there was a small area of potential overlap in the instantaneous region. The team concluded that adequate coordination had not, therefore, been fully demonstrated. The team also concluded that this was not an immediate safety concern due, in part, to conservative assumptions used in the licensee's calculations (e.g., fault type and cable length). The licensee committed to address this coordination issue before the end of the next refueling outage. The team noted that, until the licensee demonstrated adequate margin in this area of electrical coordination, even small changes such as replacement of fuses or breakers with similar, but not identical, performance characteristics could adversely impact ADS vulnerability to a single failure (electrical fault).

The adequacy of coordination between the 125 Vdc breakers and fuses to the ADS valves and the consequential potential vulnerability of the ADS system to a single failure (electrical fault) is unresolved (50-219/92-80-11).

5.6 Temporary Modifications

Procedure Number 108, Equipment Control, establishes the administrative methods and requirements for the installation and control of temporary variations to configuration of power system and components. These include installation of bypasses and jumpers and safety grounds, lifting of leads, control of switching and tagging, and verification of equipment alignment. The procedure was found to be very detailed, with easy to follow instructions, complete with illustrations, forms, check off sheets and charts to aide in the selection of the applicable processes and procedures.

The team noted that the procedure did not specify the duration of a temporary modification. However, the procedure did mandate its removal as soon as practicable consistent with the safe operation of the plant and the requirements of the Technical Specifications. Periodic reviews of summary log are performed by the Group Shift Supervisor who is responsible for the approval and control of all temporary modifications. A review of the latest log revealed that fewer than 40 temporary modifications existed at the time of the inspection. This amount represented the lowest recorded in the previous 12 months, but the trend was downward. Of the existing temporary modifications, the great majority were less than a year old and mostly non-safety related. Only two, which removed from service the exhaust differential pressure alarm and indication from the Turbine Building and one from the Reactor Building, respectively, were dated November 1985. A safety evaluation according to 10 CFR 50.59, which had been performed at the time of the modification, was found to be satisfactorily performed and in conformance with the licensee's applicable procedures.

5.7 Engineering Support/Interface

The team reviewed the communications between the engineering and plant organizations and the effectiveness of the engineering staff to support design functions, maintenance, and the other operations organizations at the site.

Engineering support at the Oyster Creek station is provided by various corporate and plant engineering and technical organizations, each with specific functions and responsibilities. The engineering involvement in all plant activities was found to be extensive and generally with good communications among various functional areas. The team discussed with the licensee the tracking mechanism for controlling and assigning priorities for engineering action items and engineering requests, but found no centralized system. Action items were, at times, tracked by the individual departments which also assigned priorities. No safety-related activity was identified which did not receive the proper attention.

Communications between the site and corporate engineering organizations were considered good. The methods currently used to ensure that activities affecting a plant system were appropriate and resolved in a timely manner couples a corporate and a site engineer for each systems. Corporate system engineers regularly visited the plant site and participated in the implementation of the design activities. This method was consider to be effective in establishing the lines of communication between the design engineers and the implementation team.

Good communications between engineering and plant organizations was evident in the attendance of the morning and afternoon meetings where daily activities and concerns were discussed by representatives of all functional areas. Good communication was also evident in the evaluation of the recent "brush fire" event. The report of the licensee's post trip review was found to be comprehensive and well done.

5.8 Conclusions

Based upon the sample of documents reviewed and of personnel interviewed, the team concluded that the nuclear and plant engineering organizations were staffed with competent personnel. The proposed realignment of the system engineering group at the site was viewed as an improvement in the technical support of the plant organization and a positive step toward improving the effectiveness of the engineering staff. The calculations initiated as a result of the design basis reconstitution program were good and presented in a comprehensive manner. However, the status of old and superseded calculations was not clearly annotated to prevent potential design errors.

One area for improvement was identified involving the extension of the trending program to other maintenance activities, such as preventive maintenance, with a better use of the accumulated data. Modification and design changes were found to be properly handled with good safety impact evaluations. Communications between the various engineering groups and between these and the operation organizations also was considered good as demonstrated by the analysis of the recent brush fire near the plant. The self assessment program was found to be extensive and was enhanced by good root cause analyses.

6.0 EXIT MEETING

The inspectors met with licensee personnel and licensee representatives (denoted in Attachment 1) at the conclusion of the inspection on June 5, 1992. The inspectors summarized the scope of the inspection and the inspection findings.

ATTACHMENT 1

SUMMARY OF INSPECTION FINDINGS

A. Violations

	Description	Section	Number 50-219
1.	Safety-related components not functionally tested	4.2.4 4.2.7	92-80-01
2.	Wrong voltage used in calculations (NCV)	2.4	N/A

B. Unresolved Items

	Description	Section	Number 50-219
1.	Adequacy of MCC control circuit voltage	2.4	92-80-02
2.	Adequacy of voltage to ac components	2.4	92-80-03
3.	RFP start on auxiliary transformer not fully analyzed	2.4	92-80-04
4.	Adequacy of voltage to dc components	2.11.2	92-80-05
5.	Adequacy of dc short circuit protection	2.11.3	92-80-06
6.	Adequacy of HVAC temperature control to 4kV and 460V switchgear rooms	3.3	92-80-07
7.	Adequacy of EDG battery hydrogen level during normal operation	3.4	92-80-08
8.	Seismic qualification of C battery room heater	3.5	92-80-09
9.	Adequacy of TS minimum battery voltage to start hot EDG	5.2	92-80-10
10.	Adequacy of coordination between ADS breakers and fuses	5.5	92-80-11

ATTACHMENT 2

PERSONS CONTACTED

GPU Nuclear Corporation

A. Agrawal, Senior Electrical Engineer
F. Aller, Supervisor, Maintenance Assessment
J. Barton, Director, OCNGS
T. Blount, Licensing Engineer
M. Budaj, Manager, Planning and Support
G. Busch, Manager, Site Licensing
T. Dempsey, Manager, Plant Engineering
J. Gulati, Manager, Oyster Creek Project
D. Jerko, Licensing Engineer
D. Jones, Senior Engineer
M. Kapil, Supervisor, Electrical Engineering
R. Lewis, Manager, Maintenance Engineering
S. McCann, Operations Training
R. McGoey, Director, Electrical Engineering
D. Ranft, Director, Plant Engineering
H. Robinson, Manager, Electrical Power

Jersey Central Power and Light

R. Sherman, Relay Engineer
J. Weighel, Field Supervisor

U.S. Nuclear Regulatory Commission

C. Anderson, Acting Chief, Engineering Branch
A. Dromerick, Project Manager
W. Hodges, Director, Division of Reactor Safety
D. Vito, Senior Resident Inspector

All personnel were present at the exit meeting on June 5, 1992.

ATTACHMENT 3

ABBREVIATIONS

A or Amp	Amperes.
AC or ac	Alternating Current.
ANSI	American National Standards Institute.
ASME	American Society of Mechanical Engineers.
BHP or Bhp	Brake Horsepower.
BIL	Basic Insulation Level.
CRF	Containment Recirculation Fan.
CB	Circuit Breaker.
CFR	Code of Federal Regulations.
CONED	Consolidated Edison
CCR	Central Control Room.
CVT	Constant Voltage Transformer.
DBA	Design Basis Accident.
DC or dc	Direct Current.
DEMA	Diesel Engine Manufacturers Association.
ECCS	Emergency Core Cooling System.
EDG	Emergency Diesel Generator.
EDS	Electrical Distribution System.
FLA	Full Load Amps.
FSAR	Final Safety Analysis Report.
FTOL	Full Term Operating License.
GDC	General Design Criteria.
GE	General Electric.
GM	General Motors.
GPM or gpm	Gallons per Minute.
HV	High Voltage.
HVAC	Heating Ventilation and Air Conditioning.
IEEE	Institute of Electrical and Electronics Engineers.
kV	kilovolts.
kVA	kilovolt-amperes.
kW	kilowatts.
LC	Load Center.
LOCA	Loss of Coolant Accident.
LOOP	Loss of Offsite Power.
LV	Low Voltage.
MCC	Motor Control Center.
MOV	Motor Operated Valve.
MS or ms	Milliseconds.
MVA	Mega Volt-Amperes.
NEC	National Electrical Code.
NEMA	National Electrical Manufacturers Association.

PR	Protective Relay(s).
PSI or psi	Pounds per Square Inch.
RCP	Reactor Coolant Pump.
RG	USNRC Regulatory Guide.
SCR	Silicone Controlled Rectifier.
SEP	Self Evaluation Program.
SF	Service Factor.
SI	Safety Injection.
STD or Std	Standard.
TS	Technical Specification.
UL	Underwriters Laboratories.
UPS	Uninterruptible Power Supply.
USNRC	United States Nuclear Regulatory Commission.
UST	Unit Service Transformer(s).
UV	Undervoltage.
V	volt(s).
Vac	volts alternating current.
Vdc	volts direct current.
W	Westinghouse.