APPENDIX C

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-382/90-23          Operating License: NPF-38

Licensee: Entergy Operations, Inc.
P.O. Box B
Killona, Louisiana 70066

Facility Name: Waterford Steam Electric Station, Unit 3

Inspection At: Taft, Louisiana

Inspection Conducted: December 4, 1990 through February 1, 1991

Inspectors: T. O. McKernon    4/10/91

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Inspection Summary

Inspection Conducted December 4, 1990, through February 1, 1991 (Report 50-382/90-23)

Areas Inspected: A nonroutine, announced, special inspection of the Waterford Steam Electric Station, Unit 3, electrical distribution system and of the engineering and technical support staff's capabilities.

Results: Within the areas inspected, two violations and one deviation were identified. The violations involved a failure to verify or to check the adequacy of design and a failure to establish, follow, and maintain procedures appropriate to the circumstances. The deviation involved the failure to follow the previous commitments to Regulatory Guide 1.97. Other results of the special inspection are discussed in the executive summary to this report.

## EXECUTIVE SUMMARY

A team of Nuclear Regulatory Commission (NRC) staff members and consultants conducted an inspection of the electrical distribution system (EDS) and the engineering and technical support for the EDS at Waterford Steam Electric Station, Unit 3 (W-3). The inspection was conducted from December 4, 1990, through February 1, 1991.

The NRC team utilized the guidance in Temporary Instruction (TI) 2515/107, "Electrical Distribution Functional Inspection," Revision 0, dated October 19, 1990, to evaluate the design and implementation of the plant EDS. This guidance also provided for the assessment of associated engineering activities and the plant technical support.

The inspection team reviewed selected modifications, design calculations, and design basis documents. Further, the inspection team conducted interviews of key plant managers and reviewed training records, corrective action records, procedures, maintenance and surveillance test records. The team also attended routine plant meetings. The review of the EDS focused on the offsite power supply grid and the associated onsite safety-related buses and loads, protective devices, station batteries, chargers and inverters, and the emergency diesel generators including mechanical support systems.

The team considered the licensee's ongoing efforts to develop design basis documents and to conduct engineering self-assessments to be a strength. The engineering organizations appeared to have good verbal interfaces with other plant organizations. The recent establishment of personal performance goals and training plans should improve the engineering staff's capabilities and performance. Additionally, the team observed that material condition of the plant was good and that plant equipment was generally well maintained.

The inspection team considered the design of the EDS at Waterford 3 to be generally acceptable. The design attributes of the EDS were retrievable and verifiable. The licensee had implemented actions to develop design basis documents (DBDs) and had conducted some recent self-assessments safety system functional inspections (SSFIs) of plant systems. Many of the issues discussed during the inspection had also been identified by the licensee during these SSFIs. However, the inspection team also identified a number of concerns pertaining to engineering calculations containing erroneous and/or nonconservative assumptions, and erroneous computations. The team considered that the DBDs and modifications affecting the EDS, occasionally lacked rigorus engineering evaluations.

The team identified some findings regarding inadequate design reviews for certain operating conditions and postulated failures of certain EDS equipment. For example, degraded grid protective relays had not been adequately evaluated to protect and ensure functionality of safety-related loads on the 120 volt ac level. Additionally, safety-related inverter trip setpoints had not been evaluated for their associated voltage drops from the station batteries.

The team also identified concerns related to the station batteries. Although the inspection team did not perform an in-depth investigation of the requirements for station blackout, it did observe that design margins for the station batteries with regard to certain load profiles were small. Further, in order for the batteries to perform their design function adherence to strict criteria for battery room temperatures and battery charging was required. It was also noted that the existing design of the dc electrical distribution system did not allow for potential load growth and would require replacement of the batteries earlier in the life cycle than initially anticipated.

In addition to the above, the inspection team had concerns related to the licensee's root cause and corrective action programs. Instances were identified in which calibration procedures for EDS equipment did not adequately account for setpoint attributes for EDS equipment. In other isolated instances, the licensee's corrective actions appeared specific and did not consider generic plant impacts. Further, weaknesses were identified in the operability and reportability assessment process. These weaknesses resulted in deficient conditions for certain EDS equipment not being evaluated by engineering.

As a result of the above concerns and other issues discussed in the report, the licensee made commitments to take specific actions. These commitments were discussed during the exit meeting conducted on February 1, 1991, and are enumerated below:

1. The degraded voltage protective relays will be reviewed to evaluate and develop necessary actions to adjust equipment settings and/or replace equipment where appropriate. Anticipated long-term corrective actions will be implemented by Refueling Outage No. 5. As an interim action, administrative controls for operator actions have been implemented through Standing Instruction No. 91-02.

2. The battery capacity calculations will be revised. This action has been scheduled for completion by October 1991. Based upon the revised calculations, a commitment to replace the station batteries at an earlier appropriate time in the life cycle will be established and tracked through the licensee's commitment management system.

3. Clarifications to the Technical Specifications and associated bases related to battery electrolyte specific gravity requirements, onsite emergency diesel generator fuel oil storage requirements, air receiver testing, and emergency diesel generator fuel oil transfer surveillance testing will be made where appropriate. The appropriate submittals will be made to the NRC by October 1991.

4. Procedures identified as nonexistent or inappropriate to the circumstances during the inspection shall be established or revised as appropriate. Examples identified during the inspection included procedures for the calibration of degraded voltage protective relays, safety-related inverters and chargers, 4160 volt circuit breakers and the control of chain hoist systems which could potentially affect safety-related equipment. This action has been scheduled for completion by the end of 1991.

5. Corrective actions related to the revision of operations and mechanical maintenance procedures to further clarify battery room surveillances and battery cell testing will be accomplished as appropriate. This includes the implementation of controls for the maintenance of battery room temperatures. These corrective actions will be implemented by July 1991. Long-term actions will include revising the dc calculations based upon postulated lower electrolyte temperatures and, if necessary, a revision to the limiting operability criteria temperatures contained in the Technical Specifications. These long-term actions are scheduled to be implemented by Refueling Outage No. 5.

6. Corrective actions related to fuse control will be implemented to incorporate fuse control into the configuration control program and to verify through a sampling program the adequacy of the existing plant configuration. This action was scheduled to be implemented by February 7, 1991.

Overall, the inspection team concluded that the EDS was generally adequate from a design perspective to perform its intended function. As a result of the above mentioned weaknesses, the team considered the activities of your engineering and technical staff to be marginally acceptable. This conclusion was based principally upon the station battery related issues.

Within the scope of the inspection, the team identified two violations of regulatory requirements and one deviation from a licensing commitment. The inspection findings are enumerated and referenced to the applicable sections of the inspection report in the attachment entitled, "Inspection Findings Index."

## TABLE OF CONTENTS

## DETAILS

### 1. EXIT MEETING ATTENDEES

Entergy Personnel

R. Barkhurst, Vice President, Operations
R. Burski, Director, Nuclear Safety
J. McGaha, General Manager, Plant Operations
R. Azzarello, Director, Engineering & Construction
T. Brennan, Design Engineering Manager
D. Packer, Operations & Maintenance Manager
P. Prasankumar, Technical Services Manager
B. Thigpen, Construction Manager
P. Jackson, Principal Engineer
G. Matharu, Electrical Engineering Supervisor

NRC PERSONNEL

J. Jaudon, Acting Director, Division of Reactor Safety (DRS)
T. Stetka, Acting Deputy Director, DRS
W. Smith, Acting Chief, Plant Systems Section (PSS), DRS
T. Westerman, Chief, Section A, Division of Reactor Projects
R. Wharton, Acting Project Manager-Waterford-3, NRR
T. McKernon, Team Leader, Operational Programs Section (OPS), DRS
P. Wagner, Assistant Team Leader, OPS, DRS
C. Paulk, Reactor Inspector, PSS, DRS
M. Runyan, Reactor Inspector, PSS, DRS

### 2. ELECTRICAL DESIGN REVIEW

The team reviewed a sample of electrical design attributes at each ac and dc voltage level of the electrical distribution system (EDS). The documents reviewed addressed design calculations for ac and dc system loading, voltage regulation during normal and degraded conditions, voltage regulation during sequencing of safety-related loads onto the emergency diesel generators (EDGs), degraded voltage relay setpoints, Class 1E battery selection, short circuit and ground-fault analysis, fault current system protection, protective device coordination, and the protection of the EDS from power surges. The team also reviewed design basis documents (DBDs) for the EDS; procedures controlling design calculations, configurations, and plant modifications; selected deficiency reports; and plant drawings.

### 2.1 Offsite Electrical Power System

The Waterford-3 facility is connected to the utility grid by parallel transmission lines from the two main transformers to the 230kV switchyard. The main transformers are supplied from the main generator. Additionally, the main generator supplies two unit auxiliary transformers (UATs) that provide power to plant systems during operation.

When the main generator is unavailable, power is supplied to the plant systems through two startup transformers from the grid. In addition, when the plant is not operating, disconnect links between the main generator and the main transformers may be opened and loads supplied through the main transformers and the UATs.

### 2.1.1 Adequacy of the Offsite Electrical Power Supply

To evaluate the adequacy of the offsite electrical power supply, the team reviewed the stability of the 230kV grid under changing load conditions. The licensee explained that the grid was very stable and provided a continuous trace record from the online voltage records which covered a period of 6 months. Since the trace indicated that the grid voltage varied within ± 2 1/2 percent of the nominal value, the team considered the stability of the grid to be acceptable. The team also reviewed the surge protection equipment used on the startup transformers and the main transformers. The licensee provided a single-line diagram for the power system and vendor data on the equipment. The team determined that the surge protection was adequate.

The team determined that the startup transformers had adequate capacity for the loads listed on the plant load study document. Both startup transformers were adequately protected by differential current relays, timed elapsed overcurrent relays, and sudden pressure relays.

The team reviewed the non-class 1E bus transfer scheme for the UAT 4.16kV loads to the startup transformer. The team reviewed the elementary and control wiring diagrams (LOU 1564-B424) and had no concerns about the operability of the transfer scheme.

### 2.1.2 Station Grounding Grid

To evaluate the station grounding system, the team reviewed the "Grounding Design Criteria," dated April 12, 1975; Procedure ME-007-200, "Station Ground Testing Maintenance Procedure," Revision 1; and Procedure SPS-01-001, "Station Ground Test Procedure."

The team noted that the grounding design matrix had many blank spaces which should have been filled in when the grounding grid was installed, that no basis for some design parameters existed, and that no documentation to existed verifying that the grid was installed using procedures specified by IEEE-80. The licensee agreed that these were deficiencies and agreed to revise and complete the grounding design matrix. The licensee further agreed to produce a design calculation to verify that the design of the ground grid was in compliance with IEEE-80. The team noted that this appeared to be a documentation problem, since the tests results reviewed were acceptable.

The team determined that there was no immediate safety impact for the identified ground-grid deficiencies. However, the team considered that since the grounding grid was a maintenance free, passive piece of equipment with no access for visual inspection, its design needed to be verified. The licensee actions to resolve the ground grid deficiencies will be reviewed as part of an inspector followup item.

Inspector Followup Item (382/9023-04): Determine the adequacy of the station grounding grid design.

2.2 Onsite Electrical Distribution System - 4.16kV

The onsite electrical distribution system at Waterford 3 included four 4.16kV nonsafety-related buses (3A2, 3B2, 3A4, 3B4) and three 4.16kV safety-related buses (3A3-S, 3B3-S and 3AB3-S). Buses 3A2 and 3B2 were normally powered off the Unit Auxiliary Transformers 3A and 3B, respectively. In addition, buses 3A2 and 3B2 powered buses 3A4 and 3B4, which were associated with the plant's chilled water system. In the event of a loss of normal power from the main generator, buses 3A2 and 3B2 were powered from an offsite source of power through two start-up transformers, 3A and 3B. These nonsafety-related buses also powered the 4.16kV safety-related buses 3A3-S and 3B3-S. Each of the safety-related buses was capable of receiving emergency onsite power from one of two 4400kW diesel generators. Bus 3AB3-S could be powered from either the 3A3-S or 3B3-S buses, depending on its breaker alignment, and was designed to be a swing bus. The 3AB3-S bus provided power to loads which were intended to be backups to the equipment on the divisional buses. This afforded the licensee operational flexibility when the corresponding divisional equipment was not operable because of maintenance activities.

2.2.1 Switchgear Short-Circuit Ratings

The team reviewed the licensee's short-circuit evaluations, "AC (6.9kV, 4.16kV, 480V) Short Circuit Study," and Calculation Number EE6-38-01, Revision 01. The calculation was performed using computer program (ESP) V2 AUX SYS 2027. The team compared the calculated short-circuit levels with vendor supplied data. The team determined that the switchgear equipment had adequate interrupting capacities to handle the calculated short-circuit currents.

2.2.2 Protective Relaying

Each safety-related bus was protected against bus faults or uncleared-feed faults by three inverse, time-overcurrent relays which tripped the incoming supply feeder. Each of the outgoing feeders was protected by phased overcurrent relays.

Motor feeders had two-element, inverse-time relays in each phase and an overload alarm function on one of the phases. In addition, the motor feeders had high-dropout instantaneous relays to provide locked-rotor protection.

Low voltage on the 4.16kV bus for more than a few seconds would be sensed by the degraded grid relays, which would trip all loads fed from the bus. The purpose of the degraded grid relays was to ensure that adequate voltage would be available to operate all safety-related loads fed both directly and indirectly from the 4.16kV buses. The relays accomplished this by sensing the level of voltage at the 4.16kV buses. When normal offsite supply to these buses became degraded and the voltage fell to an unacceptable level, the degraded grid relays would separate the 4.16kV buses from the offsite electrical supply, start the diesel generators, and then connect them to the bus. Relay setpoints should have been chosen at a value which would provide adequate voltage to all downstream safety loads. The team was unable to review original calculations in the DBD to verify the above.

As a result of the DBD missing calculations and the team's concern, the licensee produced draft calculations. These draft calculations indicated that 3936V was needed at the 4.16kV buses in order to ensure proper operation of all downstream loads. The most limiting of these downstream loads was at the 120V ac level. Therefore, in order to ensure acceptable voltage to loads the degraded grid relays should have been set at a trip setpoint no lower than 3936V. The actual setpoint could have to be somewhat higher as no calibration inaccuracies or adjustments for relay drift were considered in the draft calculations.

In contrast to these draft calculations, Technical Specifications (TS) Table 3.3.4 listed a trip setpoint of 3640V with an allowable value of 3604V. Surveillance Procedure ME-003-319, "GE Undervoltage Relay Model 12NGV13BK," Revision 4, delineated a dropout setting of between 104 and 105 volts for these relays, which was equivalent to between 3640 and 3675 volts at the 4.16kV level. Therefore, this setting was too low to ensure proper operation of all Class 1E equipment had the bus voltage degraded to less than 3936 volts and remained above the degraded grid relay setpoints. The licensee's failure to properly analyze potential undervoltage conditions resulting in inoperable safety-related equipment was considered to be an apparent violation of Criterion III, Appendix B to 10 CFR Part 50 which requires the verifcation of facility design adequacy.

Violation (382/9023-01): Failure to verify or check the adequacy of facility design as required by Appendix B to 10CFR Part 50.

2.2.3 Cable Short-Circuit Ratings

The team evaluated a sample of electrical cables and found that cables were adequately sized for their rated continuous current at the allowable voltage drop. The team also noted that the installed protective devices were sufficient to protect the cables against short-circuit currents.

2.3 Emergency Diesel Generators (EDGs)

Two EDGs, one for each division, provided standby power in the event of a loss of offsite power. Diesel Generator 3A-S supplied power to the 4.16kV bus 3A3-S and Diesel Generator 3B-S supplied power to the 4.16kV bus 3B3-S. Each diesel generator was rated at 4400kW and had separate control circuits, fuel-storage feed tanks, and fuel-oil transfer systems. Each diesel generator was rated to provide sufficient and reliable power to all safety-related loads as well as critical nonsafety-related loads which were manually loaded on to the diesel generator.

Each diesel generator set was designed for fast starting and load acceptance within 10 seconds. The generators had open, drip-proof frames, Class B insulation, and were wye connected, synchronous type with static, solid-state excitation systems. The EDGs were furnished with automatic field flashing equipment for quick voltage buildup during the start-up sequence. The automatic voltage regulators provided steady-state voltage regulation within 1.0 percent for any load from no load to full load.

The EDG controls were designed for automatic as well as manual operation. The manual operation was feasible from either the EDG control panels (local) or the main control room panel (remote). The choice of the operating location was controlled by "LOCAL-REMOTE" selector switches located at the engine and generator control panels and indicated in the main control room. It was further noted that regardless of the "LOCAL-REMOTE" selector position, the EDGs would start automatically on either a loss of offsite power or a safety injection actuation signal.

### 2.3.1 Load Capability

The team reviewed Design Basis Document (DBD) W3-DBD-002, "Emergency Diesel Generator Design Basis Document," Revision 0, to determine the capability of the EDGs to supply the required loads during accident conditions.

The calculations revealed that with loss of power under the three accident scenarios of loss of coolant accident (LOCA), main-steam line break (MSLB), and loss of offsite power, the 4-hour to continuous loading ratio on the EDGs were 99.5 percent, 96.2 percent, and 96.5 percent, respectively. The load profile for a LOCA condition showed that during a manual loading period between 11.5 minutes to 40 minutes in the profile, the EDG load rose to 108 percent. Similarly, under the MSLB condition the load during 3.5 minutes to 10 minutes rose to 105 percent.

The team also noted in Calculation W3-DBD-002, that the losses considered for Class 1E transformers 3A31, 3A32, and 3A315 were very low. A review of vendor data confirmed that the actual losses were much higher than the values considered in the licensee's calculation. Similarly, the lighting loads listed on EDG loading tables (FSAR Table 8.3.1) were low in comparison to those listed on Calculation EE5-37.01, "Plant Load Study," Revision 01. Additionally, the computer power supply load shown on the EDG loading table did not match the plant load study.

In response to the above discrepancies, the licensee explained that the load figures used in the calculation were generally very conservative. A revision of the calculation was produced using brake horsepower (BHP) data from pump/motor vendor curves in lieu of the motor-nameplate rating. The revised document included the actual transformer losses, revised lighting loads, and the computer power supply loads. However, the team noted that some electrical equipment (e.g., cables, smaller transformers, etc.) losses were not included in the revised calculation. The licensee agreed to include those losses in the final version of the calculation. The team determined from the draft calculation results that the EDGs would not be overloaded in the accident scenarios studied.

In addition to the above, the team noted that the DBD did not include a basis for several setpoints or system design parameters. There was no evaluation for degraded grid voltage because the licensee assumed that the architect/engineer had performed the analysis. Furthermore, the licensee made other conclusions without supporting documentation. The team noted these examples as typical of weaknesses in the licensee's design basis document program. Since the licensee was in the process of revising the emergency diesel generator DBD, no specific inspector followup was considered necessary.

### 2.3.2 Protective Relaying and Timer Relays

The licensee provided both mechanical and electrical trips to protect the EDGs during normal and emergency operations. During emergency operations, however, only overspeed or generator differential conditions would trip the EDG. A safety-injection actuation signal (SIAS) or a bus undervoltage signal would start the EDGs, signal bus loads to be shed, and close the EDG breaker onto the bus within 10 seconds. Upon EDG breaker closure, the appropriate sequencer, loss of offsite power (LOOP) or loss of coolant accident (LOCA), would begin to sequence loads back onto the bus.

During a recent in-house safety system functional inspection (SSFI), the licensee noted that there was a lack of analysis addressing EDG dynamic loading and a lack of DBDs for protective relays. The licensee had established a completion date of December 15, 1990, for the dynamic loading issue but had not established a date for the protective relay issue.

The team reviewed the dynamic loading responses and the sequencer-timer relay inaccuracies and determined that there did not appear to be a problem with loading the EDGs.

The team noted that some protective relays had been replaced. However, the licensee did not have documentation to show that Westinghouse SA-1 solid-state differential relays were adequate replacements for the originally installed General Electric 12FD12B1A differential relays. The General Electric relays were replaced by Westinghouse relays because the original relays were obsolete. The team considered this to be a documentation problem that was not safety significant.

### 2.3.3 Voltage Regulation

The team reviewed the licensee's voltage stability studies to ascertain if changing load conditions on the power system would create undue voltage fluctuations on the terminals of equipment and devices. The team noted that the licensee's calculation assumed that the plant would be operating with 97 percent of nominal grid voltage. The calculation concluded that:

- Starting the largest motor on the 4.16kV Class 1E bus would leave enough minimum voltage (89 percent) at the bus to preclude a loss of voltage trip signal (87.5 percent).

- Loading the EDG with the largest load block would not result in a loss of the voltage trip signal.

- The minimum available voltage at the starting coils of motor starters in the motor control centers (MCCs) was 103.2 volt, which was above the minimum required pick-up voltage of 91.2 volt.

The team considered the calculation to be satisfactory and had no concerns about the adequacy of the Waterford 3 voltage regulation.

## 2.4 480V AC Distribution System

The separation between Class 1E and non-Class 1E 480V power distribution systems was similar to the 4.16kV systems. Power in each class was distributed through 480V switchgear, motor-control centers (MCCs), step-down transformers and power-distribution panels. The larger motors (more than 100 horsepower) were fed directly from the switchgear. The MCC cubicals used for supplying power to motors were equipped with magnetic circuit breakers and 3-pole magnetic contractors with thermal overload relays for motor protection.

A 480V switchgear swing bus, 3AB31-S, could be connected to either bus 3A31-S or 3B31-S through a double-tie breaker arrangement. The loads connected to the swing bus 3AB31-S were utilized as standby to the safety-related bus loads. Similarly, MCC Bus 3AB222 acted as a swing bus between buses 3A22 and 3B22 and could be powered from either.

### 2.4.1 Transformer Sizing

The team reviewed the loading of selected EDS transformers. The Train A, Class 1E transformers 3A31, 3A32, and 3A315 were rated 2500/3333kVA, 2500/3333kVA and 1000kVA respectively. The plant load-study document (EE5-37-01, Revision 1) indicated that the respective loading on these transformers were 90 percent, 40 percent, and 87 percent of their maximum rating. Similarly on Train B, transformers 3B31, 3B32, and 3B315 were loaded to 56 percent, 31 percent, and 87 percent respectively. The team considered the transformer loading margins to be adequate.

### 2.4.2 480V Switchgear Short-Circuit Ratings

The team noted that the maximum symmetrical interrupting capacities for 480V switchgear and MCC buses were as follows: switchgear buses, 50k amperes and 30k amperes; MCC buses, 14k amperes, 22k amperes, and 30k amperes.

The tie breakers connecting swing bus 3AB31-S to either bus 3A31-S or 3B31-S had a continuous rating of 1600 amperes. The continuous-current ratings of branch breakers ranged from 480 amperes to 800 amperes.

The team verified that the calculated short-circuit currents were within the short-circuit ratings and interrupting capabilities discussed above.

### 2.4.3 Voltage Regulation

The team reviewed computer program (ESP) V2AUX SYS2027 (File No. 7Q-6-38-01), which was used to calculate the voltage profile for the 480V level, and compared the data with hand-calculated voltage drops on selected Class 1E load terminals. The team noted that the voltage drops under full load conditions met the acceptance criteria, assuming the 230kV start-up transformers maintained the system voltage above 0.97 per unit and the EDG automatic-voltage regulator kept the Class 1E system in the proper range under emergency loading conditions. The team considered the voltage profile of the 480V level to be acceptable.

### 2.4.4 Protective Relays and Coordination

The team reviewed the Class 1E 480V system protection and coordination, including the 4.16kV source system and the connected Non-Class 1E loads. The team noted that the Non-Class 1E loads would be disconnected from the Class 1E sources on loss of voltage and could only be reclosed manually.

In November 1988, during an in-house SSFI, the licensee observed that the overcurrent relay coordination curves were uncontrolled. Since then, the licensee had acquired the original time-current (T-C) curves for the 6.9kV, 4.16kV, and 480V load protection and coordination from the architect-engineer. The team reviewed the T-C curves and noted numerous minor discrepancies which indicated that the documents had not been rechecked or updated upon onsite receipt. The following were examples of noted discrepancies: T-C curve sheets 28 and 29, curves number 6 and 7 should be swapped; T-C curve sheet 28 should include Charging Pump AB.

Although the selected overcurrent protection and coordination was found to be adequate, the failure to review the T-C curve documents appeared to be a weakness in the licensee's design control efforts. The team did not consider any of the above examples to be a safety concern.

### 2.4.5 Design Document Control

The team identified a number of additional errors in the design documents at Waterford 3. The licensee agreed to revise and update the involved documents. Examples of the errors and the licensee's actions were:

- Calculation EE6-38-01, "AC (6.9kV, 4.16kV, 480V) Short Circuit Study," Revision 1

  The team questioned Assumption 2.5 which stated, "High Pressure Safety Injection (HPSI) pump was not running and therefore not contributing to the total fault current." The licensee agreed that the HPSI pump could be running and would contribute to short-circuit current and, therefore, that the statement in Assumption 2.5 was invalid. The licensee agreed to revise the document to correct the mistake.

° Calculation EE6-38-02, "6.9kV, 4.16kV, 480V Voltage Drop Study," Revision 0

The team noted that the licensee had added static loads in kVA directly to dynamic loads in horsepower units. The team questioned the validity of this procedure. The licensee agreed to revise the calculation and correct the error. The team determined that the correction did not have a significant affect on the end result.

The team determined that the above errors were not safety significant.

## 2.5 120V AC Class 1E System

The 120V Class 1E systems were powered from either the 480V system or through static inverter systems. A 120V uninterruptible ac system had been provided to supply the plant protection system (PPS) control and instrumentation channels. The 120V uninterruptible ac system consisted of rectifier and/or inverters and power distribution panels. Each inverter was normally supplied through its rectifier from a safety-related 480V ac bus. Upon loss of the normal power supply, the inverters were supplied automatically from safety-related 125V dc system batteries.

The PPS used four inverters, two from each division, to supply the four measurement channels. The other safety-related control and instrumentation systems were connected to two separate inverters, one for each division.

The four PPS ac systems and two ac safety-related control and instrumentation systems were ungrounded. Each system was arranged so that any type of single failure or fault would not negate proper protective action of the safety-related systems.

Single-pole circuit breakers were used for single-phase 120V ac circuits, double- pole breakers for 208V ac single-phase circuits, and triple-pole breakers for 208V ac three-phase circuits. The safety-related 120V uninterruptible vital ac systems also used double-pole breakers. The thermal-magnetic breakers provided overcurrent and short-circuit protection. An instantaneous trip on short-circuit current protected circuits from faults on the feeder cables or on the 480-208V/120V transformers. The circuit breaker overcurrent settings (125 percent of equipment full-load current) allowed for setpoint drift.

The team checked selected loads and found the protection and coordination of the 120V ac system to be adequate.

## 2.6 125V DC Class 1E System

The 125V dc system was designed to provide a source of reliable continuous power for the PPS control and instrumentation and other loads for start-up, operation, and shutdown under normal and emergency conditions. The 125V dc system consisted of three, 60-cell, 125V batteries, each with its own battery chargers, load centers and distribution panels. Any nonsafety loads capable of being connected to the safety buses had been considered in the sizing of the batteries.

The three banks of batteries, designated 3A-S, 3B-S, and 3AB-S and their associated load centers and distribution panels had been arranged to feed the safety-related redundant dc loads and the nonsafety-related loads associated with divisions A, B, and AB. Batteries 3A-S and 3B-S were rated at 1200 ampere-hours for an 8-hour rate of discharge or 600 ampere-hours for a 1-hour rate of discharge to 1.75V per cell at 25°C. Each battery was sized to provide the maximum simultaneous combination of steady-state loads and peak loads for an emergency duty cycle of 1 hour. The 3AB-S battery was rated 2400 ampere-hours for an 8-hour rate of discharge to 1.75V per cell at 25°C. The 3AB-S battery design duty-cycle was 8 hours.

Four battery chargers, 3A1-S, 3A2-S, 3B1-S, and 3B2-S were provided, two each for batteries 3A-S and 3B-S. Each charger was rated at 150 amperes continuous capacity. Two other chargers, 3AB1-S and 3AB2-S, provided for battery 3AB-S, were rated at 200 amperes continuous capacity.

2.6.1 Voltage Drop Considerations

The team reviewed numerous design calculations related to voltage drop considerations. The following observations were made in this area:

2.6.1.1 Calculation EC-E89-008, Revision 0, "Electrical Design Criteria"

The team requested voltage-drop calculations for the 125V dc power-supply feeder cables. The licensee indicated that no specific calculations existed; however, guidance for sizing those feeder cables was contained in Waterford 3's electrical design criteria. Electrical design criteria, Calculation EC-E89-008, included a set of curves which provided the maximum length which could be used for the power feeder cables assuming a 3 percent voltage drop. The curves were based on 105V dc minimum battery terminal voltage. The team was concerned that the curves could be used in situations where a 3 percent voltage drop would not satisfy the minimum required voltage at the loads. An example of this concern involved the inverters powered from 125V dc buses 3A-DC-S and 3B-DC-S. Discussions with the licensee and review of safety-related inverter equipment specifications (LOU 1564.282 and LOU 1564.282A) indicated that the minimum required operating voltage for the four Solidstate Controls, Inc. (SCI) and two Elgar inverters was 105V dc. The team noted that this minimum operating voltage was the same as the minimum battery terminal voltage. Therefore, any voltage drop in the cables between the batteries and the inverters would reduce the voltage at the inverter input to a value less than 105V dc. This condition resulted in the potential loss of inverter output regulation or, because the Elgar inverters were provided with low-voltage protection circuitry, shutdown of these inverters. The team reviewed draft battery load profiles provided during the inspection and concluded that no immediate safety concern with feeder cable voltage drop existed. However, additional problems involving marginal battery sizing (refer to paragraph 2.6.3) and unknown inverter shutdown reset features (refer to paragraph 4.4), could result in feeder cable voltage drops affecting inverter operation.

2.6.1.2 Calculation EC-E89-014, Revision 0, "Justification of Ebasco Calculation EE2-12-03 DC Control Loop Length"

Calculation EC-E89-014, Revision 0, was developed to supplement the results of Ebasco Calculation EE2-12-03, Revision 0. Calculation EE2-12-03 had been intended to verify adequate cable sizing for 125V dc control circuits associated with the 6.9kV, 4.16kV and 480V switchgear. The calculation first determined the voltage drop between the battery and the individual switchgear at the minimum battery terminal voltage of 105V dc. This voltage drop was then used to calculate the voltage at the switchgear control bus. A maximum allowable circuit length was then calculated assuming minimum operating voltages at the closing (90V) and tripping (70V) coils. As a result of this calculation, a number of cases were identified in which the installed circuit lengths exceeded the maximum permissible lengths. Those cases were analyzed and recommendations were made for resolution of any problems. Calculation EC-E89-014 was then developed to address the remaining deficiencies identified in Calculation EE2-12-03.

The team reviewed both of the above calculations and identified a number of concerns related to the assumed conductor operating temperature, simultaneous operation of more than one circuit breaker, operation of closing spring charging motors, and impacts from other control circuit loads. During the inspection, the licensee produced draft calculations that indicated the noted concerns did not pose an operability problem.

2.6.2 Inverters

The six safety-related inverters were powered from dc buses 3A-DC-S and 3B-DC-S. Four of these inverters were manufactured by SCI and were rated at 20kVA. The SCI inverters provided vital 120V ac power to plant nuclear instrumentation. The other two inverters were manufactured by Elgar and were rated at 10 kVA. The Elgar inverters provided vital 120V ac power to safety-related balance-of-plant loads.

Discussions with the licensee indicated that the Elgar inverters were provided with a shutdown function at approximately 105V dc, whereas, the SCI inverters were provided with only an alarm function (after a 30 to 60 second time delay). However, continued voltage reduction to less than 105V at the input of the SCI inverters could result in internal fuse failure. Because batteries 3A-S and 3B-S were marginally sized for the present plant loads (refer to paragraph 2.6.3 of this report) and because the original design did not consider power feeder cable voltage drops between the battery and individual inverters (refer to paragraph 2.6.1 of this report), the team had concerns whether or not the Elgar inverters would remain operable when battery terminal voltages approached 105V dc.

The licensee provided three test cases for each of the Elgar inverters. The voltage at the inverters was calculated on the basis of the battery approaching its end of duty-cycle voltage and assumed a different aging factor and electrolyte temperature for each of the three cases. The results of the test cases indicated that in order to maintain a voltage above 105V dc at the input to the inverters, the licensee would have to encroach upon the 1.25 battery aging factor, which was normally used to size batteries.

The team was concerned about the apparent lack of knowledge about the static uninterruptible power supplies (SUPS) operation because relevant information had been previously provided through issuance of NRC Information Notice 90-22. The information notice stated, ". . . the potential may also exist for unanticipated plant response to restoration of power to similar equipment from other manufacturers. Awareness of the potential consequence of rendering numerous safety-related components inoperable . . . is also important." The information notice dealt with components changing status during undervoltage shutoff and reset situations. Although the title implied the notice was for Rosemount Transmitter Trip Units, the discussion section showed that the problem was broader. The licensee, however, did not evaluate any of the low-voltage shutoffs that were present on all SUPS. A summary of the licensee's response stated, "Upon investigation of NRC Information Notice 90-22 'Unanticipated Equipment Actuations Following Restoration of Power to Rosemount Transmitter Trip Units' it was determined that Waterford 3 has no trip units of this type in use." This response indicated that the licensee's answer was narrowly focused rather than considering the broader implications of the issue.

Because of this prior NRC information and licensee design reviews, the team concluded that the existence of the shutdown circuitry in the Elgar inverters should have been identified and considered this a design control failing. The failure to verify or to check the design adequacy of the dc voltage at the input to the inverters was another example of the licensee's failure to comply with the requirements of 10CFR50, Appendix B, Criterion III as cited in paragraph 2.2.2 of this report (Violation 382/9023-01).

The team reviewed Calculation EE7-39-02, which was developed to determine the load on 120V ac vital power distribution panel, PDP390SA, and its associated inverter supply, SUPS 3A-S. Panel PDP390SA had a continuous bus rating of 100 amperes, while the rated output of inverter SUPS 3A-S (10kVA) was 83.33 amperes. The calculation identified each of the circuits powered from panel PDP390SA, as well as the associated control wiring diagram (CWD), connected load (i.e., amperes, watts, or volt-amperes), type of load (e.g., relays, solenoids, indicating lights, etc.), and source of information (e.g., CWD, vendor drawing, design change notice, etc.). The team reviewed the calculation and noted that it did not adequately account for the affect of power factor on the total loading of panel PDP390SA and SUPS 3A-S. The calculation had assumed a 1.0 power factor with no supporting justification. In addition, the total load was calculated to be 93.2 amperes. A load factor of 0.8 was then applied to account for loads which might not be energized. The total load calculated after applying a 0.8 load factor was 74.56 amperes, however, the 0.8 load factor could not be supported. In response to the team's concerns, the licensee developed an additional draft calculation to demonstrate that the inverter and the vital bus were not overloaded. The results of this calculation indicated a total load of 56.29 amperes, which was within the capacity of the inverter and the vital bus.

The team also noted that the licensee had revised the loading calculation as a result of Design Change Package 3080, Revision 3, dated August 1989. The above concerns should have been identified by the licensee during the revision of the bus loading calculation and, therefore, reflected a lack of design control. The failure to verify or check the adequacy of a design calculation was another example of the licensee's failure to comply with the requirements of 10 CFR 50, Appendix B, Criterion III as cited in paragraph 2.2.2 of this report (Violation 382/9023-01).

### 2.6.3 Battery Sizing/Short Circuit Studies

The team reviewed the calculations associated with the sizing of all three station batteries as well as the short-circuit calculations for the dc loads associated with those batteries.

#### 2.6.3.1 Existing Battery 3A-S, 3B-S, 3AB-S Capacities

The team reviewed Calculations EE4-29-02, Revision 2, to verify the capacity of batteries 3A-S and 3B-S for their 1-hour duty cycle and Calculation EE4-29-03, Revision 2, to verify the capacity of battery 3AB-S for its 8-hour duty cycle. In general, the information contained in these calculations could not be readily verified by an independent reviewer of design basis document, Waterford 3-DBD-008, Revision 0. The concerns identified included:

- The licensee was unable to provide the basis for key assumptions used in determining the loading on the batteries.
- Source documentation identified in the calculations was not available for review.
- Load shedding credited in the calculations was not always consistent with existing plant operating procedure (OP-902-005) for a loss of offsite power event.
- Specific breaker operation credited during the battery-duty cycle was not clearly identified in Procedure OP-902-005.
- The impact of certain loads (e.g., diesel generator field flashing and the energization at four circuit-breaker spring charging dc motors) was not addressed.
- Minor discrepancies were identified for total load during the certain periods of the duty cycle between the load tabulation and the calculation. The values of total load were inconsistent with the duty cycle identified in Figures 8.3-2, 8.3-3, and 8.3-4 of the USAR.

The team noted that many of the above concerns were not identified by the licensee's review of the design basis document.

In addition, the battery sizing worksheets identified a temperature correction factor of 1.0 which impled an electrolyte temperature of 77°F (25°C). The team was concerned with the use of 77°F as the minimum electrolyte temperature because the battery room temperatures had been recorded well below this minimum temperature on a number of occasions. Also, the temperatures identified in the plant Technical Specifications (TSs) and surveillance procedures were inconsistent with the required minimum value of temperature.

The most significant concern noted was the lack of margin in the calculations. In response to the team's concerns, the licensee performed a preliminary assessment to demonstrate the adequacy of the batteries. The licensee based this assessment on reduced battery-room temperatures of 64°F for the 3A-S and 3B-S batteries, and 72°F for battery 3AB-S. Also, loads associated with the inverters fed from the batteries were revised (the previous calculation assumed inverters were either fully loaded or at 90 percent of full load). The results of the licensee's assessment indicated that the existing batteries would satisfy the revised 1-hour/8-hour battery-duty cycles. The team noted, however, that the revised battery sizing calculations contained no design margin and revised load-shedding assumptions were not reflected in existing Emergency Operating Procedure OP-902-005, Revision 4.

The licensee indicated that the lack of design margin, the need to account for potential load growth, and the battery capacity degradation effects caused by aging, had been recognized in recent reviews of the batteries for station blackout requirements. In response to the problem, the licensee was evaluating the replacement of the batteries at some earlier time in their life cycle than had originally been projected. The activities involving new calculations to determine the replacement of the batteries will be considered an inspector followup item.

Inspector Followup Item (382/9023-05): Review the completion of the calculations associated with early battery replacement because of aging and loading effects.

2.6.3.2 Load Shedding Provisions

During the review of the battery capacity documentation, the team noted differences in the assumed battery loading values. The team was informed that refined calculations had been performed assuming actual battery loading. The assumed loading included consideration of the equipment that would be deenergized in accordance with operating procedures. The team reviewed Emergency Operating Procedure OP-9023-005, "Loss of Offsite Power/Station Blackout Recovery Procedure," Revision 4, and observed the lists of equipment being deenergized.

Of particular concern was the instruction (Section E.9) which opened the power supply breaker to the pressurizer level, post-accident monitoring instrumentation recorders. The licensee had designated the pressurizer level indicators and recorders as key indication parameters in their July 6, 1983, submittal to the NRC related to the implementation of Regulatory Guide 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following An Accident." The failure to maintain these key recorders in operation during accident conditions is an apparent deviation of the licensee's commitment to the NRC.

Deviation (382/9023-03): Failure to maintain pressurizer level recorders operable as committed in Regulatory Guide 1.97 submittal.

2.6.3.3 Short-Circuit Study for 125 Volt Buses No. 3A-DC-S, 3B-DC-S, and 3AB-DC-S

The team reviewed calculations to determine the short-circuit currents at dc buses 3A-DC-S, 3B-DC-S, and 3AB-DC-S as well as, at various loads fed from these buses. The calculations determined the potential short-circuit currents at various loads (e.g., panels, switchgears, etc.) in order to provide information for the sizing of circuit breakers and fuses protecting the loads. The calculations identified the maximum short-circuit currents delivered by various sources (i.e., battery and battery chargers) and then considered the impact of cable resistances between the sources and the bus or load. The team identified a number of concerns several of which were not identified through the DBD process, and included:

- The maximum value of short-circuit current for the Gould NCX-1200/2400 batteries used in the calculations were 10,300 and 19,400 amperes, respectively. These values were intended to reflect the maximum short-circuit current at an electrolyte temperature of 77°F. However, a licensee discussion with the battery manufacturer indicated that the actual values were 10,404/19584 amperes, respectively. In addition, the team found that the licensee had not considered the effects of higher electrolyte temperature on the battery's short-circuit capabilities. (Based on manufacturer's data, the short-circuit current at 90°F would be approximately 107-109 percent of the value at 77°F).

- The potential short-circuit currents had not been determined for all loads fed from panels 3A-DC-S, 3B-DC-S and 3AB-DC-S. For example, in reviewing "Power Distribution and Motor Data," sheets 108, Revision 10 and sheet 109, Revision 11, for panels 3A-DC-S and 3B-DC-S respectively, a total of 19 circuits were identified on each panel. The calculation addressed only 7 loads. This similarity was also found with the 3AB-DC-S panel. In addition, short-circuit currents were identified in the calculation for loads which were no longer powered from these buses. For example, annunciator panel 3B was identified in the calculation as being powered from panel 3B-DC-S. However, this load was not listed on the associated power distribution and motor data sheet.

Discussions with the licensee indicated that efforts had been initiated to revise the calculations and draft copies of the revised calculation were provided to the team. However, the draft calculation did not address the impact of increased electrolyte temperature on battery maximum short-circuit currents. This concern was discussed during the exit meeting conducted on February 1, 1991, and the licensee committed to revising the dc short-circuit calculations. This concern will remain an inspection followup item pending future NRC review.

Inspector Followup Item (382/9023-06): Review the revision to the dc short-circuit calculations.

2.6.4 Review of DC Voltage to Motor-Operated Valves (MOVs)

The steam admission valves to the steam-driven auxiliary feedwater pumps were the only two safety-related, dc MOVs at Waterford 3. The team reviewed Calculation EC-E89-200, "DC Motor Operated Valves, Design Inadequacies - Cable Sizing Calculation," Revision 0, which pertained to the available terminal voltage at these MOVs. Using motor locked-rotor current, and temperature-corrected cable resistances, the licensee calculated that 75.5 volts would be available at the motor terminals under worst-case conditions. This represented 60.4 percent of the nominal 125 volt motor rating. Using this number in the standard limitorque equation, the licensee determined that the actuators could develop more than the 176 ft-lbs of torque that had been calculated by the valve vendor as necessary to stoke the valve. Assuming that the vendor torque value was adequate, the calculations indicated that adequate torque could be delivered under design basis conditions.

2.6.5 Protective Relays and Coordination

Since ungrounded circuits were used on the plant dc systems, two-pole circuit breakers were used for each feeder cable. In cases where containment penetrations occurred, circuit breakers with back-up fuses or double fuses were used in the circuit.

The team determined that overload settings were approximately 120 percent of the rated full-load current for the protected device. The team observed that voltmeters and ground-fault relays were provided to indicate or annunciate ground faults.

The team found the protection and relay settings to be adequate.

2.7 <u>Containment Electrical Penetrations</u>

The team performed a review of the following documents: Calculation EE2-11-06, "Containment Electrical Penetration Back-up Protection," Revision 0, and Specification LOU 1564-258, "Containment Electrical Penetration Specifications," Revision 9.

These documents indicated that the penetration cables were provided with adequate protection for short-circuit conditions. The protective devices (circuit breakers and/or fuses) were set to operate before the cables would attain dangerous temperature levels. The documents also indicated that the penetrations had adequate thermal capacities to withstand, without loss of integrity, the heat generated by the short-circuit current. The team had no concerns about the operability of electrical penetrations.

## 2.8 Conclusions

The team considered the design of the EDS at Waterford 3 to be generally acceptable. To the greater extent, design attributes of the EDS were retrievable and verifiable. The licensee had implemented actions to develop DBDs and had conducted some recent, in-house SSFIs of plant systems. Many of the issues discussed during the inspection had also been identified by the licensee during these efforts. However, the team identified a number of concerns in which engineering calculations contained unsupported and/or nonconservative assumptions, and erroneous computations. The team considered that the licensee's engineering staff's review of issues and modifications affecting the EDS, in some instances, lacked critical engineering evaluatio .

The team identified some findings regarding inadequate design reviews for certain conditions of operations and postulated failures of certain EDS equipment. Degraded grid-protective relays had not been adequately evaluated to protect and ensure the functionality of safety-related loads on the 120 volt ac level. Additionally, the safety-related inverters' trip setpoints had not been evaluated for the associated power-supply cable voltage drop.

The team also identified concerns related to the station batteries. Although, the inspection team did not investigate in-depth requirements for station blackout, it did observe that design margins for the station batteries with regard to certain load profiles were small. The team was concerned with the licensee's controls required to ensure the batteries could perform their design function. In addition, allowances for potential load growth had not been taken, and replacement of the batteries earlier in the life cycle than initially anticipated would be required.

# 3. MECHANICAL DESIGN REVIEW

To determine the capability of mechanical systems supporting the design function of the emergency diesel generators (EDG), the team reviewed calculations, design basis documents (DBDs), equipment modifications, and other information regarding fuel-oil storage and transfer, lubricating oil, starting air, and diesel heating and cooling equipment. The team reviewed design documentation concerning the heating, ventilating, and air conditioning (HVAC) of the diesel generator rooms, battery and switchgear rooms, and safety-related pump rooms. The team also performed a design review of the component cooling water and safety-related chilled water systems. The team performed plant walkdowns of the systems described above. The team reviewed the translation of various mechanical loads (selected pumps and fans) to electrical loads for input into design-basis calculations.

## 3.1 Diesel Generators and Support Systems

The team reviewed design calculations, modification packages, DBDs, and other documentation related to the emergency diesel generators and the associated support systems. The team also conducted walkdown inspections of the EDGs and the support systems. Issues identified during the review are discussed in the following paragraphs.

### 3.1.1 Seismic Support for EDG Governor Cooling-Water Line

As a result of Modification Project (MP) No. 1821, dated July 28, 1988, the EDG speed governor's heat exchanger cooling-water source was converted from components cooling water to engine-jacket water. This change implemented a vendor (Cooper-Bessemer) recommendation to increase the cooling water temperature for more stable governor operation. The team observed that the 3/8-inch stainless steel tubing installed for this modification on the "B" EDG was unsupported over its entire span of approximately 6 feet from the jacket-water supply header to the governor heat exchanger. The team questioned the seismic qualification of this tubing, because a loss of the cooling supply could destabilize the operation of the governor and result in loss of the EDG. The licensee responded by performing Calculation EC-M91-005, Revision 0, which showed that the tubing as configured could withstand seismic forces up to a total span of 11 feet. However, the licensee acknowledged that the as-found condition did not meet Waterford 3 Specification B-430, "Standard Installation Detail for Instrumentation and Tubing," which specified a support every 48 inches for 3/8 inch stainless steel tubing. The licensee initiated condition identification (CI) report CI273358 to document this discrepancy. Since the identical modification on the "A" EDG was installed in accordance with Specification B-430, the licensee speculated that the support on the "B" EDG may have been inadvertently missing. The inspectors observed a broken hanger weldment in the area where the support hanger should have been installed. In addtion, the modification package contained verification signoffs that the tubing was installed to the above specification. The team considered the licensee's response as acceptable and did not consider the issue to be a safety concern.

### 3.1.2 EDG Air-Receiver Capacity

The team requested startup test results supporting USAR Section 9.5.6.3, which stated that each of the two air receivers was sized to store enough air to crank and start the diesel engine five times without the use of the air compressors. The receiver air pressure was automatically maintained at 240 to 260 psig ± 5 psig. The test results showed that air receiver 3A-2 produced only four starts at an initial pressure of 250 psig before being retested successfully for five starts at 255 psig. The initial air-receiver pressure for the other successful tests ranged from 245 to 250 psig. The team noted that the USAR five-start capability had not been demonstrated at the low end of the normal control band, i.e., 240 psig. The licensee acknowledged that no information existed to assure five starts at 240 psig but performed a draft calculation showing that this capability existed for a hypothetical receiver when the best-case results from all startup tests were used. The team concluded that the potential marginal undersizing (or underpressurization) of the air receivers was not of sufficient safety significance in that the automatic-start system would continue to attempt diesel starts until sufficient air pressure was lost. The licensee committed to clarify the Technical Specification (TS) basis regarding this issue.

### 3.1.3 EDG Fuel-Oil (FO) System

The team reviewed the USAR, DBD-002, "Emergency Diesel Generator," Revision 0, Flow Diagram LOU-1564 G-164, sheet 1 of 6, and calculations related to the sizing of the fuel-oil storage, day tanks and the transfer pumps. Each EDG had a two-train FO system. Each train had a storage tank, a transfer pump, a day tank, and the associated instrumentation. Interconnecting piping existed on the suction and discharge side of each train's transfer pump to allow the transfer from either storage tank to either day tank.

The team reviewed Calculations MN(Q)-9-21, "Diesel Oil Transfer Pumps," Revision 2, and EC-M90-90-084, "EDG Fuel Oil Transfer Pump NPSH [net positive suction head] for Pump A Taking Suction on Tank A or B," Revision 0. These calculations determined the total dynamic head and NPSH, respectively, for the FO system, assuming the most restrictive case where 246 feet of cross-connect suction piping was required. The calculations, however, omitted the effect of the recirculation flow back to the storage tank and the pressure loss through the strainer located on the suction of the transfer pump. Including these factors would affect the NPSH required for the pumps and the total flow to the day tank. During the inspection, the licensee performed Calculation EC-M91-001, Revision 1. This calculation showed that as long as the opposite-train fuel storage tank level was greater than the low-alarm setpoint (43 feet), the transfer pump would be able to transfer fuel at a sufficient rate to the opposite train-feed tank. Lower tank levels would likely result in pump cavitation as a result of insufficient NPSH. Despite this restriction, the team concluded that the licensee had provided adequate assurance of the transfer pumps' operational versatility.

Technical Specification (TS) 4.8.1.1.2.d.10 requires the licensee to "verify that each fuel transfer pump transfers fuel from each fuel-storage tank to the diesel-oil feed tank of each diesel via the installed cross-connection lines," every 18 months. Additionally, USAR 9.5.4.2 stated that interconnecting piping with two normally closed valves was provided between the two storage tanks to enable either of the emergency diesel engines to be supplied from either of the tanks should one of the transfer pumps fail. The team considered these requirements to mean that each fuel transfer pump was designed to transfer fuel from the opposite train-storage tank to the opposite train-diesel oil feed tank. However, the licensee's test procedure pursuant to TS 4.8.1.1.2.d.10 (OP-903-069, Revision 7) did not directly test this configuration nor did any calculation exist showing that the transfer pumps were capable of performing this operation. The licensee committed to clarify the TS or the TS bases to specify the current practice of testing the suction and supply cross-connects in separate tests.

The team noted that ANSI N195-1976 recommended that a differential pressure indicator be provided for the strainer located on the suction side of the transfer pump. The Waterford 3 design had no such indicator. The licensee stated that Surveillance Procedure OP-903-32, "Quarterly IST Valve Test," Revision 7, used to establish the operability of the transfer-pump check valves, EGF-109A and B, would indirectly verify if the strainers were functioning properly. The team reviewed the procedure and found this response to be acceptable.

The team reviewed the response to observation ME-08 of the licensee's SSFI of the EDG systems (prepared by a contractor for Entergy Operations in a report dated October 26, 1990). The observation concerned a postulated overpressure event involving the failure of the feed tank high-level cutoff on the fuel transfer pump. The licensee performed Calculation EC-M90-072, Revision 0, which showed that at the feed tank's design pressure (15 psig), the feed tanks' vent line would pass approximately 40 gpm and the drain line approximately 60 gpm which combined would be greater than that flow delivered by the pump (50 gpm). The team reviewed this calculation and concluded that the licensee had adequ[illegible]ly demonstrated compliance with ASME III, ND-7000 thus preventing overpre[illegible]zation.

### 3.1.4 Fuel-Oil Storage Capacity

The team reviewed the latest preliminary Fuel-Oil Consumption Calculation EC-E90-006, "Emergency Diesel Generator Loading and Fuel Oil Consumption," which superseded the previously approved Calculation MN(Q)-9-42, Revision 3. The latest preliminary calculation indicated that the FO consumption, including a 10 percent margin, was 37843.9 gallons compared with an adjusted TS value of 38337.4 gallons. This new calculation omitted FO consumption values needed for periodic testing (approximately 400 gallons) and FO required for operation of the engine at minimum loads as required by ANSI N195-1976. In addition, horsepower values for pumps used to calculate the diesel loading were, in some cases, lower than the manufacturer certified pump curves (see Section 3.3); however, the team determined that these adjustments would not affect the overall conclusion of the calculation.

Finally, this calculation used a FO specific gravity value of 0.85 based on the lowest value obtained from analysis of FO delivered to the plant. This value is critical since a lower specific gravity would result in a larger required volume of FO. The TS, Procurement Specification PROC-MISC-902, Revision 2, and CE-2-030, "Technical Procedure Maintaining Diesel Fuel Oil," Revision 2, allowed the FO to be purchased within a specific gravity range of 0.8 to 0.99. If the lower specific gravity of 0.8 were used, the required FO volume would increase by about 6 percent, thus, exceeding the TS limit of 38760 gallons. The licensee stated that procedures were in place to ensure that the specific gravity was closely monitored and maintained within a narrow range so as not to effect the calibration of the level indicators for the storage and day tanks. However, the team noted that the narrower specific gravity requirement had not been translated into the official plant documents such as the TS, the procurement FO specification, or the FO analysis. The team's overall assessment was that sufficient FO was being maintained onsite to allow for

7 days of operations of the diesels, and that procedures were in place to adequately monitor the FO volume. The licensee maintained FO levels above the TS limit and further committed to clarify the TS basis with regard to the 7-day diesel operation.

3.1.5 Seismic Interaction with Air-Receivers Safety Relief

During a walkdown of the EDG air-start systems, the team noted that the air compressor discharge line was in close proximity to some air receiver relief valves. Design Basis Document DBD-002, Section 3.2.4.4, classified these lines as nonnuclear safety and nonseismic. The team was concerned that failure of these lines during a seismic event could damage the relief valve resulting in the depressurization of the associated air receiver. The licensee showed that these lines had been supported using a simplified method of seismic protection developed by a subcontractor. The team observed that the lines appeared to be adequately supported to survive the design-basis earthquake loads.

3.1.6 EDG Floor Drains

The SSFI conducted by the licensee raised the concern whether the EDG floors drains could handle the overflow from the EDG jacket-water standpipe since there was no high-level alarm. The team reviewed Calculation EC-M90-085, "EDG Jacket Water Standpipe Overflow," Revision 0, which concluded that the maximum flow would be 30.6 gpm while the floor drains are sized for a maximum flow rate of 125 gpm. This calculation was found to be acceptable.

3.2 HVAC Equipment Supporting the EDS

The team reviewed the HVAC systems for a number of plant locations.

3.2.1 Class 1E Battery Room Ventilation

The Class 1E battery rooms were ventilated as part of the reactor auxiliary building (RAB) cable vault and switchgear areas. The USAR showed that the minimum and maximum battery room temperature was 77°F, however, the licensee stated that room temperatures normally varied between 77°F and 80°F. Each battery room had local temperature indication and the licensee surveyed these rooms at least once every 24 hours. The team performed a preliminary calculation which showed that if the non-Class 1E heater failed, the steady-state room temperature, after a few hours, would be approximately 70°F based on a cold-air supply temperature of about 56°F. Heat transmission from the adjacent rooms and heating from the battery room lighting would maintain this temperature. From a mechanical perspective the team had no concern regarding this possible lower temperature, even though it contradicted the USAR value. (The evaluation of the lower temperature affect on battery performance is discussed in paragraph 2.6, above.)

The team noted that both the USAR and Flow Diagram LOU-1564-6-853-S08 showed that each battery room (i.e., A, B, and AB) had two 100 percent exhaust fans; one powered from the A train and the other from the B train Class 1E power supplies. However, the supply side of all three battery-room fans were fed from a common supply header. Although the lines were seismically qualified, a failure of the common supply header would remove the normal air supply to all three battery rooms. This situation was contrary to the licensee's design philosophy of separating individual safety trains, especially considering the redundancy on the exhaust side. However, the team did not consider this situation to be a safety concern.

In addition to the above, the team noted that battery electrolyte specific gravity specifications in the TS were inconsistent with the vendor technical manual requirements (TS Table 4.8-2 stated that the maximum difference between the average and lowest connected cell specific gravity be no more than 0.020, whereas the vendor requirement stated 0.010 was the maximum difference). The licensee committed to review this issue and make revisions where appropriate.

3.2.2 EDG Room Ventilation

Calculation 7-9-C-2.3-11-H-1 (file B13.7), dated April 29, 1976, showed the air flow to the EDG rooms was sized to maintain a room temperature below the design limit of 120°F when the EDGs were in operation. Calculation 7-9-C-2-4-X-7-E, dated May 28, 1976, gave the normal air-supply requirements when the EDGs were not in operation. However, no calculation was available to verify the design flow nor to evaluate the heat loads from the piping and from the lube- oil and jacket-water heaters. The licensee stated that each EDG room temperature was consistently below the design value. In addition, there was a high-temperature alarm for either EDG room in the control room, and records showed that the alarm had never annunciated.

3.3 Conversion of Pump-Mechanical Load to Electrical Load

The team reviewed the licensee's calculation of pump brake horsepower for several safety-related pumps that had been used as input to the licensee's draft Calculation EC-E90-006, "Emergency Diesel Loading and Fuel Oil Consumption." The team noted that the brake-horsepower values used in the calculation were generally 3 to 8 percent lower than the brake horsepower shown on the certified pump curves at the pump operating points. The licensee had used information from vendor data sheets and was unable to explain the differences between the data sheets and the pump curves. The differences were minor and should not cause a diesel loading concern, but the team expressed concern that the inconsistencies should be resolved. Licensee personnel acknowledged the team's concern.

3.4 Component Closed Cooling Water (CCW) System

In reviewing the USAR, Flow Diagram LOU-1564-G-160, sheet 3 of 3, and Cooper-Bessemer Cooling-Water Schematic KSV-47-16, the team noted that the CCW side (tube side) of the EDG lube-oil cooler and the jacket-water cooler could be individually isolated, and that no adequate overpressure protection had been provided. This condition appeared to be contrary to ASME Code III, Article ND 7000. The tube side could be overpressurized when either or both coolers were isolated and the normal operation of the jacket-water or lube-oil heater caused the CCW temperature to rise to about 130°F. In addition, should either cooler be isolated, the operator would have no indication of this event, since only the combined flow from both coolers was monitored. The licensee stated there was no steady-state or transient conditions of pressure coincident with temperature in the CCW system that would exceed the design condition of coolers. They also stated that the coolers would not be in this condition without first taking the EDG out of service. If cooler maintenance was required, the EDG would be declared inoperable prior to isolating the cooler and the cooler would be vented and drained after isolation. The team found no specific procedures for the CCW system or the EDGs to confirm these statements. The licensee agreed to further evaluate current maintenance practices to ensure that if the CCW was isolated that there would be no possible heat source available to cause overpressurization of the lube-oil and jacket-water coolers.

### 3.5 Chilled-Water (CW) System

In reviewing the USAR and Flow Diagram LOU-1564-G853 SO3, the team noted that valves 3AC-F144A, 3AC-F135B, 3AC-F151B, and 3AC-F136A were required to close in order to isolate the nonsafety portions of the CW system during a design basis accident. If the nonseismically-qualified line failed during a seismic event, the team questioned whether the valves would close fast enough to prevent draining of the expansion tanks and subsequent pump cavitation or gas locking. In response, the licensee made a rough estimate which indicated that 281 gallons would be lost within the assumed 5 second closing time for the air-operated valves. This quantity exceeded the nominal capacity of one expansion tank by 101 gallons. However, it was not clear whether only one tank would be totally drained or if the expansion tanks in each train would be partially drained. The licensee agreed to prepare a more detailed calculation which would properly document the closing time for the slowest air-operated valve, assume the lowest CW inventory in the expansion tank, and justify the assumption of a linear decrease in flowrate with time. The team had no immediate concern about the operability of the system since even if both the A and B trains became inoperable, the A/B train would still be available to provide the required chilled water to at least one train.

### 3.6 Conclusions

The team concluded that the mechanical systems supporting the electrical distribution system appeared adequate to perform their design function. Questions regarding the operability and design basis of the associated equipment were satisfactorily answered. Observations where some design features appeared marginal did not represent safety issues.

The team noted that several aspects of the plant's design basis were not well supported by controlled calculations. Additionally, some of the licensee's engineers appeared unfamiliar with many of the calculations requested by the team. This raised the concern that the plant's design basis may not be adequately protected during modification activities. The inclusion of calculations and design-basis documents into the design input checklist as of March 1, 1990, was considered a positive step.

During the exit meeting, the licensee committed to correcting and/or clarifying inconsistencies in the USAR and the TS related to air-receiver testing (Section 3.1.2), fuel-oil transfer surveillance testing (Section 3.1.3), onsite emergency diesel generator fuel-oil storage requirements (Section 3.1.4), and battery electrolyte specific gravity requirements (Section 3.2.1). This commitment will remain an inspector followup item pending future review.

Inspector Followup Item (382/90-23-08): Review the licensee's activities to correct station battery electrolyte and EDG mechanical system inconsistencies.

## 4. ELECTRICAL DISTRIBUTION SYSTEM (EDS) EQUIPMENT, TESTING, AND SURVEILLANCE

To confirm the implementation of the electrical system design, the team inspected the as-built configuration of selected safety-related equipment in the plant. Additionally, the team evaluated the testing and surveillance programs, fuse control program, and modifications program.

### 4.1 Relay Calibration Program

The team reviewed the preventive maintenance and surveillance programs for the EDS relays. The team selected several relays and verified that they were appropriately included in the surveillance program, the preventive maintenance program, and the calibration program.

The team noted several concerns in the review of the undervoltage relay setpoints and associated procedures. Surveillance Procedure ME-003-319, used for the calibration of the undervoltage relays, did not provide for the readjustment to mid-band for relays found to be at the extreme end range of their setting band. Consequently, on April 8, 1987, and May 17, 1990, undervoltage relay 27-1E1B3 was found with a setpoint which approached the Technical Specification (TS) setpoint and was not recalibrated. By leaving this relay at the as-found setting, the margin allotted for drifting was decreased so that further drifting would cause the relay to be outside of the TS limit.

Review of calibration data for the undervoltage relays showed that on 6 out of 18 calibrations since 1985, the setpoints were found to have drifted below the trip value given in TSs. On October 3 and 4, 1985, all three relays on the A bus and one relay on the B bus were found to have drifted below the TS allowable value. As a result, both divisions of degraded grid protection may have been inoperable. This issue, as related to relay design, was discussed in paragraph 2.2.2 of this report. The issue resulted in a violation of 10 CFR Part 50, Appendix B.

Surveillance Procedure ME-003-319 required that the control room shift supervisor be notified when out-of-tolerance readings were found; however, no procedure existed that required the control room shift supervisor to evaluate the out-of- specification equipment for operability or reportability. Consequently, when the undervoltage relays were found to be below the TS range, as on April 8, 1987, reportability and/or evaluation determinations were not performed. This was confirmed through interviews with control room personnel.

In addition, information was not provided to engineering for the review of the surveillance interval acceptability or reevaluating the assumed drift factors used in the original setpoint calculations. The above examples were considered weaknesses in the licensee's corrective action program.

The team's concern with the lack of engineering evaluation was heightened because the licensee did not have a formalized trending program. Without a trending program, the licensee would be unable to evaluate and adjust the calibration period for relay setpoint drifting considerations. This capability was apparently not considered by the design engineers who, when questioned by the team, stated that drift was not a concern in establishing the setpoints. The failure to have an adequate procedure that considered equipment drift in setpoint determinations and to have a procedure that provided guidance related to equipment found outside of its acceptance criteria was considered to be a violation of TS 6.8.1, which requires procedures to be established, implemented, and maintained covering activities recommended in Appendix A of Regulatory Guide 1.33.

Violation (382/9023-02): Failure to establish, follow, and maintain procedures as required by TS 6.8.1.

### 4.2 Circuit-Breaker Testing Program

The team reviewed circuit-breaker maintenance and surveillance procedures and compared them to the manufacturer's recommended practices. The licensee's procedures generally agreed with the manufacturer's recommendations. The step-by-step test and checking of processes against reference values and allowable ranges mentioned in the procedures were concise and easy to follow. However, the team discovered that the maintenance and surveillance procedures for certain circuit breakers (GE Magna-Blast Breaker Type AM-4.16-350-2H and -2C) failed to mention checking and replacing the tertiary contacts even though these arcing contacts were specifically discussed in the manufacturer's manual. Discussions with the maintenance department could not verify whether or not maintenance had been perio[illegible] performed on the tertiary contacts. Followup discussions with the vendor indicated that failure of these contacts could adversely affect the operation of the circuit breaker. The failure to provide adequate circuit-breaker maintenance and surveillance procedures was considered to be another example of the failure to establish, implement, and maintain procedures as required by TS 6.8.1 and as cited in paragraph 4.1 above (Violation 382/9023-02).

The team considered the licensee's use of a single procedure to address different types of breakers instead of having specific procedures for each type of breaker to be a weakness.

### 4.3 Fuse Control

On October 31, 1990, the 15 ampere fuses for the 26 and 24 volt dc power supplies to card rack 100 in Process Analog Cabinet (PAC) OP26 failed. The licensee contacted the vendor and was informed that the proper fuse size was 20 amperes. The use of incorrect fuse sizes and types could indicate an inadequate fuse control program. The team requested documentation that governed the fuse control program and were informed that at Waterford 3 fuse replacement was accomplished by size-for-size.

The team noted that Waterford 3 had various procedures related to fuse control and replacement. The procedures provided for the inspection of installed fuses for conditions such as corrosion, excessive heating, and clip tension. The licensee had no procedures which ensured fuses were controlled or replaced in conformance with the original designs. Additionally, the corrective-action program at Waterford 3 provided procedures (NOP-005 and UNT-005-002), by which an identified condition, such as a deficiency associated with a fuse, would require an investigation of root cause. Finally, operations and maintenance supervisory personnel promoted awareness among personnel for concerns that are not a result of simple fuse overloads, but which may be indicative of fuse deficiencies, and which required a condition identification (CI) report. However, there were no instructions which would alert operations and maintenance personnel to the discrete differences between fuse types within a same amperage rating.

The team inspected approximately 25 fuses in the 6.9kV switchgear and the EDG control panels. None of the inspected fuses were found to be improperly sized; however, the team was not able to verify other characteristics to ensure that the short-circuit characteristic of fuses would coordinate properly with circuit-breaker protective devices. The licensee did not have a listing of fuses installed in the plant, nor which fuses should have been installed. The failure to establish appropriate procedures for the control of safety-related fuses was contrary to TS 6.8.1 and was considered to be another example of the violation (382/9023-02) cited in paragraph 4.1.

## 4.4 Inverter Testing

The team reviewed the maintenance procedures and technical manuals for the Elgar and Solidstate Controls, Inc. (SCI), static uninterruptible power supplies (SUPS). The team found that the licensee was not testing all of the protective features for the SUPS that were delineated in the technical manuals. This was considered to be the result of inadequate control of vendor information (see paragraph 5.4).

The SCI SUPS had four trips: high dc rectifier voltage, off frequency, high ac volts, and low ac volts. Maintenance Procedure ME-004-172, "Static Uninterruptible Power Supply 3MA-S, 3MB-S, 3MC-S, 3MD-S," Revision 4, had instructions for testing the high dc voltage trip and only the alarm status of the remaining trips. The trip relay (RL 16) was disconnected during this test to prevent the breakers from tripping during the other tests.

The Elgar SUPS had four automatic shutoff features: low voltage, overcurrent, blown fuse, and high output. Maintenance Procedure ME-004-175, "Static Uninterruptible Power Supply 3A-S and 3B-S," Revision 3, did not contain instructions for testing any of these protective circuits. The shutoffs were part of a modification made to the SUPS in 1988. The modification package included provisions for testing the undervoltage and overcurrent shutoffs, but not the blown fuse or high-output shutoffs.

The team interviewed the design engineer involved with the modification and noted that the engineer was not aware that the dc voltage was auctioneered high, nor how the auctioneering (selecting) of the higher dc voltage was performed. Additionally, the engineer did not know that the voltage in the SUPS had to recover to 130 volts in order to reset the low-voltage shutoff.

The NRC concerns over the automatic shutoff features of the Elgar SUPS (see paragraph 2.6.2), were also the subject of Violation 382/8911-01. The failure to have adequate procedures that included the testing of all protective functions of the SUPS in the maintenance procedures was another example of the violation of TS 6.8.1 (382/9023-02) cited in paragraph 4.1.

4.5 Battery Testing

The team reviewed a number of battery surveillance procedures for consistency with TS requirements, industry standards, and design basis considerations and also battery surveillance test results data.

The following concerns were identified during the review:

- Surveillance Procedure ME-003-200, Revision 5, stated that the battery room temperature was to be maintained between 70°F and 90°F. This temperature range was inconsistent with the plant design bases (refer to paragraphs 2.6.3 and 3.2.1 of this report).
- Surveillance Procedure ME-003-210, Revision 6, stated that the average electrolyte temperature of at least 10 sampled cells should be above 60°F. This temperature was inconsistent with the plant design bases (refer to paragraph 2.6.3 of this report).
- The performance test data conducted in accordance with Surveillance Procedure ME-003-240, Revision 7, for battery 3A-S (performed under Work Authorization No. 01006448 in April 1988) indicated that Cell No. 6 measured 0.68 volt at the end of the 8-hour test period. This low-cell reading was an indicator that reversal of cell voltage (i.e., cell voltage less than or equal to 1 volt) had occurred. Test documentation did not identify the low-cell voltage as a discrepant condition nor did the condition appear to have been evaluated. Discussions with the licensee revealed that the battery was recharged, physical measurements taken (e.g., electrolyte specific gravity, cell voltage, etc.), and then returned to service. No further evaluation or testing was performed. The licensee provided the team with a copy of the battery surveillance (service) test, Surveillance Procedure ME-003-230, Revision 6, performed under Work Authorization No. 01036534 in September 1989. Although Cell

No. 6 had the lowest cell-voltage reading (1.82 volt), the test data did not indicate any sign of cell damage. The team did not observe any administrative controls requiring discrepant test results to be evaluated by engineering.

- The team observed that the existing 60-minute time intervals specified in Surveillance Procedure ME-003-240, Revision 7, for measurement of battery terminal and cell voltages over the 8-hour (480 minutes) test period were not advantageously spaced to assist in the interpretation of test data.

The team concluded that although subsequent testing of the battery gave confidence in the reliability of the battery, the above items were additional examples of weaknesses in the licensee's programs. The team did not have an immediate safety concern.

### 4.6 Equipment Walkdown Inspection

The team performed physical inspections and observed the following: the EDS equipment conformed to design requirements; switchgear and buses were properly labeled, easily identifiable, and accessible; proper physical separation existed in the field for the EDS equipment and components; good housekeeping was apparent in the plant; few deficiency tags were observed; and the equipment appeared to be well maintained. The team also observed that the support staff appeared to be knowledgeable, competent, and timely in answering questions.

Drawings used to facilitate the walkdowns were clear, traceable, and in most cases, reflected the observed configuration. Minor inconsistencies between design drawings and the installation of certain EDS equipment were noted. The ranges and types of some relays were incorrectly identified on the drawings. The licensee confirmed that the equipment in the field met the design requirements, and committed to write document revision notices to correct the drawing errors. The team determined that the identified deficiencies were not safety significant.

During equipment walkdowns in the EDG rooms, the team brought two observations to the attention of the licensee. The first observation was that the control cabinet doors in EDG B room could not be fully shut because they were locked with the doors in the open position and that the doors in EDG A room were missing the mechanism needed to latch them shut. The licensee responded to this observation by properly closing and locking the EDG B cabinet doors and initiating Condition Identification No. 273127 to replace the missing latches on the EDG A room cabinet doors as soon as a new latch mechanism was procured. The licensee further stated that the doors for both cabinets would normally be maintained locked closed.

The second observation concerned the control of the installed 3-ton chain hoists. The team found the hoist in the A EDG room left with the hook and chain on top of the generator electrical connection box. The team was informed that the licensee had no specific administrative controls for ensuring that the hoists were properly secured when not in use. During the second week of the inspection, the team found and informed the licensee of another example of improper hoist storage in the chilled-water system rooms. The team informed the licensee that the lack of controls for securing hoists was a potential equipment and personnel hazard. The licensee is considering establishing controls for the disposition of such equipment. This is considered to be an inspector followup item.

Inspector Followup Item (382/9023-07): Review the establishment and implementation of appropriate controls for securing hoists and other such equipment.

4.7 Equipment Modifications

The team reviewed the modification package (MP) for each of the following four mechanical modifications which could affect the EDGs:

MP-1821 Convert Governor Heat-Exchanger Cooling Source from CCW to Jacket Water MP-1878 Adjust Air Compressor Air-Relief Valve Settings
MP-395 Add Isolation Valves to Various Instrument Tubing
SMP-316 Add Recirculation Line for Turbocharger Lube-Oil Filter

Plant walkdowns of the modifications were made where applicable. A walkdown discrepancy related to MP-1821 is documented in paragraph 3.1 of this report.

The team identified two areas of weakness during the review of the above modifications. First, the design input process did not appear to consider design basis analyses or calculations. The team noted a lack of familiarity with design calculations on the licensee's part. Second, the 10 CFR 50.59 safety evaluations were very brief and lacked depth. However, both of these concerns had been programmatically addressed by procedures implemented subsequent to the closeout of the four modifications. In particular, Procedure NOEP-309, "Design Input Checklist," Revision 0, added the phrase ". . . . consider the input on DBA documents, station blackout analysis, or other design documents/calculations . . . . .," and Procedure NOP-013, "10 CFR 50-59 Safety and Environmental Impact Evaluations," Revision 1, had upgraded procedural guidelines for safety evaluations.

4.8 Conclusions

The EDS equipment appeared sufficient to support the safe operation of the plant. The team did not identify any issues which questioned the operability of the EDS nor which represented items of major safety significance. However, weaknesses were identified in the programs controlling testing and surveillance of the EDS. The weaknesses included the relay-setpoint calibration program, the circuit-breaker testing procedures, the lack of a fuse-control program, the testing of all protective functions of the SUPS, and poor procedural control of battery testing.

## 5. ENGINEERING SUPPORT REVIEW

The team assessed the capability and performance of the licensee's engineering organizations. The team reviewed the composition, training and qualifications of each of the engineering groups. In addition, the team examined the interfaces between the technical disciplines internal to the engineering groups and between the engineering groups and the functional groups performing field modifications, surveillances, testing, and maintenance.

The team evaluated the control of vendor and industry information through a review of licensee procedures and referenced material. The team also reviewed a sampling of licensee event reports (LERs), condition identification (CI) reports, and vendor information notices to ascertain the adequacy of the licensee's root cause analyses and corrective actions.

### 5.1 Organization

The licensee had established a number of engineering organizations to support the operation of the Waterford 3 facility. The engineering and construction department contained five engineering groups (safety analysis, modification control, procurement programs, construction, and design) which provided the majority of the engineering support. In addition to the engineering and construction department, engineering support functions were also assigned to the operations and maintenance, the technical services, and the event analysis and reporting (EA&R) organizations of the plant operations department.

The team was informed that system and design engineering groups were both represented at the daily plant meetings. The licensee viewed this interaction as an opportunity to be proactive in support of anticipated needs.

During the course of interviews with various engineering group supervisors, the team was informed of a number of changes which had been, or were being implemented to improve the performance of the engineering support function. These changes were mainly intended to broaden and complement the experience levels of the engineering groups. The changes included cross-training between engineering groups and other organizational groups, and the employment of additional engineering personnel. The team noted that the changes and additions should improve the breadth of the engineering background and provide a better understanding of the engineering interface activities.

The team also had frequent contact and discussions with members of the various engineering groups, and reviewed numerous engineering documents. The team found the contacted engineers to be helpful and competent, but observed an apparent narrowness in the approach used to evaluate and resolve some problems (see paragraphs 2.6.3 and 3.1.4 above). The team observed numerous documentation errors which appeared to be careless mistakes or unsubstantiated assumptions (see the discussions in paragraphs 2.6.1 and 3.3 above).

## 5.2 Review of Condition Identification (CI) Reports

The team selected seven CIs, germane to the electrical distribution system, for detailed review. The team questioned the disposition and/or reporting of three of the selected CIs and was provided additional information. Following the review of the additional information, the team found the licensee's engineering effort to be adequate in the resolution of the selected CIs.

## 5.3 Self-Assessment and Training

As mentioned above, the team noted that the licensee was in the process of conducting some internal safety system functional inspections and was developing some design basis documents. While the team found these efforts to be commendable, numerous problems were identified during the review of the licensee's documentation of these efforts.

The team was informed that both the system and design engineering groups had programs for assessing engineer performance. A new personnel evaluation program was implemented in 1990, which included structured goals and objectives. The program also provided a method of feedback on yearly accomplishments and input for the next year's goals. Periodic presentations on systems or projects by the responsible engineer were being used to evaluate the presenter and for training of the management and engineering personnel in attendance.

The team noted that training programs for engineers were established and being implemented. The training department was in the process of developing and implementing a job task analysis training program. Design engineers had individual yearly training plans which were reviewed through a quarterly status report. System engineers were attending system courses. Over one-half of the system engineers and one-third of the design engineers had completed the licensee's 8-hour root-cause analysis course.

## 5.4 Control of Vendor and Industry Information

The team's review of Maintenance Procedure ME-004-175, "Static Uninteruptible Power Supply 3A-S and 3B-S," Revision 3, and Vendor Technical Manual 457000387 was discussed in paragraph 4.4, above. The team noted that the licensee had not included testing provisions recommended by the vendor technical manuals. This example (see paragraph 4.4) of the failure to establish, follow, and maintain procedures, violation (382/9023-02) was cited in paragraph 4.1.

During the review of Operating Procedure OP-6-001, "Plant Distribution (7KV, 4KV and SSD) Systems," Revision 4, the team noted that the biennial review required by UNT-001-001 "Procedure initiation, Review and approval; Change and Revision; and Deletion," Revision 13, had not been completed. The team noted the review period for the procedure was from 1988 through 1990 with a late date of October 28, 1990. This failure to complete the biennial procedure review was considered to be another example of the violation (382/9023-02) cited in paragraph 4.1.

The team reviewed Maintenance Procedure ME-004-035 "Station Battery Charger Setpoints Verification," Revision 6, and Vendor Technical Manual 457000349. The team noted that the licensee had not followed the technical manual recommendation for setting the shutdown device at least 15 percent above the equalize voltage setting. The maintenance procedure set the shutdown device at approximately 7.5 percent above the equalize voltage setting. The team asked the licensee why the vendor had made the recommendation and the justification for setting the shutdown device below the recommended minimum setting. The licensee informed the team that the lower setting had been used to protect other equipment from higher voltages but apparently the battery charger vendor had not been consulted to determine if there could be a problem with setting the shutdown device below the recommended value.

## 5.5 Conclusions

The team noted an apparent weakness in numerous engineering support function activities during the course of the inspection. The team observed that the engineering response appeared to be reactive to specific issues. Further, the response to some issues was frequently found to lack an evaluation of related and consequent considerations. For example, engineering failed to consult with the licensing department about previous Regulatory Guide 1.97 instrumentation commitments. As a result, procedures for shedding Regulatory Guide 1.97 instrumentation loads were developed without deference to that licensing commitment.

The team also noted that the documented engineering effort was frequently more narrow in scope than have been normally observed at other nuclear facilities.

## 6. OVERALL CONCLUSIONS

The team determined that the overall design of the electrical distribution system at the Waterford 3 facility was generally acceptable. The team found the design documents to be generally acceptable but noted numerous errors and nonconservative assumptions and calculations. The team considered the observed errors as a failure by the licensee to adequately review the design basis documents. The team remains concerned about the adequacy of the battery capacities and this issue has been identified as an inspector followup item.

The team considered the licensee's efforts to pursue self-assessment initiatives as a strength. Further, the plant and equipment appeared to be well maintained.

The team considered the engineering activities in support of the operation of the Waterford 3 facility to be marginally acceptable. While the team observed good informal communication and cooperation among the various engineering groups, the lack of designated responsibilities in some areas was considered to be an organizational weakness. The documented engineering efforts were frequently found to contain omissions of relevant considerations and in some instances, corrective actions were not as comprehensive as might be expected. The team did not, however, identify any immediate operability concerns.

## 7. EXIT INTERVIEW

The inspectors summarized the scope and findings of the inspection during the exit interview conducted on February 1, 1991, in the NRC Region IV office with the personnel identified in paragraph 1. Although some proprietary documents were reviewed by the inspectors, no proprietary documents were removed from the facility, and no proprietary information is contained in this report.

## ATTACHMENT

## INSPECTION FINDING INDEX

1. Apparent Violation (382/9023-01), Example A

FINDING TITLE: Failure to verify or check the adequacy of design (Paragraph 2.2.2 and Appendix A)

2. Apparent Violation (392/9023-01), Example B

FINDING TITLE: Failure to Verify or to Check Adequacy of a Design Calculation (Paragraph 2.6.2 and Appendix A)

3. Apparent Violation (382/9023-01), Example C

FINDING TITLE: Inadequate DC Voltage at Input to Inverters (Paragraph 2.6.2 and Appendix A)

4. Apparent Violation (382/9023-02), Example A

FINDING TITLE: Inadequate Degraded Grid Undervoltage Relay Setpoint Calibration Procedure (Paragraph 4.1 and Appendix A)

5. Apparent Violation (382/9023-02), Example B

FINDING TITLE: Inadequate Procedures for Testing Circuit Breakers (Paragraph 4.2 and Appendix A)

6. Apparent Violation (382/9023-02), Example C

FINDING TITLE: Failure to Establish Appropriate Procedures for Fuse Control (Paragraph 4.3 and Appendix A)

7. Apparent Violation (382/9023-002), Example D

FINDING TITLE: Inadequate Procedures for Testing SUPS (Paragraphs 4.4 and 5.4 and Appendix A)

8. Apparent Violation (382/9023-02), Example E

FINDING TITLE: Failure to Complete Biennial Procedure Review (Paragraph 5.4 and Appendix A)

9. Apparent Deviation (382/9023-03)

FINDING TITLE: Deviation from Licensee Commitment to RG 1.97 (Paragraph 2.6.3.2 and Appendix B)

10. Inspector Followup Item (382/9023-04)

FINDING TITLE: Station Grounding Grid Adequacy
(Paragraph 2.1.2)

11. Inspector Followup Item (382/9023-05)

FINDING TITLE: Review Calculations Concerning Replacement of Batteries 3A-S, 3B-S, and 3AB-S
(Paragraph 2.6.3.1)

12. Inspector Followup Item (382/9023-06)

FINDING TITLE: DC Short-Circuit Calculations
(Paragraph 2.6.3.3)

13. Inspector Followup Item (382/9023-07)

FINDING TITLE: Uncontrolled Chain Hoists
(Paragraph 4.6)

14. Inspector Followup Item (382/9023-08)

FINDING TITLE: Review Licensee's Activities to Correct Station Battery Electrolyte and EDG Mechanical System Inconsistencies.
(Paragraph 3.6)