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REGION I

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Licensee: GPU Nuclear Corporation
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Facility Name: Three Mile Island Nuclear Station, Unit 1

Inspection Conducted: November 19 through December 21, 1990

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Inspection Summary: Inspection on November 19 through December 21, 1990 Report No. 50-289/90-81)

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

Results: The team determined that the electrical distribution system's design had been adequately implemented. However, two violations were identified and several issues remain unresolved, pending appropriate corrective actions by the licensee. Areas of strength and weakness are identified in the executive summary and discussed in the report. The sections of the report which address the specific findings are identified in tabular form in the Executive Summary.

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EXECUTIVE SUMMARY

During the period between November 19 and December 21, 1990, a Nuclear Regulatory Commission (NRC) inspection team conducted an electrical distribution system functional inspection (EDSFI) at Three Mile Island, Unit 1, Nuclear Station (TMI-1) to determine if the electrical distribution system (EDS) was capable of performing its intended safety functions, as designed, installed and configured. A second objective of the inspection was the assessment of the licensee's engineering and technical support of the (EDS) activities. For these purposes, the team performed plant walkdowns and technical reviews of studies, calculations, and design drawings pertaining to the EDS, and conducted interviews of corporate and plant personnel.

Based upon the sample of design drawings, studies and calculations reviewed and equipment inspected, the team's conclusions were that the electrical distribution system at TMI is capable of performing its intended functions. In addition, the team concluded that the engineering and technical support staff, both at TMI and at the Corporate offices, in Parsippany, N.J., is adequate for the safe operation of the plant. The inspection also identified various strengths and weaknesses, as discussed in the paragraphs below.

The most notable strength identified by the team was the quality of engineering and technical support, as evidenced by the proper and timely dispositioning of material nonconformance reports (MNCRs) and licensee event reports (LERs), generally the team noted thorough investigation of root causes, and detailed engineering of modifications and design changes. Communications between engineering and other site organizations was considered good, as was the self assessment program. Maintenance of electrical distribution system equipment was found to be adequate with effective setpoint control and calibration of protective devices. The licensee initiated a systematic safety functional inspection (SSFI) of the electrical distribution system which identified the need to replace the two auxiliary transformers in order to correct the voltage regulation problems. This is indicative of an aggressive program to achieve a safer and more reliable plant.

The weaknesses identified by the team were primarily in the area of available documentation particularly in original design basis documents. Several of the team's findings were considered to be unresolved issues, pending further evaluation and corrective action by the licensee. Two deficiencies resulted in violations; the first relates to inadequate safety evaluations performed in conjunction with the installation of two maintenance cranes; the second relates to inadequate acceptance criteria for the testing of safety related batteries

Examples of inadequate or unavailable documents were found by the team in several areas of review. Most notable was the lack of documentation to confirm the seismic qualification and structural integrity of mechanical components and systems, such as the emergency diesel and support components and the gantry crane. Also unavailable was an emergency diesel generator load study addressing transient conditions, a voltage drop calculation for 120 Vac vital bus loads, and a heat load calculation for the containment penetrations.

Examples of inadequate documentation were found: (1) in the calculation for the auxiliary transformer loading, where the bases for old assumptions and data were not self evident; (2) in the DC voltage drop calculation, the results of which could not be verified; (3) in the AC systems short circuit current calculation, where the maximum grid voltage was not addressed; (4) in the DC System short circuit calculation, which did not consider maximum battery room temperature and limiting conditions for the battery charger and battery; and (5) in the calculation for static load of the emergency diesel generator, where some feeder cable losses and added loads resulting from the limiting mode of the battery charger and inverter were not included.

With respect to potential design deficiencies, the team was primarily concerned with the use of potentially underrated motors associated with the makeup pumps and with the interrupting capacity of certain breakers when the diesel generators are paralleled to the grid. Other design weaknesses included the lack of short circuit protection for the batteries, and the setpoint for the low pressure alarm associated with the emergency diesel generator starting air.

Inadequate controls were identified in conjunction with the fuse replacement program and with the use of transfer switches for swing (yellow) loads.

A summary of the team's findings is contained in the attached table. The table also identifies the sections of the report which address the specific issues.

SUMMARY OF INSPECTION FINDINGS

A. Violations

	Violations	Section	Number 50-309/
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2.	Inadequate Design Control	6.7	90-81-11

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2.	120 Vac Vital Bus Voltage Drop	3.4	90-81-02
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C. Weaknesses

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1.0 INTRODUCTION

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

In view of the above, the objectives of this inspection were to assess: (1) the capability of the electrical distribution system's power sources and equipment to adequately support the operation of TMI's safety related components and (2) the performance of the licensee's engineering and technical support in this area.

To achieve the first objective, the team reviewed calculations and design documents paying particular attention to those attributes which ensure that quality power is delivered to those systems and components that are relied upon to remain functional during and following a design basis event. The review covered portions of onsite and offsite power sources and included the 230 kV offsite power grid, station auxiliary transformers, 6.9 kV system, 4.16 kV Class 1E system, emergency diesel generators, 480 V Class 1E unit substations and motor control centers, station batteries, battery chargers, inverters, 250/125 Vdc Class 1E buses, and the 120 Vac Class 1E vital distribution system.

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

A physical examination of the EDS equipment verified its configuration and ratings and included original installations as well as equipment installed through modifications. In addition, the team reviewed maintenance, calibration and surveillance activities for selected EDS components.

The team's assessment of capabilities and performance of the licensee's engineering and technical support included organization and key staff, timeliness and adequacy of root-cause analysis for failures and recurring problems, and engineering involvement in design and operations.

In addition to the above, the team verified general conformance with General Design Criteria (GDC) 17 and 18 and appropriate criteria of Appendix B to 10 CFR Part 50. The team also reviewed portions of the plant's Technical Specifications, the Final Safety Analysis Report and appropriate safety evaluation reports to ensure that technical requirements and licensee's commitments were being met.

The details of specific areas reviewed, the team's findings and the applicable conclusions are described in Sections 2 through 6 of this report. Section 7 contains a summary of the conclusions, as well as the strengths and weaknesses identified.

2.0 ELECTRICAL SYSTEMS

Three Mile Island, Unit 1, generates electric power at 19 kV, which is fed through an isolated phase bus to the unit main transformer bank, where it is stepped up to the 230 kV transmission voltage and delivered to the substation. The substation design utilizes a breaker-and-a-half scheme and is comprised of four circuits, as follows:

- two full capacity Middletown junction circuits;
- one half capacity circuit to Jackson;
- one line to the 500 kV grid through a 230/500 kV autotransformer.

Power for plant start-up, operations, shutdown, and post-shutdown requirements is supplied through two full size auxiliary transformers connected to two different 230 kV buses. Reliability of offsite power is provided by the breaker-and-a-half switching arrangement, in the 230 kV substation and two full capacity buses which can be switched under normal or faulted conditions, without loss of external power.

The medium voltage distribution system consists of two-6.9 kV and five-4.16 kV buses. The two 6.9 kV buses provide power solely to the reactor coolant pump motors. During normal operation, each bus is fed from the associated auxiliary transformer. However, in the event of a source or transformer failure, the affected bus is powered through the other transformers by an automatic fast transfer. The 4.16 kV distribution system includes three balance of plant (BOP) buses and two redundant Class 1E buses, 1D and 1E, each receiving preferred power from the two auxiliary transformers. There are no automatic transfers associated with these buses. However, standby or emergency ac power supply is provided by two redundant 3000 kW (2000 hours) emergency diesel generator units.

The 480 V switchgear consists of nine load centers, five for BOP loads and four for Class 1E loads. Load centers 1P and 1R, in one division, and 1S and 1T, in the other, provide redundant Class 1E power to the 480 V electrical system. Tie breakers are provided to physically connect redundant load centers. However, adequate administrative controls exist to ensure circuit independence, during normal and emergency operating conditions. Class 1E motor control centers are arranged such that engineered safeguards (ES) channels, power systems, and redundant equipment are fed and controlled with no intentional cross connections. Selected loads are automatically tripped upon receipt of an ES signal. A simplified single line diagram of TMI-1 AC Electrical Distribution System is shown on Attachment 2.

The station Class 1E, dc system consists of 2 - 250 Vdc battery banks (3 wire bus) each feeding its respective main distribution panel. Each battery has 3 - 125 V, 150 A battery chargers connected to each of the main distribution panels. The main distribution panels feed various engineered safeguards distribution panels, balance of plant panels, emergency generator panels, substation distribution panels, and the station 120 Vac inverters.

The vital 120 Vac system consists of 5 - 15 kVA inverters normally fed from a Class 1E, 480 Vac bus with an auctioneering circuit to provide a "hot standby" dc supply to the inverters. The vital 120 Vac buses normally fed by the inverters with an optional supply from a regulated 120 Vac bus. Two panels, ATA and ATB, are supplied by static switches that derive power from either an inverter or a regulated power, without interruption.

3.0 ELECTRICAL DESIGN

To assess the adequacy of TMI's electrical design, the team reviewed a variety of documents related to the electrical distribution system. These documents addressed design calculations for ac and dc system loading, voltage regulation during normal and degraded conditions, voltage regulation during sequencing of engineered safeguards (ES) loads onto the preferred power supply and onto the emergency diesel generators (EDG), degraded voltage relay setpoints, short circuit and ground fault analysis, system and equipment overcurrent protection, and protection of the EDS from power surges. Particular attention was given to a sample load path, or "vertical slice" through the Class 1E distribution system. The team also reviewed procedures and guidelines governing the EDS design calculations, design control, and plant modifications; ac system voltages during degraded voltage conditions; and EDS single-line diagrams and wiring schematics.

Other design issues addressed by the team included: adequacy of the auxiliary transformers' kVA rating and load capability (kW) of the emergency diesel generators; load current capabilities of the 4160 V Class 1E buses, connected cables, and breakers; voltage drop in cables serving safety-related loads; and short circuit capabilities of circuit interrupting devices.

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

3.1 Electrical Distribution System Loading

To demonstrate the capacity of the station's auxiliary transformer the licensee presented informal, hand written, calculations, dated March 3, 1967, and titled, "Unit Auxiliary Transformer." The calculations included a number of assumptions without supporting information. Because of the age of the calculations, discussions with the licensee provided no further insight as to the origin of the assumptions and values used. However, further discussions with the licensee revealed that the required information could be extracted from the loads used in the Technical Data Report (TDR) No. 995, Revision 1, dated 2/21/90, "Voltage Drop Study on Degraded Grid Condition." The team reviewed the transformer loading under worst case conditions, i. e., with one auxiliary transformer and all ES loads running, and concluded that the auxiliary transformers are adequately sized to supply the required power to the connected loads. Although operation with one transformer is allowed, both auxiliary transformers are required for plant startup, when loads from reactor coolant pumps could be higher.

The team had no further questions regarding the adequacy of the auxiliary transformer capacity. However, the team noted that the actual review of the calculation was difficult, since data and computer generated results contained no explanatory notes. For instance, the computer run showed 61571 kVA as the projected power flow through the transformer. However, this figure did not represent the actual loading on the transformer, since the reactive volt-amperes lost by the transformer and supplied by the grid should not be included in the loading of the transformer. Appropriate notes would have facilitated understanding the significance of the specified transformer load.

3.2 Electrical Distribution System Voltage Regulation

To demonstrate the capability of the electrical distribution system to provide adequate voltage to Class 1E equipment, under worst case loading conditions, the licensee provided Technical Data Report, TDR No. 995, Revision 1, dated February 21, 1990, "Voltage Drop Study on Degraded Grid Condition." This study, performed by GPU in response to NRC generic letter 88-15, assumed the degraded grid condition to be 227 kV on the 230 kV system and the TMI-1 generator to be off line. In addition, for the worst case condition, the study considered operation with one auxiliary transformer, one set of ES buses (green train) fed from the transformer, and the ES signal actuation present (case 3b of TDR #995). To perform the required voltage drop calculations the study utilized the commercially available DAPPER program.

The team reviewed the study's acceptance criteria for both steady state and transient conditions and found them generally acceptable. However, the team noted that the study did not cover voltage drops at the motor terminals, during motor starting conditions. The licensee agreed, but stated that the deficiency was not a concern since the motors were capable of starting and accelerating, even during a significantly degraded voltage condition, such as during the 18 month load sequencing test performed on the emergency diesel generators. During such tests, the voltage drop at the emergency diesel generator terminals was recorded to be as high as 35%.

The review also revealed that the study had concluded that, during postulated degraded voltage conditions, i.e., 227 kV at the grid, the degraded voltage relays on the Class 1E 4160 V buses would not pick up, because the lowest calculated voltage at the bus would be only 3715 V, whereas the relays were set to pick up at 3595 V, with a 10 second delay. Since the situation would cause some of the ES motors to operate below the manufacturer's recommended limits, the study recommended resetting the degraded voltage relays at 3748 V with 10 seconds delay.

The licensee complied with the study's recommendation by issuing, on November 20, 1990, a Technical Specification Change Request, TSCR No. 203, in which it proposed setting the relays in question at 3760 V. In addition, the licensee prepared a justification for continued operation which adequately addressed the degraded voltage condition concerns.

For long term resolution of TMI's voltage fluctuations, the licensee initiated a Request for Project Authorization (RPA) to install new auxiliary transformers with automatic tap changers. This would maintain the voltage at the 480 V buses essentially constant during grid fluctuations.

3.3 <u>DC Voltage Drop Calculations</u>

The 250 Vdc voltage drop was addressed in calculation No. C1101-734-5350-004. Review of this document shows that the licensee's evaluation resulted in three recommendations.

The first, "Inverter low voltage operation", required addressing the voltage drop between the batteries and the downstream inverters. This was considered necessary because the voltage required at the inverters' input terminals is 105 Vdc, which is the same voltage for which the associated batteries are sized. The licensee agreed that the issue needed review and advised that an evaluation would be completed by May 31, 1991 (Licensee Letter No. C311-91-2003, dated January 15, 1991).

The second recommendation, "DC motors low voltage operation", suggested field testing of motor operated pumps and valves. This testing was considered necessary because no minimum voltage had been identified for these devices. Since, at stall, the voltage drops more than 30%, it is not immediately evident that the voltage at the devices will not drop below their respective design limits and it is not clear that the closing torque will be sufficient to seat the valves.

The third recommendation, "RC-RV2 Solenoid valve operation", suggested field testing of solenoid valves at various voltages. The recommendation was the result of a lower than design limit voltage calculated at the solenoid terminals, due to high inrush currents.

At the time of the inspection, the licensee had not taken any actions to resolve the three issues identified in the calculation. However, the team found that they had been placed in a tracking mechanism with completion scheduled by June 1991.

The team's review included verification of the computer results given in Section II of the calculation. However, these results could not be verified by hand calculations using the formulas and assumptions identified within the body of the document itself. Discussions with the licensee did not identify the reason for the difference between the computer and the manually obtained results.

The adequacy of the DC voltage regulation is unresolved pending completion of corrective actions and confirmation by the licensee of the correctness of the calculation method used (50-289/90-81-01).

3.4 Vital Bus Voltage Drop

The team inquired about available documents which described individual loads on vital bus circuits or which evaluated the acceptability of the voltage levels at the end devices, but no documents were available. The team expressed two concerns, one relating to the inverter loading and the other to the voltage drop itself.

Regarding the inverter loading, the team determined that the licensee had taken actual load readings at the inverter terminals. However, no assurances could be given that all of the loads were energized when the measurements were taken. With respect to the voltage drop, the licensee had performed calculations to confirm that the voltage at the end devices would not fall below 108 Vac. However, the criteria and assumptions used by the licensee for the verification were not clear. Also not clear was the accuracy of the results since, during the last two outages, corrective measures had been taken to increase the nominal inverter terminal output voltage.

The licensee assured that, on the basis of past experience, the inverters' design limits were not exceeded and that the voltage, at the end device terminals, was adequate. However, they agreed to address the team's concerns and perform the necessary analysis by June 1992 (Licensee's Letter No. C311-91-2003, dated January 15, 1991). This item is unresolved pending completion of the analysis and review by the NRC (50-289/90-81-02).

3.5 AC System Fault Analysis

To assess the adequacy of the interrupting and momentary fault current rating of the Class 1E distribution system equipment, the team reviewed Calculation No. G/C 2734, Revision 0, dated November 20, 1987, "Electrical System Studies, Short Circuit and Coordination Review, Technical Report."

The above study considered the most stringent conditions to be: (1) the 230 kV system operating with all lines in service; (2) the plant operating at full power; (3) one auxiliary transformer supplying power to all plant auxiliary loads; (4) a short circuit occurring during an ES condition. For the purpose of calculating the maximum short circuit available at the various buses, the study considered two particular cases: one with an emergency diesel generator undergoing a load test and in parallel with the system and the other without contribution from either generator.

The team reviewed the analysis and noted that, under the conditions stated for the first case, the available short circuit current exceeded the interrupting capability of the 6900 V and 4160 V circuit breakers. In response to the concerns expressed by the team on the matter, the licensee stated that their design basis did not include sizing of circuit breakers for this particular condition and that they considered a bolted fault, under the stated conditions, a low probability event. Following the inspection, on February 25, 1991, the licensee further clarified the conditions under which the short circuit capability of the breakers would be exceeded. In view of the clarifications provided, the team concurred that the short circuit, under stated conditions, would be a very low probability event. Therefore, it had no further questions.

For the second study case, the review of the analysis revealed that adequate margin existed between the interrupting capability of the breaker and the short circuit current available. The team, however, observed two areas of concern which could affect the results of the calculation:

1. The study did not consider the maximum grid voltage. In conjunction with this, the "1986 TMI 230 kV Grid Voltage Study" states that the grid voltage can reach or exceed 242 kV. In addition the justification for continued operation prepared by the licensee to address degraded grid voltage conditions, JCO No. PSC 90-001, states that "the TMI 230 kV substation voltage exceeded 242 kV at least 17 times between 1989 and 1990 with TMI on line and 16 times with TMI off the line."

2. The study assumed the transformers' tap position to be the central one (0%). However, according to the licensee and as verified by the team, the present tap setting of the auxiliary transformers is -2.5 %.

In response to the first concern, the licensee performed a voltage study, using the DAPPER program. This study showed that, on a per unit basis, the voltage at the Class 1E buses D & E, under postulated conditions, would be substantially lower than that used in the short circuit study. However, rough calculations performed by the team, using the newly calculated voltage, show that only a narrow margin existed between available short circuit current and interrupting capability of the 4.16 kV breakers. This margin would be further reduced if the transformer impedance associated with the tap setting of item 2 above, were used. In addition, Table 2 of Technical Data Report TDR# 995 indicated that the bus voltages obtained using the DAPPER program was slightly lower than those observed during the walkdown performed to confirm the results of the program. This voltage difference also affects the results of the study, in a non-conservative direction. The licensee concurred that the study needed to be upgraded to take into account the different tap setting and proposed a revision to be completed by October 31, 1993 (Letter No. C311-91-2003, dated January 15, 1991), indicating that the short circuit current contribution from the different tap setting would be minimal. However, the licensee disagreed with the team regarding the difference between the calculated and the measured voltages, stating that this difference was within expected tolerances. The team explained that, in consideration of the fact that only minimum margin had been calculated to exist, the impact of this difference could not be ignored without adequate justification. Following the inspection, on February 25, 1991, during a telephone discussion, the licensee agreed that the revised calculation would also address maximum grid voltage.

This item is unresolved pending completion of the analysis and review by the NRC (50-289/90-81-03).

3.6 DC System Fault Analysis

The team's review of the short circuit calculation for the 250 Vdc system, document No. 1101X-5350-053, revealed that the calculation did not consider maximum battery room temperature, the charger input at current limit, and battery voltage at equalization voltage (138 V).

Currently, the calculation establishes a maximum fault current of approximately 15,000 A. The team estimated that, if the three variables above were taken into consideration, the maximum fault current could increase to 17,500 A. Since the lowest rating of the downstream equipment, such as distribution panel buses and fuses, was determined to be about 20,000 A, the team concluded that the DC equipment was adequately designed for the available fault current.

3.7 EDG Load Sequencing Timers

The team reviewed the method for adding emergency loads to the bus, following a design basis accident, and determined that loads are added in five steps, at regular intervals of 5 seconds each. Accordingly, the motor of each major load must start, accelerate to rated speed, and stabilize within this design interval of 5 seconds. The same timing and sequence is used regardless of whether power is supplied from the preferred source or standby source. Independent Agastat timers, having a tolerance of +/- 10 % are used for each load group.

The team reviewed Surveillance Procedure No. 1303-11.10, 'Engineered Safeguards System Emergency Sequence and Power Transfer Test' as well as test results from the last five quarters and determined that the acceptance criteria for timer actuation had been set to be ± 1 second. The team observed that, in most cases, the actuation fell within the established tole[illegible] band. However, for a particular timer, these actuation (3 for each timer at each test sessio[illegible] were neither consistently higher nor consistently lower that the setpoint. Therefore, the time when the actuation would fall out of tolerance could not be predicted. As a consequence, no calibration of the timers was performed. In those cases where a timer was found to be out of tolerance, a resistor was changed.

Although the tolerance itself is not significant, its effect on the diesel generator loading is significant, since it could determine whether or not a motor would be able to accelerate and stabilize within the allotted time. Therefore, this tolerance should be appropriately addressed [illegible] transient analysis. This issue is further discussed in the following section.

[illegible] Diesel Generator Transient Loading

[illegible] uate the response of the diesel generator during loading, the team reviewed the results o[illegible] diesel generator load test performed in accordance with the licensee's Test Procedure [illegible]622/1, on September 5, 1981. The particular test was the only one for which a trace of t[illegible] pertinent electrical variables was available. This review showed that, when the first block of loads was added to the bus, he voltage at the generator terminals dipped to 2744 V which is approximately equivalent to a 34 % dip. Since this dip far exceeds the limit of 25 % recommended by the IEEE Std. 387 - 1977 and Regulatory Guide 1.9, the team asked the licensee if they had any acceptance criteria for voltage and frequency. The team's concern was that motors may not start and accelerate to rated speed within the allotted time, or that running motors may coast down and stall. The licensee responded that the only requirement for the load test was that all loads be on line and running within 30 seconds from the initiation of an ES signal. The team concurred that this requirement may be adequate to establish operability of the emerg[illegible]cy diesel generator. However, since it provides no information as to the diesel generator's performance, changes in system's capability may not be detected. Therefore, the team concluded that the lack of trending was a weakness in the testing of the diesel generator.

Evaluation of the [illegible] results revealed that the voltage at the generator's terminals recovered within approximately [illegible] seconds, following the addition of the first block of loads to the em[illegible]rgency bus. However, in consideration of the fact that: (1) the timers may be off by 1 second (see Section 3.7 above), with a minimum time of 4 seconds between the first two load blocks and 3 seconds between subsequent ones; (2) load tests are performed with pumps in the recirculation mode and, hence, at a lower horsepower demand; and (3) an unusually large voltage dip was observed; the team determined that no analysis existed to confirm that the accident mitigating pump motors would come to speed within the allowed time and perform their safety function, under accident conditions.

In response to the team's concern about the capability of the emergency diesel generator to perform its safety function, during an accident, when loads are higher than those used for the test, the licensee's Plant Review Group (PRG) performed an evaluation of the loading sequence (meeting No. 90-095 of December 18, 1990) and concluded that the operability of the emergency diesel generators was not in question. The primary basis for the PRG's conclusion was that the speed at which valves open prevents the pumps from operating at run-out conditions immediately upon application of power to the motors. Therefore, the generator's response, during accident conditions, was not expected to be different from that observed during the load test. However, the licensee agreed that a transient analysis was warranted and agreed to complete it by August 31, 1991 (Letter No. C311-91-2003, dated 1/15/91). This item is unresolved pending completion of the analysis and NRC review (50-289/90-81-04).

3.9 Emergency Diesel Generator Static Loading

The team reviewed licensee's Document No. 836, Revision 3, dated August 28, 1989, "Evaluation of Loading for the Emergency Diesel Generator and ES buses" to assess the capability of the emergency diesel generator to supply power to all the ES loads, during the worst conditions. The team reviewed the Class 1E tabulated loads and found that the study did not include losses in all the feeders and the additional loads resulting from the current limiting mode of the inverters and the battery chargers.

The licensee agreed to revise the subject document by December 31, 1991 (Letter C311-91-2003, dated 1/15/91). This item is unresolved pending completion of the analysis and NRC review (50-289/90-81-05).

3.10 EDG Parallel Operation

To meet the requirements of the Technical Specification Section 4.6.1a for testing, the emergency diesel generators are paralleled with the offsite power and operated in this mode for the required time. The team reviewed the generator's protection and determined that, under this particular mode of operation, the ES signal did not bypass the test signal and that no relays had been provided to protect the EDG from a sudden overload. Regarding this latter observation, the team's concern was that, during paralleling, in the event of a LOCA followed by a loss of offsite power, the degraded voltage relays on the bus would not sense loss of voltage from the preferred source and trip the necessary circuit breaker. As a result, the EDG would be subjected to a sudden overload which, dependent on its magnitude, could either damage the diesel generator or trip the diesel generator breaker.

In the latter case, restoration of power to the Class 1E bus would first require the local resetting of the protection relays. The resulting effect would be a temporary station blackout, if the event were to occur when one of the diesel generators is out for maintenance.

The team recognized the low probability of occurrence of a LOCA during the parallel operation of the diesel generator with the system. Nonetheless, it considered both conditions to be a weakness in the design.

3.11 Selection and Sizing of Power Cables

In order to determine if feeder cables were properly selected, the team reviewed Engineering Standard ES-023, Revision 0, titled "Selection and sizing of power, lighting and control cables." The team found the document to be comprehensive, technically accurate, and well prepared.

The team found no examples of improperly sized cables.

3.12 Adequacy of the Makeup Pump Motors

Comparison of nameplate information with data used to perform load calculations revealed that the makeup pump motors are rated 700 Hp with a 1.0 service factor, whereas the maximum horsepower required for this pump, during LOCA conditions, is approximately 837 Hp. In response to the team's question regarding adequacy of the motors to provide the required horsepower, the licensee presented a letter from the manufacturer, dated February 27, 1985. This letter stated that, based upon the calculations performed, the motors were capable of providing 837 hp for 18 hours with a temperature rise of less than 80°C, calculated by the resistance method. The temperature rise is within the allowable limits, per NEMA standards. However, the licensee could not provide any supporting analysis from the manufacturer to backup the statement in the letter or to ascertain whether the operating temperature of the motor, under accident conditions, would exceed its design temperature limits. Following the inspection, on January 9, 1991, the licensee indicated that an appropriate calculation would be completed by July 31, 1991. This date was confirmed in the licensee's letter No. C311-91-2003.

This item is unresolved pending completion of the calculation and verification by the NRC (50-289/90-81-06).

The team also reviewed the adequacy of feeder cables and protective relays for the makeup pump motors. Both were found to be satisfactory.

3.13 Coordination and Ground Fault

To ensure that appropriate coordination existed between protective devices, the team reviewed study No. G/C 2734, Sections 1 through 8 and Appendices No. 10.1, 10.2 and 10.3. The review concentrated primarily on the devices within the selected load path. Except for an apparent inadequate coordination between a feeder breaker (150A) on vital bus VBA and a load breaker on non vital bus ATA, the team found the protective devices to be properly coordinated. The same study also showed that adequate ground fault protection had been provided for the station EDS.

Regarding the miscoordination between the two breakers on buses VBA and ATA, the team was concerned that a fault affecting a non safety device could impair safety equipment. However, discussions with the licensee revealed that the condition did not also apply to the redundant vital bus, VBB. The team concurred that the particular application appeared to present no safety concerns and had no further questions.

3.14 Battery Short Circuit P ection

The team's review of the DC system revealed that no fuse or circuit breaker was provided to protect the battery and the distribution bus from short circuit currents.

The concern was that a catastrophic failure of a battery could occur, if a downstream fault was not appropriately cleared. According to the battery manufacturer's literature, if a circuit protective device does not quickly open to clear the fault, a battery terminal or connection will generally assume the role of a fuse, sometimes with destructive consequences for the battery.

Discussions with the licensee indicated that the lack of fault protection was due to the design philosophy existing at the time of the original design. Upon evaluation, the licensee concluded, that because of the physical independence between the two battery systems, a modification was not necessary.

The team recognized the low probability of a fault in the DC bus area and that physical independence existed between redundant batteries. Nonetheless, the team considered the condition to be a design weakness.

Environmental effects resulting from a catastrophic failure of the battery were considered to be minimal, as discussed in Section 4.7, below.

3.15 Penetration Heat Load Calculation

The team inquired about heat load calculations for containment electric penetrations, but determined that none were available. The team determined that the original penetration design had been verified by the manufacturer and that no new loads had been added by the licensee. Therefore, the lack of documentation did not compromise the safety of the plant.

The licensee agreed that a calculation would be prepared to document the expected heat loads by December 1991, as per Letter No. C311-91-2003, dated January 15, 1991). Limiting conditions and methods for calculating heat loads were originally provided by the manufacturer. This item is unresolved pending completion of the calculation and review by the NRC (50-289/90-81-07).

3.16 Conclusions

Based on the inspection sample, the team identified no operability problems, and concluded that the design of the EDS system was generally adequate. However, the team did find some areas of concern which require further evaluation and added attention from the licensee.

Significant areas of concern identified by the team were: (1) short circuit current available while operating with one auxiliary transformer, especially if the associated diesel generator is operating in parallel with the offsite power; (2) diesel generators' response during sequencing of emergency loads; (3) horsepower rating of the makeup pumps; (4) voltage available at end devices, particularly for the low voltage circuits (125/250 Vdc and 120 Vac); and (5) lack of supporting calculations, as in the case of the containment penetration heat loads.

The licensee support for this portion of the EDSFI from the corporate office and the site was adequate. Licensee personnel were considered knowledgeable and competent.

4.0 MECHANICAL SYSTEMS

To determine the ability of mechanical systems to support the emergency diesel generators (EDGs) during postulated design basis accidents, the team reviewed sample documentation and conducted walkdowns of fuel oil storage and transfer, lubricating oil, starting air, and diesel heating and cooling equipment. The team reviewed equipment associated with the heating, ventilation and air conditioning (HVAC) of the diesel generator building, battery rooms, essential switchgear rooms, and selected EDG and HVAC design modifications. The team also reviewed the translation of various mechanical loads (selected pumps) to electrical loads for input into design basis calculations.

4.1 Power Demands For Major Loads

The team reviewed the power demands for the major pumps motors powered by the EDGs, following a loss of offsite power, during LOCA conditions. The team determined that the translation of mechanical loads to electrical loads was generally acceptable. However the team noted that the maximum required horse power for the make-up pump was approximately 837 hp, whereas the rated horse power for the pump motor was 700 hp. This issue is addressed in details in Section 3.12, above.

4.2 Gantry Cranes In Diesel Generators Building

The team reviewed Engineering Evaluation Request EER 87-049-M, Revision 3, dated April 30, 1987 regarding the installation of two large gantry cranes in the diesel generator building. The gantry cranes, one for each diesel generator, were installed, on the floor and above the diesel engine; the frames were held in place by steel cables clamped to anchors in the concrete wall and floor. The installation itself had been performed using maintenance procedures No. 1410-Y-57 and 1401-18.

The team determined that no seismic analysis or testing had been performed to verify the integrity of the gantry cranes, during a design basis earthquake and to ensure that no damage would occur to the Class 1E equipment in the area. This issue is further discussed in Section 6.7, below.

4.3 EDG Starting Air Receiver Low Pressure Alarm

According to Operating Procedure No. 1107-3, Revision 56, dated November 5, 1990, Table 3-1, the required setpoint for emergency diesel generator low starting air pressure alarm is 150 $\pm$ 5 psig. However, review of test procedure TP 401/1, "Diesel Generator Start-up Test", dated August 22, 1973, indicated that no test was conducted to determine whether the diesel generator would be capable of starting and ready to accept its loads, within 10 seconds, with 150 psig starting air pressure available. The ability of the diesel generators to accept load in 10 seconds is required by Section 4.6.1 of TMI's Technical Specification

Discussions with the licensee revealed that the starting air pressure was checked every shift and recorded once each day and that necessary actions would be taken to correct the problem, if the pressure were found to have fallen below 225 psig. The applicable operating procedure confirmed the licensee's statement. However, to ensure adequacy of the low pressure alarm setpoint, the licensee initiated an engineering evaluation request, EER 90-1341, and proposed to raise the setpoint to 185 $\pm$ 5 psig. This setpoint is within the range of air pressure used by the licensee for the diesel generator start test.

The team had no further concerns in this area.

4.4 Fuel Oil Storage And Transfer System

Fuel Oil Day Tank Vent

The team noted that the vent line for the train "A" diesel generator's fuel oil day tank extended approximately three feet outside the diesel generator building. However, the line and the associated flame arrestor were not protected from tornado generated missiles. The team was concerned that, if the vent line containing the flame arrestor was sheared off, an external fire could spread to the day tank, or that water could enter the fuel system.

The licensee reviewed the vent line's design and stated that an outside fire would not spread to the day tank, via the vent line, since the size, length and orientation of the pipe would not provide adequate oxygen to support combustion in the tank. The licensee also analyzed the amount of rain water which could enter the day tank as well as the amount of unusable fuel at the bottom of the tank, and concluded that the day tank fuel would not be compromised.

The team had no further concerns in this area.

Fuel Oil Day Tank Capacity

According to the Final Safety Report (FSAR), Section 8.2.3.1, the amount of fuel stored in the day tank was sufficient to support engine operation for approximately three hours at full load. Since calculations performed by the team indicated that the usable portion of fuel in the tank would last for about two hours, the team inquired about the basis for the statement, but determined that no backup calculation was available. Further discussions with the licensee revealed that no specific requirements existed for sizing the day tank and that the specified three hours were based upon a rough estimate of the entire tank volume, without consideration of pipe locations. The licensee also pointed out that operability of the diesel was based upon fuel available in the storage tank (per Technical Specification) from which fuel is pumped in the day tank as soon as the diesel is started.

The licensee agreed to clarify the FSAR statement and to reflect the correct value at the next update.

4.5 Diesel Generator Cooling

The jacket water and lubricating oil of the diesel generators are cooled by air through radiators. The team reviewed the manufacturer's requirements for fan angle and coolant and determined that no coolant changes or fan angle adjustments were being made for summer/winter cooling. To ensure that the fan angle used by the licensee met the temperature requirements, the team reviewed the records of the coolant outlet temperature in

1989 and 1990 and noted that the temperature (152° to 171°F) was within the manufacturer's specified maximum values of 180°F. The records were evaluated against ambient conditions and, on the basis of these, the diesel's cooling system performance was considered to be adequate.

4.6 Diesel Generator Lube Oil Sludge Buildup

In the past, the licensee had experienced some problems with sludge buildup in the fan drive gear boxes. To limit potential failures of the diesel generators' fan drive, the licensee's corrective actions consisted of a revision to the gear box inspection procedure and the use of synthetic oil in the gear box.

The team reviewed the results of the annual inspection conducted in October 1990, and noted that no sludge was present in the gear box, in the gear drive oil pump strainer, or in the gear drive oil pump's suction check valve. Therefore, the sludge buildup problem appeared to be under control.

4.7 Control Building HVAC

Battery Room Exhaust

The team reviewed the control building ventilation system and noted that the exhaust air from the battery rooms, rather than being discharged to the outside atmosphere, was mixed with the exhaust from other rooms in the control building. Since the hydrogen generated in the battery room was not exhausted to the atmosphere, the team was concerned that it may build up in the upper portion of the battery room and that its concentration may reach the explosive limit. In addition, the team was concerned that, since the batteries were not protected from short circuit, a catastrophic failure could result in the release of a substantial amount of sulfuric acid vapor to the control building atmosphere.

The licensee calculated the concentration of hydrogen in the battery room and conducted a test to demonstrate that there was no build up of hydrogen in the room. The licensee also addressed the effect of a battery failure resulting in release of sulfuric acid and concluded that the toxicity limit would not be reached either in the battery room or in the control room.

The team had no further concerns in this area.

Battery Room Temperature Control

The team evaluated control of the battery room temperature and determined, from data sheets 1301-4.6, that the recorded temperature in the year 1990 was as high as 81°F. Regarding the potential impact of high temperatures on the battery, the licensee stated that the battery capacity would not be adversely affected, up to the maximum design room temperature of 96°F. Although the team concurred with the licensee's statement regarding effects on capacity, the team noted that high temperatures directly impact service life. However, it concurred that a drastic reduction of the service life would be detectable during regularly scheduled discharge tests.

Regarding control of the minimum temperature, the licensee stated that the battery was equipped with a thermostat which energizes a duct heater when the ambient temperature drops below 72°F. The licensee stated that the battery electrolyte temperature was checked on a weekly basis and that the electrical maintenance foreman would be notified, if the electrolyte's temperature was found to have dropped below 70°F.

The team had no further questions in this area.

4.8 Seismic Qualification

To assess the capability of mechanical equipment to perform its safety function, during and following a design basis earthquake, the team requested the licensee to provide seismic qualification documents for the diesel generator and auxiliary systems and components. The team determined that these documents were not available. Subsequent discussions with the licensee revealed that the diesel manufacturer, at the time of the original purchase, had furnished documents which addressed the seismic qualification of the equipment supplied. However, those documents, not part of the document package turned over, were apparently discarded, in error, by the Architect Engineer (AE).

The team requested available documents to show the adequacy of structural supports for some Class I piping and non safety related equipment near or above safety related components. In this case, the licensee responded that no documents were currently available, but that the piping and components in question had been designed and installed by the AE, in accordance with the standards and requirements in effect at the time of the licensing of the plant. Regarding the seismic adequacy of the equipment in question, the licensee indicated that it would be verified as part of the Seismic Qualification Utility Group program (Unresolved Safety Issue A-46) when the group's recommendations were approved. The licensee also indicated that the review would include portions of piping associated with the equipment and structural integrity of non safety related component in the vicinity of the equipment.

When completed, the results of TMI's review will be evaluated by the NRC in light of the approved criteria.

4.9 Conclusions

The teams review of mechanical components associated with the diesel generator and support systems identified no operability concerns. However, the lack of support documents in the area of seismic qualification and structural analysis was considered to be a weakness.

5.0 EDS EQUIPMENT

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

5.1 Equipment Walkdowns

The team inspected various areas of the plant to review the as-built configuration of the installed equipment. Areas inspected included the diesel generator, switchgear, battery, and electrical panel rooms. Nameplate data for transformers, breakers, protective relays and pump motors were recorded. This information was collected to verify the completeness and accurateness of system calculations and to compare it to applicable design drawings.

The inspected equipment was found to be installed in accordance with design drawings with the following two exceptions:

Fuse Control

The direct current (dc) electrical coordination study is based upon the use of Gould-Shawmut fuses. However, the team found that fuses of different types were installed in two of the dc distribution panels. In particular, the team observed that fuses manufactured by Gould-Shawmut, Bussman, and Littlefuse were installed in dc panel 1A and that dc panel 1E contained a circuit with a Gould-Shawmut fuse on one pole and a Bussman fuse on the other. These discrepancies can result in inadequate circuit coordination and protection.

Guidance for replacement of fuses is provided in Procedure 1420-Y-13, "Troubleshoot and Repair of Control, Indication, Lighting, and Power Circuits". The procedure requires that blown fuses be replaced with identical fuses. However, the required fuse data is not always retrievable from the fuses, themselves, and is not always available from system drawings, particularly for fuses specified in the original design. In addition, no administrative controls exist to record fuse changes and to ensure that the changes are correct. Therefore, the team was not able to determine whether the incorrect type fuses identified were part of the original installation or the result of an improper application of the procedure requirements. Unless an effort is made to ensure that adequate administrative controls are established and that all fuses are identified by type, size, and rating on applicable drawings, there is no assurance that the replacement fuses will always provide the necessary circuit protection.

The licensee agreed to correct this deficiency and revise applicable procedures and drawings, where necessary, by December 31, 1991, as per letter No. C311-91-2003, dated 1/15/91. This item is unresolved pending verifying proper fusing and establishing configuration controls (50-289/90-81-08).

Circuit Breaker

Field verification of Class 1E, 120 Vac, Vital bus panel VBB revealed that one of the circuit breakers was rated 20A, in lieu of 30A, as indicated on applicable design drawing. The discrepancy was brought to the attention of the licensee who initiated the necessary investigation. Preliminary results indicated that the discrepancy was due to a drawing error rather than a wrong size breaker. Therefore, the team had no further questions.

5.2 Equipment Maintenance and Testing

The team reviewed various maintenance and testing procedures for such equipment as diesel generator, switchgear, circuit breakers, thermal overload devices, batteries and battery chargers, inverters, and protective relays. The team also reviewed the controls established to control instrument setpoints during the calibration and testing process. The team's observations are described below.

125/250 Vdc Battery System

Battery 'A' (250 Vdc) is made up of a "Yellow" 125 Vdc bank and a "Red" 125 Vdc bank. In accordance with the battery sizing calculation No. C-1101-734-5350-003, Revision 1, "TMI-1 Station Battery 'A' Capacity Calculation," the "Yellow" and "Red" batteries must each be replaced when they reach 80 and 87 percent of their rated capacity, respectively. Therefore, individual battery discharge tests are required to establish the end of their individual service lives. The team's review of procedure 1303-11.11, "Station Storage Battery Load Test", indicated that the two 125 Vdc batteries were tested in series. In addition, the procedure specified an acceptance criteria of 83 percent. Neither the method nor the acceptance criteria were considered adequate in that, when the 'A' battery reaches 83 percent, the "Red" bank is no longer able to carry its design load. For this, an 87 percent of rated capacity is required. Failure to establish the appropriate acceptance criteria for the testing of the 'A' battery is considered a violation of 10 CFR 50, Appendix B, Criterion XI (50-289/90-81-09).

The licensee indicated that the subject procedure would be revised to reflect the bounding 87 percent capacity requirement. A review of the most recent test results indicated that sufficient capacity is available to enable both banks to carry the design loads.

Protective Device Setpoint Control and Calibration

Procedure 1056, "Control and Setting of Regulatory Required/Nuclear Safety Related System Protective Devices At TMI" describes the method for the preparation, transmittal, documentation, implementation and field testing of protective devices to ensure they are properly coordinated and that they provide the necessary protection. Device settings are controlled through the issuance of Relay Setting Notices (RSN) as determined by the Met-Ed Relay Engineering Department. Testing and calibration of protective devices are accomplished through specific procedures.

The team reviewed site procedures for various protective instruments and concluded that they contained appropriate acceptance criteria, as specified in applicable RSNs. The team also reviewed completed calibration and test documents of several protective devices. This review included diesel generator protective relays, undervoltage and degraded grid relays, and overcurrent relays. In addition, the team verified that the as-found settings identified during the plant walkdown were in conformance with the RSNs and completed test results.

Through discussions with GPU staff, the team observed that there was no formal program established for the evaluation and trending of instrument drift. Trending of instrument drift is desirable since it can provide information as to the reliability of the instrument set point, during the time interval between calibration checks.

The team identified no protective relays or other devices outside the allowable values. In addition, the team determined that the relays specified in the facility's Technical Specifications are evaluated and trended.

Circuit Breaker Testing

The team evaluated the licensee's program for testing Class 1E circuit breakers. For this purpose, the team reviewed several procedures addressing the inspection and testing of Molded Case, 480 V, and 4160 V Circuit Breakers.

The team concluded that the above procedures contained adequate guidelines and acceptance criteria to properly test circuit breakers. However, the team did note that procedure E-62, which is used in the testing of molded case circuit breakers, only addressed testing of the thermal element, even though the breakers are equipped with an instantaneous magnetic trip element as well as the thermal element. Discussions with the licensee indicated that testing of the thermal element only was sufficient to establish proper operation of the circuit breaker within the selected time band.

Selected test results reviewed by the team indicated that the circuit breakers were operating within the allowable tolerance limits.

Other Electrical Equipment

The team reviewed test procedures for other Class 1E equipment, such as battery chargers, inverters, and alarm relays. The procedures reviewed were determined to be technically adequate with applicable acceptance criteria.

5.3 Circuit Independence

The Class 1E portion of the electrical system consists of two redundant and physically independent electrical divisions color-coded red and green, respectively. A third division, color-coded yellow, is used to power certain loads from either one of the two redundant divisions, by means of transfer equipment, such as dual breaker arrangements and transfer switches. The team's review of applicable design drawings and cable routings, revealed the possibility exists for two swing loads to be powered by two different divisions. In this case, cables associated with redundant divisions would be routed through the same cable tray or conduit. For example, pump NS-P-1B and motor control center 1C-ESV-MCC can be powered from either the red or the green division through two different transfer switches. Whenever pump NS-P-1B is powered from the green division and the MCC is powered from the red division, or vice versa, the circuit independence would be compromised, since the associated "yellow" (swing loads) cables are routed through the same raceway. Presently no controls exist to power all transfer switches from the same division, at the same time, to ensure that the required circuit independence is maintained in conjunction with the yellow train as well as the other divisions. The above described condition is further complicated by the fact that certain switches are equipped with an automatic transfer. In this case, a single electrical fault could result in a transient on two divisions and would require two breaker trips to be cleared. The licensee indicated that, during safety injection conditions, automatic transfers are blocked. However, the licensee still needs to address the effects of resulting transients on redundant divisions and the capability of equipment and cables to withstand fault currents, during normal operating conditions.

This issue is unresolved, pending further review of the licensee's corrective actions to ensure that electrical system independence is maintained and that redundant divisions are not affected by single failures. The study is scheduled for completion by July 1991, as per licensee's letter No. C311-91-2003, dated 1/15/91. (50-289/90-81-10)

5.4 Conclusions

Based upon the sample of equipment and documentation reviewed, the team concluded that the licensee had established adequate configuration controls for most electrical equipment. In addition, the team determined that, in general, adequate criteria had been established for surveillance testing of the EDS equipment. Maintenance and test procedures were found to be acceptable and technically adequate. Similarly, the test and calibration records reviewed showed that the selected devices were operating within the applicable acceptance range.

The team found areas of concern, nonetheless, particularly in the areas of fuse control and circuit independence. In addition, the team identified one case where inadequate acceptance criteria had been established for the testing of the Class 1E 'A' battery.

6.0 ENGINEERING AND TECHNICAL SUPPORT

The team assessed the capability and performance of the licensee's organization to provide engineering and technical support by examining the interfaces between the technical disciplines internal to the engineering organization and the interfaces between the engineering organization and the technical support groups responsible for plant operations.

The team also reviewed a sampling of the licensee's Potential Safety Concerns (PSCs) reports, Material Nonconformance Reports (MNCRs), Licensee Event Reports (LERs), major, mini and temporary modification programs, training, quality assurance (QA) audits, root-cause investigation and corrective action programs, and self assessment programs.

6.1 Organization and Key Staff

Engineering and technical support for the TMI-1 station is provided by the Technical Functions Division of the corporate staff at Parsippany, New Jersey, the corporate Resident Engineering group at the site, and the site Plant Engineering group. Corporate engineering support for the electrical distribution system area is provided by the plant systems group and the engineering project group within the Technical Functions Division. These engineering groups, in general, handle al[illegible]ineering and design, in-house. Engineering consultants are used to supplement the in-house capabilities, on an as needed basis. The site Plant Engineering group is responsible for providing site engineering support to plant operations, maintenance and design support and coordination of technical functions input and recommendations. The electrical and I&C group, within the Plant Engineering group, is responsible for the proper functioning of the electrical distribution system. The licensee has utilized a system engineer approach to resolve technical issues in the plant. An individual systems engineer is considered the station's expert for his assigned systems or subject area.

The team concluded that the engineering positions are adequately staffed with knowledgeable personnel.

6.2 Root Cause Analysis and Corrective Action Programs

The team reviewed several Licensee Event Reports (LERs), Potential Safety Concerns (PSCs), Material Nonconformance Reports (MNCRs), trending programs and root cause investigation programs to assess the effectiveness of the licensee's root cause analysis and corrective action program.

The team reviewed MNCRs and the receipt deficiency notice program in accordance with procedure 1000-ADM-7215.01. The evaluations and dispositions of all MNCRs reviewed were technically correct and demonstrated a good understanding of the applicable procedures and requirements. In addition, appropriate evaluations were made for operability and reportability.

Several PSC reports, in accordance with procedure 1000-ADM-7330.01, were reviewed by the team to determine whether the safety concerns were properly identified and corrected. In all cases, the licensee promptly identified potential problems, made accurate operability and reportability evaluations, and performed necessary corrective actions.

The team evaluated selected LERs to assess the adequacy of the engineering organization involvement in NRC reporting requirements in accordance with 10 CFR Parts 20, 21, 50.72, 50.73, and 50.36. The selected LERs were evaluated in accordance with licensee procedure AP-1044. In all cases, the team determined that the reports had been made in a timely manner and that the corrective actions were thorough and complete.

The team reviewed the licensee's procedure AP-1407 "Root Cause Investigation" to determine whether the licensee had taken proper corrective actions for the multiple close spring charging and inadvertent breaker closing problems experienced with the 4.16 KV Westinghouse breaker. The team's evaluation revealed that the licensee had taken immediate actions by replacing the faulty breakers with spare breakers. In addition, failure information was reported through the NPRDS system and caution statements were added in procedure AP-1002 to warn operators about these problems. Root cause investigations were also performed. The team concluded that the licensee has a good systematic program for determining root causes of the problems identified in the plant.

The licensee's trending program was reviewed to verify whether it addressed performance trending of all components in the plant. The team found that the Plant Material Department performs trending of maintenance items, in accordance with maintenance procedure 1407-3. This trending addresses failures and out-of-tolerance conditions of particular components. However, the team determined that the licensee had no trending program to track the performance or drift of EDS components such as relays, timers, and instruments. Discussions with the licensee indicated that they are planning to enhance the existing program and use the GMS2 computer system. This would allow all components' data to be available for future trending. The team concluded that the lack of a trending program to monitor the performance of an EDS component is a weakness in their preventive maintenance program.

The team reviewed the licensee's actions for the 17 recommendations made by Gilbert Commonwealth in its electrical distribution study and determined that the licensee had implemented most of the recommendations. Not implemented, at the time of the inspection, were the corrective actions to address the inadequate interrupting rating of nine non safety related breakers and to change certain relay settings to improve the existing coordination. Regarding the circuit breakers, the team noted that the licensee's conclusions were inaccurate in that no bases existed to demonstrate the ability of a breaker, that is rated 22000 A for 30 cycles, to withstand more than 24000 A for 11 cycles. In addition, adequate coordination with the upstream breaker does not prevent damage to the affected breaker since the fault clearing time of the upstream breaker is longer. However, the team did recognize that the recommendation applied to non safety related breakers. Regarding the relay setting changes, the licensee's evaluation indicated that no immediate relay coordination concern existed. A Technical Functions Work Request, No. BT 5831, had been generated to resolve this recommendation. The team's review of the short circuit and coordination studies for Class 1E equipment is discussed in Section 3.0, above.

6.3 Self Assessment Programs

The team reviewed the licensee's self assessment programs to assure that safety problem areas are identified and corrected. The team noted that the licensee had performed safety system functional inspections for three systems including the emergency electrical power distribution systems. The team reviewed the report related to the EDS, TDR 992, and found it to be comprehensive and appropriate in identifying programmatic problems in the particular area. The team considered the licensee's efforts to be commendable, but was concerned about the closure of some of the licensee's inspection findings. For example, one item regarding the lack of a 50.59 evaluation for a screen house heater modification was closed without performing an appropriate safety evaluation. This issue is further discussed in section 6.7.

Another self assessment program reviewed was the licensee's potential safety concerns program which identifies and then resolves safety issues, after adequate engineering evaluation and approval by the plant review group. Two potential safety concerns regarding degraded grid voltage set points and DC fuse ratings were identified by the licensee during their inspection. Justifications for continued operation are in place for cycles 8 and 9 and a Technical Specification amendment request was submitted to revise the existing undervoltage setpoint.

The quality assurance (QA) area was also reviewed by the team to evaluate the involvement of QA personnel in assessing the quality of engineering services. Both corporate and on site QA support staff are responsible for engineering audits which are conducted biannually in each area. The QA audits in the design control, engineering administration, operating experience, contractor design controls, engineering technical reviews and a TMI-1 mini modification program were reviewed during this inspection. Also reviewed were QA's annual assessment report of various licensee activities. The team determined that the findings and observations identified in the above audits were resolved in a timely manner. Therefore, it concluded that QA audits and QA involvement in monitoring engineering effectiveness are adequate.

6.4 Technical Staff Training

The licensee's training program was reviewed to evaluate the adequacy of training given to the corporate and plant engineering support personnel. The team discussed the program with the training supervisor and reviewed the training procedures and records. The team noted that 50.59 safety evaluation training is provided only to independent reviewers and to responsible technical reviewers for both corporate and on site engineers. Remaining engineers are trained only on an as needed basis, depending on each department manager's recommendations. The licensee explained that all design modifications are reviewed by independent/qualified technical reviewers and that this process ensures adequate review in this area. The team also noted that the licensee engineers actively participate in industry groups and programs, regularly contact industry partners, and are aware of the technical issues. The team concluded that the technical staff does receive the training required for performing engineering and design functions and for providing technical support for the plant's operational activities.

6.5 Temporary Modification Program

Temporary modifications are administered and controlled by procedure AP 1013. This procedure identifies the controls for use of bypass features on safety related equipment and for temporary modifications of systems that have operational or safety significance. The team's evaluation of selected temporary modifications revealed that they contained proper review and approval by the Operations Department and appropriate safety evaluations/review are performed in accordance with 10 CFR 50.59 requirements. The team noted that the number of open temporary modifications are low and that the Plant Engineering group oversees the modifications program. The open temporary modifications are reviewed periodically and a log is kept in the control room for tracking. The team reviewed this log and interviewed control room supervisors and determined that the licensee has a good program for controlling temporary modifications and bypasses in the plant.

6.6 Engineering Support/Interface

The team reviewed the involvement and effectiveness of the engineering staff to support design functions, operations, maintenance and other organizations, at the site. The team observed that adequate support to the station was provided. The team discussed with the licensee the tracking mechanism for controlling or assigning priorities for engineering action items and modification requests but determined that no priority list was available during the inspection. A review of the open modifications indicated that there are 137 modifications to be processed through cycle 11R. The interface between station and engineering personnel at TMI-1 was found to be effective, as evidenced by the presence of plant engineering and corporate staff, at the site, to support the engineering/technical needs of the plant. This indicates a close working relationship between the engineering and operations personnel. In order to improve communications between the engineering staff and the support organizations, the licensee has established various meetings, during which engineering, maintenance and operations action items are discussed. The active participation of management representatives from different organizations for these meetings is indicative that effective communications exist between engineering and plant organizations.

6.7 Design changes and modifications

The team reviewed this area to ascertain that design changes and modifications were performed in conformance with the requirements of the Technical Specifications, 10 CFR, FSAR and applicable procedures.

The GPUN's modification process is categorized into mini-mods and major-mods. The mini-mods, which are projects limited by a specified cost, are handled by both corporate and plant engineering groups. The major-mods are those modifications which exceed the specified value and are performed by the corporate engineering group, at Parsippany, New Jersey. Design and corrective changes performed by Plant Engineering are done in accordance with Procedure AP-1021; the modifications performed by the Technical Functions Division are done in accordance with Procedure EMP-002. The nuclear safety/environmental input determinations and evaluations are performed in accordance with procedure EP-016.

The mini-mods and major-mods reviewed were found to be well organized, complete and in accordance with the applicable procedures. Materials and equipment were identified properly and were suitable for the application. The applicable design inputs were correctly incorporated into the designs. The safety evaluation reviews were descriptive and supported conclusions. Design drawings were updated and training was completed for installed work packages. However, the team noted that design changes performed, at TMI-1, through other than the mini-mod/major-mod process, appeared to be weak. For instance, the licensee replaced a 25 kW intake screen and pump house heater (AH-C-20 D) with a 15 kW heater, to address a cable ampacity concern identified in the licensee's Appendix R study. Originally, a recommendation had been made by engineering to lock open the breaker until either the cable or the breaker was replaced. However, when the corrective modification, CM 0863, was performed to change the heater size, no engineering evaluation was included to determine whether the minimum design basis temperature of 60 degrees F (FSAR Table 9.8-1) could be maintained to support operation of the safety related equipment in the pump house. The NRC team also noted that the licensee, in response to the SSFI finding, (TR# BT 5226) stated that the existing condition met the design basis temperature requirements, as specified in the FSAR without a formal evaluation.

The team reviewed the licensee's program for requesting engineering evaluations to address identified plant deficiencies. Plant Engineering Procedure No. PEP-3 establishes the methods by which one can submit an engineering evaluation request (EER) and Plant Engineering can respond to such a request. This procedure requires processing an engineering change modification request in accordance with Procedure No. AP 1021. The team noted that the licensee had installed two large maintenance cranes above the emergency diesel generators, via EER No. 87-049M, without utilizing the appropriate modification process and that no safety evaluation or review had been performed, in accordance with 10 CFR 50.59, to determine whether any unreviewed safety questions existed due to the modification. In addition, the team noted that the licensee had not performed any calculations to evaluate the structural integrity and seismic qualification of the crane,during a design basis earthquake, or its impact on affected safety related equipment. During this inspection, the licensee stated that they had performed this modification under the generic maintenance Procedure No. 1401-18 titled "Equipment Storage Inside Class I Buildings". The team concluded that this procedure did not establish a basis for the installation of the above cranes and that no supporting engineering evaluations had been performed to address the adequacy of the installation.

The above modification is an example of the licensee's failure to perform and document 10 CFR 50.59 safety evaluations and constitute a violation of the 10 CFR 50.59 requirements. (50-289/90-81-11)

During this inspection, the team noted that supporting documentation for a number of design changes and calculations was not available or not easily retrievable. The team also noted that the licensee did not have design basis documents (DBD) for the electrical distribution system. The licensee stated that a design basis reconstitution effort is being implemented for TMI and that seven design basis documents had been already completed. The team noted that 17 systems are prioritized for future DBD reconstitution and that the Electrical Distribution Systems is not included in that list. The licensee is planning to complete four systems each year.

6.8 Conclusions

The Corporate and plant engineering are adequately staffed with competent personnel. Effective interfaces exist between station and engineering personnel. Communications between the various Engineering and Technical Support organizations were found to be generally good, as was the self assessment program. The root cause analysis and corrective action programs were considered adequate and the temporary modification program was properly controlled and implemented. One area of concern identified was the lack of design basis documents for the electrical and support systems. The lack of a trending program to monitor drift of the EDS components was considered to be a weakness in the preventive maintenance program. Technical training was found to be adequate. Inadequate design control was observed for a plant modification, during this inspection, which indicates the need for increased attention to the modification process.

In summary, the team concluded that the engineering and technical support available to the TMI-1 station was generally good and provided a basis for the safe operation of the plant.

7.0 GENERAL CONCLUSIONS

The inspection team concluded that generally the TMI electrical distribution system is capable of performing its intended safety functions.

With the exception of specific findings and unresolved issues identified in this report, the preferred offsite sources, the emergency diesel generators, the batteries, the switchgear equipment and the other components associated with the electrical distribution system were found to be adequately sized and configured. However, some margins were found to be minimal. Separation between redundant trains and divisions was found to have been adequately maintained, but no controls were found to ensure that separation was maintained in the "yellow" division.

The general quality of engineering and technical support appeared to be good, as was the self assessment (quality assurance audit) program.

Weaknesses were identified by the team in the area of design basis documents, particularly in seismic evaluations. However, the team determined that an effort is underway to reconstitute such documents.

8.0 UNRESOLVED ITEMS

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items or violations. Unresolved item(s) identified during this inspection are discussed in Details, paragraphs 3.3, 3.4, 3.5, 3.8, 3.9, 3.12, 3.15, 5.1 and 5.3.

9.0 WEAKNESSES

Weaknesses are conditions that do not constitute regulatory requirements and are presented to the licensee for their evaluation.

10.0 EXIT MEETING

The inspectors met with licensee corporate personnel and licensee representatives (denoted in Attachment 1) at the conclusion of the inspection on December 21, 1990. The inspectors summarized the scope of the inspection and the inspection findings.

ATTACHMENT 1

PERSONS CONTACTED

GPU Nuclear Corporation

D. Atherholt	Operations TMI-1
T. Basco	Mechanical Engineer
R. Bensel	Mechanical Engineer
T. G. Broughton	Director, O.M. TMI-1
M. Calbureanu	HVAC Design Engineer
W. County	QA Audit Manager
K. R. Eibon	Project Engineer
E. Eisen	Technical Functions Engineer
K. Garthwaite	Electrical Engineer
R. T. Glaviano	Manager Technical Functions Site
*D. L. Harris, Jr.	Consultant NEC
*C. E. Hartman	Manager Plant Engineering TMI-1
*W. G. Heysek	Licensing Engineer TMI-1
*H. D. Hukill	Director TMI-1
D. Jenkins	HVAC Engineer
D. G. Jerko	Licensing Engineer
P. P. Karish	TMI-1 Plant Engineer
L. Lanese	Mechanical Engineering Manager
R. Maclowski	QA Corporate Audit Group
*R. J. McGoey	Plant Systems Director
M. L. Moore	TMI-1 Plant Material Engineer
W. Naylor	Manager Corporate Training Department
T. Noble	Structural Engineer
*D. A. Palaferro	Consultant G/C Inc.
J. R. Paules	Lead Operations Engineer
*H. A. Robinson	Electrical Power Manager
*R. E. Rogan	Director TMI Licensing
M. Schaeffer	Mechanical Engineer
*H. P. Sharma	Electrical Engineer
*H. B. Shipman	Plant Operations Director
*G. R. Skillman	Plant Engineering Director TMI-1
*C. W. Smyth	Licensing Manager TMI-1
*P. S. Walsh	Technical Functions Site Director TMI-1
W. William	TMI Licensing
R. G. Zimmerman	Electrical Plant Engineer

U.S. Nuclear Regulatory Commission

*C. J. Anderson	Section Chief, DRS/EB/PSS
*R. W. Hernan	Project Manager
*W. L. King	Training Consultant, Resolution Dynamics
*F. I. Young	Sr. Resident Inspector

Commonwealth of Pennsylvania

*R. Cook	Power Group Leader DER/BRP

ATTACHMENT 2

TMI-1 AC ELECTRICAL DISTRIBUTION SYSTEM