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LICENSEE: GPU Nuclear Corporation

FACILITY NAME: Three Mile Island Nuclear Station, Unit 1

INSPECTION DATES: February 22-26, 1993

INSPECTORS: R S Bhatia 15 April, 93
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APPROVED BY: W. H. Ruland 4/15/93
William H. Ruland, Chief Date
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Area Inspected: This was an announced inspection to review the licensee's corrective actions of previously identified electrical distribution safety functional inspection (EDSFI) findings.

Results: No violations or deviations were identified. Of the seven open unresolved items reviewed in Unit 1, six unresolved items and one violation were closed. These items are discussed in Section 2.0.

DETAILS

1.0 PURPOSE

The purpose of this inspection was to review and verify the licensee's corrective actions for previously identified NRC findings of the Electrical Distribution System Functional Inspection (EDSFI) for Three Mile Island Nuclear Plant.

2.0 FOLLOWUP OF PREVIOUS IDENTIFIED FINDINGS

2.1 (Closed) Unresolved Item (50-289/90-81-01) regarding DC voltage regulation

Upon review of the licensee's 250 Vdc voltage drop study the EDSFI team identified that the licensee had not taken any actions to resolve three issues identified in the voltage regulation calculation. Calculation number C11-734-5350-004 presented recommendations for 1.) an evaluation to address the voltage required at the inverters' input terminals; 2.) field testing DC motor operation at low voltage; and 3.) field testing of solenoid valves at various voltages. Additionally, the team determined that computer results presented in section II of the calculation could not be substantiated by hand calculations using the formulas and assumptions identified within the body of the calculation. Collectively, resolution of the recommendations and verification of the computer results presented in the calculation were considered unresolved for determining the adequacy of DC voltage regulation.

Calculation C1101-734-5350-004, "TMI-1 DC System Calculation" questioned the operability of vital inverters due to the minimum battery output voltage and inverter input voltage being the same. The use of this same voltage neglected the voltage drop across the feeder cables between the battery and the inverter. Therefore, the possibility existed that the minimum inverter input voltage would be reached prior to the minimum battery discharge voltage. This situation would preclude the existence of sufficient performance margin for design basis conditions. In response to this concern, the licensee performed an analysis of the existing performance margins. This analysis resulted in the determination that the design basis two-hour capacity for the batteries was met in all applications except for one battery bank at its end-of-life rating. The inspectors noted that the licensee plans to replace the affected battery prior to reaching the end-of-life rating. The design basis for the two-hour rating of the batteries was used to support a postulated station blackout (SBO). However, the inspectors noted that the licensee had installed an SBO diesel generator to power the safety-related 4160V buses during the last outage with requirements that it be manually started and loaded within ten minutes after an SBO event has been declared. Therefore, the inspectors concluded that based on the licensee evaluation for determining battery terminal voltages and the addition of the SBO diesel, the inverters were capable of performing their intended safety function.

Further recommendations made along with calculation C1101-734-5350-004 included field testing of motor-operated valves MS-V-10A and MS-V-10B (emergency feedpump steam admission bypass valve) and power-operated relief valve RC-RV2 under low voltage conditions to verify adequate torque to operate the motor operated valves and to open the

solenoid valve respectively. In response to these recommendations the licensee determined that for the motor operated valves, degraded voltage conditions occurred one hour after a SBO event which may inhibit the valve from fully seating. Results of this investigation revealed that these valves had no automatic safety function and that if the valve failed to respond, an operator could be dispatched locally to properly position the valve. Regarding the solenoid valve, a reduced voltage test was successfully performed to demonstrate the valve's ability to operate at a lower voltage.

Lastly, the EDSFI team identified discrepancies between formulas and assumptions used in calculation C1101-734-5350-004 and computer results presented in section II of the calculation. The licensee determined an error in the computer input value for minimum assumed battery voltage. Based on identification of this error, the licensee calculated the correct minimum voltages for all dc circuits. The inspectors requested a sampling of four hand calculations to support the revised computer results and identified no discrepancies between them.

The inspectors determined that the above corrective actions and evaluations by the licensee to support the DC voltage regulation study were adequate. This item is closed.

2.2 **(Closed) Unresolved Item (50-289/90-81-04) regarding diesel generator transient loading**

During the previous EDSFI, the team identified that no analysis existed to confirm that accident mitigation pumps would accelerate to rated speed within the required time and perform their intended safety functions. This concern resulted from review of emergency diesel generator (EDG) study TDR 836, revision 3. This study revealed that voltage recovery time may be inadequate after the first sequencer step (2.5 seconds plus one second timer tolerance). The first load step, 3.5 seconds, may be loaded too close to the subsequent step possibly overloading the emergency diesel generator (EDG).

During this inspection, the licensee presented a completed study of EDG performance (TDR No. 1064, revision 0, dated January 10, 1992). In this study, digital simulations were performed to analyze the dynamic behavior of the EDG units. The analysis was performed to ensure the adequacy of the EDGs to start, accelerate, and supply the required engineered safeguard loads during sequencing of loads under loss of coolant (LOCA) conditions coincident with a loss of offsite power (LOOP). The inspectors noted that this study utilized the EPRI computer modeling software program, version 2.0, "Electromagnetic Transients Program" used to model the EDG 1A and its connected loads. The loads used were based on TDR 836, revision 3, and the final safety analysis report (FSAR) table 8.2-9. The inspector noted that the licensee had validated the model by comparison with test results from TDR 836, revision 4. These tests included monitoring the current and input power of the various motors while starting from offsite power. Additional tests included starting the EDG with initiation of the engineered safeguard block loading. The parameters of voltage,

current, frequency, and power were measured and monitored during this test to ensure the validity of the model. The following cases were evaluated:

Case 1. LOCA condition using the existing load block sequence and nominal sequencing time interval per the updated FSAR table.

Case 2. Same as case 1 with one second added to block 1 and block 3 timers.

Case 3. Same as case 1 with one second added to block 2 and one second subtracted from block timer 3.

Case 4. Same as case 1 except sequencing the decay heat removal pump at 3 seconds instead of at time zero.

The inspectors reviewed this study and concluded that the EDG 1A effectively maintained the maximum steady state loads. The inspectors noted that the loads were properly selected. At the time of this inspection, the EDGs loading study had been revised to reflect the current loading as presented in TDR 836, revision 4. The inspectors noted that the latest calculation demonstrated that EDG B had been loaded with an additional 90 kW static load as compared to the loading presented in this transient study. The licensee stated that the additional load difference will have minimal affect on either motor starting or acceleration. This load change resulted from the consideration of runout conditions on pumps and other associated motors. Based on the above discussion involving the 90 kW static load and other motor loads under locked rotor current conditions in this study, adequate voltages were obtained between steps. The inspectors concluded that the EDGs were capable of starting, accelerating, and accepting loads described in the FSAR load analysis including considerations for the timer tolerance under the worst-case loading conditions.

Based on the above completed study and acceptable results to confirm that the EDGs can sequence the required safety loads per the requirements, the inspector concluded that this item is closed.

2.3 (Closed) Unresolved Item (50-289/90-81-05) regarding EDG loading calculation

This item pertains to an inadequate EDG static loading calculation. The licensee committed to update this calculation by December 31, 1991. The existing document, TDR No. 836, Rev. 3, failed to include losses in all the feeder cables and consider additional loads resulting from the current limiting mode of the inverters and battery chargers.

During this inspection, the licensee had updated the calculation to include the 480V cable and 4.16kV feeder cable losses. The licensee also reevaluated their battery charger and inverter current limiting contributions and determined that all essential loads, including the feeder cable from the dc bus to the 30 horsepower lube oil pump motor had been included in this calculation.

The inspector reviewed revised calculation, TDR No.836, revision 4, dated February 17, 1993, and determined that this calculation included the remaining losses from the feeder cables. The additional 10 kw cable losses were separately calculated for the above feeder cables and were included in the existing EDG load calculation. The inspectors also verified load contributions from the inverters and battery chargers by performing a walkdown of the typical loads considered in this calculation. The inspectors determined that the comparison of the newly considered loads and loads present during full power operation were adequate and reasonable. In addition, the inspectors noted this calculation included adjustments for the increase in the load requirements of the makeup pumps (the largest pumps affected by increased flow during a large break LOCA), and other pump maximum flow condition requirements under worst case loading conditions. Per the revised calculation, the worst-case (LOOP/LOCA) EDG loading was determined to be 2970.2 kW. This value was determined to be within EDG rating of 3000 kW. This 3000 kW value is the 2000-hour rating for EDG 1B.

Based on the above, the inspectors concluded that the licensee has adequately incorporated the worst case loads in the EDG loading calculation. This item is closed.

2.4 (Open) Unresolved Item (50-289/90-81-06) regarding Makeup Pump motor rise in temperature

This item pertains to the adequacy of the makeup pump motors to provide the required horsepower under accident conditions. The EDSFI team's comparison of nameplate information with data used to perform load calculations revealed that the maximum horsepower required for these pumps during LOCA conditions exceeded the nameplate rating for the motors by 137 horsepower. In response to this concern, the licensee presented a letter from the motor manufacturer which stated that, based on the vendor's calculations, the motors were capable of providing the required horsepower for eighteen hours with a temperature rise of less than 80°C. This vendor determination was based on the resistance method calculation and was within NEMA standards' allowable limits. However, the licensee could not provide supporting analysis demonstrating that under accident conditions the motor would not exceed its design temperature limit.

During this inspection, the licensee had presented an analysis performed by Westinghouse in support of motor capability. Two separate calculations were performed to determine the motor rise in temperature values for the required motor output under LOCA conditions. The first calculation was performed assuming 4000V at nominal motor voltage condition and the second calculation assumed a degraded voltage of 3600 V.

The inspectors found that the motor frame type presented in this evaluation for calculating the rate of rise in temperature of the motor did not agree with the actual nameplate data drawing. The calculation also considered the motor frame to be Type CF instead of Type CSP as presented in Westinghouse vendor drawing 2746 D41 Sub 4. Additionally, this calculation assumed 24 hours of motor operation compared to the previous 18 hours of operation transmitted to the licensee by Westinghouse in a letter dated February 27, 1985, which was presented to the EDSFI team. Also, the shop orders presented in this calculation did not agree with the above motor outline drawing. At the conclusion of this inspection, the licensee had no additional clarifications for the inspectors regarding this concern.

Based on the information available that the motors were built and qualified to NEMA's class B rating and the statement of test results performed by Westinghouse on a similar motor rated at 700 horsepower and 4000 volts which resulted in a 48° C temperature rise, the inspector concluded that some confidence was established that this motor could meet plant requirements. However, this item will remain open pending verification by the NRC and their review of adequate supporting documentation.

2.5 (Closed) Unresolved Item (50-289/90-81-07) regarding containment penetrations' heat load calculation

During the EDSFI, the NRC determined that heat loads for containment electrical penetrations were not documented. Original penetration design by the manufacturers had been reviewed during the inspection and verification was made that no new loads had been added.

To address this issue the licensee developed calculation number C1101-774-5350-0004, "Containment Electrical Effective Heat Loads." This calculation demonstrated that the heat loads of all penetrations were within the maximum allowable effective heat loads per the manufacturers of the penetrations. Further, this calculation was based on operating limits for temperatures presented in the technical specifications. Based on review of this calculation and the determination that maximum permissible heat loads did not exceed the manufacturers' ratings, this item is closed.

2.6 (Closed) Unresolved Item (50-289/90-81-08) for inadequate administrative controls of fuses

The EDSFI team identified two dc distribution panels where differing type and manufactured fuses were installed. These discrepancies involved varying fuses from one pole to another which could result in inadequate circuit protection and coordination. The team reviewed the licensee's controls for ensuring fuse changes are correct and determined that adequate administrative controls had not been established and drawings did not identify complete information for replacing fuses. To address this issue the licensee committed to revise applicable procedures and controls necessary for adequate circuit protection.

The inspectors reviewed administrative procedures 1021, revision 10, "Plant Engineering Modifications and Corrective Changes" and 1043, revision 18, "Control of Plant Modifications" to verify adequate process controls had been established for fuse replacements when performing plant modifications. Both administrative procedures were found to reference operating procedure 1107-4, revision 118, "Fuse Control System Index" for determination or verification of proper fuse selection. In addition, corrective maintenance procedure 1420-Y-13, revision 12, "General Circuit Troubleshooting and Repair" which provides guidance for repair of control and power circuits was found to clearly delineate requirements for fuse replacements by reference of the fuse control system index, plant drawings, vendor manual, or engineering evaluation, as appropriate, for determining proper fuse selection.

However, the inspectors performed a walkdown of fuses in several dc distribution panels for verification of the fuse index with fuses installed. Results of this walkdown identified six of fourteen fuses with different manufacturers than the manufacturer specified in the index procedure. The inspectors noted that the licensee had not performed an evaluation for the interchangeability of fuses by differing manufacturers to demonstrate proper circuit coordination. In addition, the inspectors noted that like-for-like replacements of fuses would not ensure future agreement with specified fuses presented in the fuse index. Subsequent to the inspection, the licensee provided an engineering evaluation for the acceptability of interchanging fuses by different manufacturers and a procedure revision for referencing the fuse control index as the primary control document for fuse replacements in lieu of like-for-like replacements. Engineering Evaluation Request number 93-0069, revision 0, stated that although there is some difference in clearing time for the same type fuses by different manufacturers, this difference does not affect fuse coordination for the circuits.

The inspectors reviewed the licensee's engineering evaluation, quality classification evaluation for fuse procurements, and procedure change request to ensure proper circuit coordination and protection. No problems were identified. Based on the licensee's corrective actions to develop an index of fuse requirements and administrative guidance for the replacement of fuses, unresolved item 50-289/90-81-08 is closed.

2.7 **(Closed) Violation (50-289/90-81-09) for failure to establish acceptance criteria for testing of the 'A' 250 Vdc battery**

During the November 1990 EDSFI, it was determined that the existing surveillance procedure, SP 1303-11.11, "Station Storage Battery Load Test" failed to test each battery bank individually for determining rated capacities indicating battery replacement in accordance with the battery sizing calculation. Calculation number C-1101-734-5350-003, revision 1, "TMI-1 Station Battery 'A' Capacity Calculation" stated that the "Yellow" and "Red" batteries must each be replaced when they reach 80 and 87 percent of their rated capacity respectively. However, the team's review indicated that this surveillance procedure

was inadequate in its methodology and specified acceptance criteria. A review was made by the team of the most recent test results which indicated that sufficient capacity was available to enable both battery banks to carry design loads.

Subsequent to the inspection, the licensee revised surveillance procedure 1303-11.11 to measure the voltage across each battery bank individually during the discharge test for determining proper battery capacity. In addition, the correct battery capacity acceptance criteria was incorporated into the procedure for each battery bank in accordance with the battery sizing calculation. The inspectors reviewed this revised procedure and determined that the licensee's corrective actions were adequate for testing the capacities of each battery bank. Discussions with licensee personnel demonstrated an awareness of the procedure change and an understanding for measuring each battery bank's discharge voltage individually. The inspectors verified the last completed surveillance procedure adequately satisfied the correct acceptance criteria per the design basis. Based on review of the above corrective actions by the licensee this violation is closed.

2.8 **(Closed) Unresolved Item (50-289/90-81-10) regarding electrical independence**

This item pertains to the licensee's corrective actions to ensure that electrical system independence is maintained and redundant divisions are not affected by single failures when several loads are fed from either of the two redundant divisions.

Subsequently, the licensee had completed a study and evaluated all such cases where an automatic transfer or a breaker existed to resolve the system independence concern. All cases were reviewed from the standpoint of transient effects on the redundant divisions and the capability of equipment and cables to withstand fault currents during normal operating conditions.

The inspector's review of this evaluation indicated that five cases existed where transfer switches/dual breaker application in redundant divisions was questionable. The inspector further noted that for these five cases the licensee had evaluated the physical separation distances to ensure that a fault on one train would not affect the other train. The inspector selected two samples where the licensee had assumed that cables had been routed in their own dedicated raceways. The inspectors' review of the raceway routing information and walkdown which was performed to ensure that adequate cable and physical separations existed revealed no concerns. In addition, the inspectors verified that in one other case where nuclear service cooling water pump B motor had a provision to be supplied from either of the redundant division breakers, proper routing was installed and a key lock interlock existed per the installation to ensure sufficient electrical independence.

Based on the above licensee's corrective actions and walkdown of sampled cases, this item is closed.

3.0 UNRESOLVED ITEMS

Unresolved items are matters about which additional information is necessary to determine whether they are acceptable, a deviation, or a violation. Several unresolved items are discussed in detail under Section 2.0.

4.0 EXIT MEETING

The inspectors met with the licensee's personnel denoted in Attachment 1 of this report at the conclusion of the inspection period on February 26, 1993. At that time, the scope of the inspection and inspection results were summarized.

ATTACHMENT 1

PERSONS CONTACTED

GPU Nuclear Corporation

*T.G. Broughton, Director, TMI
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*P.K. Eapen, System Section Chief
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