June 29, 2011

MEMORANDUM TO: Peter R. Wilson, Deputy Director
Division of Reactor Safety
Region I

FROM: Robert A. Nelson, Deputy Director **/RA/ by CRegan for**
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: FINAL RESPONSE TO TASK INTERFACE AGREEMENT (TIA 2011-003) RELATED TO NINE MILE POINT NUCLEAR STATION UNIT 1 LICENSING BASIS FOR DEGRADED GRID RELAY TIME DELAYS

By letter dated October 12, 2010 (Agencywide Documents Access and Management System Accession No. ML102861981), the U.S. Nuclear Regulatory Commission Region I Office requested the Office of Nuclear Reactor Regulation (NRR) to provide an answer to the following Task Interface Agreement question in determining the licensing basis for the degraded grid relay function at the Nine Mile Point Nuclear Station Unit 1.

> Does the Nine Mile Point Unit 1 2nd level degraded grid relay time delay, as implemented by the current licensing bases, meet regulatory requirements?

The NRR staff's assessment is documented in the enclosed evaluation.

Enclosure:
As stated

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(301) 415-4117

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# TASK INTERFACE AGREEMENT 2011-003

# LICENSING BASIS FOR DEGRADED GRID RELAY TIME DELAYS

# NINE MILE POINT NUCLEAR STATION UNIT 1

## 1.0 INTRODUCTION

By letter dated October 12, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102861981), the U.S. Nuclear Regulatory Commission (NRC) Region I Office requested the Office of Nuclear Reactor Regulation (NRR) to provide an answer to the following Task Interface Agreement (TIA) question in determining the licensing basis for the degraded grid relay function at the Nine Mile Point Nuclear Station Unit 1 (NMP-1).

> Does the Nine Mile Point Unit 1 2nd level degraded grid relay time delay, as implemented by the current licensing bases, meet regulatory requirements?

## 2.0 BACKGROUND

During the Component Design Bases Inspection (CDBI) for NMP-1, the NRC Region I team inspected the 4kV safety buses to ensure they were capable of supporting the assumed safeguards equipment response to the design-basis accident (DBA) event. The team noted that the existing time delay field setting for the safety buses for the degraded voltage relays (DVR) was a nominal 21 seconds from the detection of a sustained degraded voltage condition until vital buses subsequently transfer to the emergency diesel generators (EDGs). The NMP-1 electrical scheme is such that the EDGs would start after this 21 seconds time delay for a postulated loss-of-coolant accident (LOCA)/degraded voltage condition and connect to the bus 10 seconds later for a sequence time of 31 seconds after the event. The two core spray (CS) pumps and two CS topping pumps are then sequenced on and the last topping pump starts 20 seconds later. There is an assumed 5 second motor acceleration time before the pump is at full speed (i.e., conservative operability determination number) for a total sequence time of 56 seconds. This system timing of 56 seconds exceeds the 35 seconds duration for assumed full core spray flowrate referenced in the current Updated Final Safety Analysis Report (UFSAR) accident analysis. However, the UFSAR accident analysis makes no reference to the capability of bounding a degraded grid/voltage condition and appears to be evaluating the standard LOCA/ loss-of-offsite-power (LOOP) assumptions. Unresolved Item (URI) 05000220/2008008-02, Vital Bus Degraded Voltage Time Delay Licensing Bases, was opened in the inspection report, ADAMS Accession No. ML083500407, as a result of the inspection.

### History of NMP-1 2nd Level Undervoltage (UV) Protection

NRC letter dated June 2, 1977 (ADAMS Legacy Accession No. 4007000603), which outlined NRC Staff Position, sent to NMP-1, stated in position B.1.c.1, that the allowable time delay for the degraded voltage protection scheme including margin, shall not exceed the maximum time delay that is considered in the accident analysis section of the UFSAR. During the CDBI, Constellation (the licensee) initiated a condition report to evaluate the issue and noted that in

the letter dated July 14, 1977 (ADAMS Legacy Accession No. 4007002130), addressed to the NRC, Niagara Mohawk Power Corporation (NMPC) stated that the time delay associated with the degraded voltage protection scheme met this criterion. In a letter dated April 17, 1984 (ADAMS Legacy Accession No. 8405160020), to the licensee, the NRC documented its safety evaluation (SE) approval for the proposed design modifications to reduce susceptibility to grid voltage degradation. In this letter, the new trip setpoint of 3605 volts was referenced with a 10 second time delay. The NRC documented in this SE that the design modification associated with the second level of undervoltage protection satisfied applicable criteria, including: "the time delay shall not exceed the maximum time delay considered in the accident analysis section of the UFSAR." In the conclusion section of the SE, the NRC found that the proposed design modifications were in conformance with the Commission's requirements with regard to: (1) sustained degraded grid voltage conditions; and (2) interaction between offsite and onsite emergency power systems. Based on the evaluation of information provided by the licensee, the design was found to be acceptable.

Subsequently, the NRC issued Amendment No. 67 to Facility Operating License No. DPR-63 (NMP-1) in a letter dated November, 9, 1984 (ADAMS Accession No. ML010990166). The amendment changed the Technical Specifications (TS) in response to NMP-1's request dated April 13, 1984 (ADAMS Legacy Accession Nos. 8404240452 and 8404240458), and supplemental letter August 3, 1984 (ADAMS Legacy Accession No. 8408090077). The 2$^{nd}$ level degraded voltage setpoint change was approved for ≥ 3600 volts dropout with an operating time or time delay of 18.5 ± 3 seconds at 3580 volts. These time delays had and still have an inverse time characteristic which means that the faster the voltage decreases, the relay's response time decreases exponentially. In this case the 18.5 ± 3 second time delay was the time required for the relay to operate when the voltage suddenly decreased from operating voltage level values to 3580 volts. The NRC determined that the revised setpoint would ensure adequate voltage at the terminals of safety equipment and the time delay would prevent spurious tripping of the preferred offsite source. The NRC concluded that the design changes and the TS revision would ensure adequate protection of Class 1E equipment for sustained degraded voltage conditions and prevent unnecessary separation of safety equipment from preferred source and thus the amendment was found to be acceptable.

By letter dated November 18, 1993, NMPC submitted a request for changes to the NMP-1 TS. The proposed change was submitted in response to findings of the NRC's Electrical Distribution System Functional Inspection conducted at NMP-1 from September 23, 1991, to October 25, 1991. This included a revised TS Table 3.6.2i incorporating a DVR setpoint change from 3580 volts with a time delay of 18 ± 3 seconds to 3705 volts with a time delay of > 3.4 seconds but < 60 seconds. The 3.4 seconds minimum time delay was described as the minimum time required to clear the voltage transients due to load sequencing to avoid separation from offsite power. The 60 seconds maximum time delay was described as the maximum time allowable to preclude load damage of the trip device actuation at voltages below the DVR setpoint of 3705 volts. By letter dated April 7, 1994, the NRC issued Amendment No. 148 to the operating license of the NMP-1 (ADAMS Accession No. ML011070061). The NRC concluded the proposed changes to increase the degraded voltage relay setpoint provided additional conservatism to the 4kV vital buses to provide safety related equipment with adequate voltage at all distribution levels. The change to the setpoint and time delay was thus found to be acceptable.

Licensee's Evaluation

The licensee (Constellation) initiated a corrective action document report, CR-NM-2008-7746, at the time of the inspection to address the issue that the current UFSAR accident analysis time duration of 35 seconds is not included in the current degraded grid voltage relay actuation time design criteria for a degraded grid concurrent with a LOCA event.

Constellation performed a review and follow-up investigation of their licensing bases for the 2nd level DVR and documented their conclusions within their corrective action program. Constellation determined that the time delay setting in the field associated with the second level (degraded) voltage relays supports the 35 seconds assumed in the UFSAR accident analysis time duration during a simultaneous LOCA/LOOP event both at the time of original installation and at the present time. This is in part because of the inverse time characteristic design of the relays and the existing field setpoint of a nominal 21 seconds. Constellation determined that its 1977 response that the original installed 2nd level UV relay time delay settings were in accordance with the timing of the accident analysis because their UFSAR analysis is associated with their licensing bases LOCA/LOOP event. As a backup to the loss-of-voltage (LOV) relays (nominal 70 percent voltage setpoint and 3 seconds time delay) given a LOCA and simultaneous LOOP, the inverse time characteristic of the 2nd level relays results in a smaller time delay which maintains the 35 seconds ECCS flowrate assumption in the UFSAR. Constellation concluded that the second level of undervoltage protection thus supports the timing assumptions for emergency core cooling system (ECCS) loading and flowrate for the existing UFSAR accident analysis evaluation. Constellation determined that both the loss of voltage relays and 2nd level DVRs have time delays that can be accommodated in the UFSAR accident analysis time duration of 35 seconds for a simultaneous LOCA/LOOP event. Constellation has concluded within its corrective action program that the NMP-1 licensing basis does not indicate that the 35 seconds ECCS response time assumed in the UFSAR LOCA analysis must encompass the time delay for actuation of the DVRs that would be associated with a degraded grid plus LOCA event (degraded grid encompassing the event where voltage may be between the second level and LOV relays during a LOCA with subsequent timing out and transfer to the onsite EDG sources).

## 3.0 STAFF EVALUATION

The NRR staff reviewed the TIA 2011-003 request, the NRC letter dated June 2, 1977, the NRC staff SE for proposed design modification dated April 17, 1984, the NRC SEs for the amendments Nos. 67 and 148 to facility operating license No. DPR-63 for the NMP-1 in letters dated November 9, 1984 and April 7, 1994, respectively; the NMP-1 UFSAR Section XV-C.2, the NRC CDBI Report 05000220/2008008 and 05000410/2008008 (ADAMS Accession No. ML083500407), and the background information above, in preparing the response to the following question from Region I.

Question: Does the Nine Mile Point Unit 1 2nd level degraded grid relay time delay, as implemented by the current licensing bases, meet regulatory requirements?

Response: No.

The NMP-1 UFSAR Section IA, “Principle Design Criterion (PDC),” describes the 27 criteria issued by the United States Atomic Energy Commission (USAEC) on November 22, 1965. The 27 criteria represented proposed "General Design Criteria for Nuclear Power Plant Construction Permits." PDC-21 states:

> Sufficient normal and emergency sources of electrical power must be provided to assure a capability for prompt shutdown and continued maintenance of the reactor facility in a safe condition under all credible circumstances.

As part of its application to convert to a full-term operating license, NMPC provided an assessment of NMP-1 against criteria being used by the Commission in evaluating new plants. These assessments discussed the adequacy of NMP-1 in relation to Appendix A of Title 10 of the Code of Federal Regulations (10 CFR) Part 50. Technical Supplement to Petition for Conversion from Provisional Operating License to Full-Term Operating License, July 1972 and Amendment No. 1 to Application to Convert Provisional Operating License to Full-Term Operating License, November 1973, concluded that NMP-1 met the intent of General Design Criterion (GDC) 17, 1971.

The regulation at 10 CFR Part 50, Appendix A, GDC-17, “Electric Power Systems,” requires, in part:

> An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of *anticipated operational occurrences* [emphasis added] and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of *postulated accidents* [emphasis added].

This part of GDC-17 requires licensees to design their onsite electric power system (assuming the offsite electric power system is not available) to be capable of protecting the safety-related equipment needed to ensure the cooling of the core and the maintenance of containment integrity and other vital functions even in the event of postulated accidents (especially LOCA). Since degradation of the offsite power system could cause the loss of capability of safety-related equipment, the NRC required, in the NRC letter dated June 2, 1977, all licensees including NMP-1 to modify their plant designs to include a second level undervoltage protection scheme so as to protect the safety-related equipment against degraded grid voltage conditions. The staff positions proposed for the implementation of the second level undervoltage protection scheme stated, in part:

> B.(1).(c): The time delay selected shall be based on the following conditions:
>
> (1) The allowable time delay, including margin, shall not exceed the maximum time delay that is assumed in the FSAR accident analyses;

In other words, the degraded voltage protection time delay should be set such that the ECCS is able to inject water into the core within the maximum allowable time assumed in the FSAR accident analyses even if a sustained degraded grid voltage condition is present. Thus, the degraded voltage protection time delay should be short enough such that, the total time duration starting from the detection of a sustained degraded voltage condition and ending at the operation of the last pump at full speed, is sufficient to assume full core spray in the event of an accident (e.g., a LOCA) coincident with a degraded voltage condition. The time delay should also be short enough to allow adequate voltage at the terminals of safety-related motors connected to the safety buses to start at the appropriate time and perform their safety functions in the event of a LOCA coincident with degraded voltage conditions.

In the licensing basis history of the NMP-1, the initial DVR setpoints of 3605 volts dropout and 10 seconds operating time (time delay), which was approved by NRC on April 17, 1984, was changed to ≥ 3600 volts and 18 ± 3 seconds at 3580 volts in the Amendment No. 67 that was issued on November 9, 1984. These final settings were later changed to the dropout voltage of ≥ 3705 volts and the time delay of > 3.4 seconds and < 60 seconds, as specified in Table 3.6.2i of the NMP-1 TS, in Amendment No. 148 issued by NRC on April 7, 1994.

In Amendment No. 148, the NRC staff stated:

> NMPC stated in the November 18, 1993, submittal that the licensee had performed an analysis to determine the degraded voltage setpoint that would ensure sufficient voltage at Power Boards 102 and 103 to support acceptable operation of critical loads. The distribution system voltages were determined using the Electrical Load Monitoring System for Alternating Current Loads (ELMSAC) software. ELMSAC is a static model voltage drop and short circuit current iterative calculation. The loads required for motor starts throughout the LOCA sequence were used in calculating the resultant bus and load voltages. These loads comprise the maximum expected loading conditions and lowest voltages which the safety related busses will experience. The required setting of the undervoltage relays were calculated using the analytical limit of the minimum allowable 4.16kV safety related bus voltages.

Based on the above, the NRR staff concludes that the licensee's assertion that the NMP-1 licensing basis does not include degraded grid plus LOCA event is incorrect.

As noted in the background discussion above and in the CDBI Report (ADAMS Accession No. ML083500407), the licensee's estimation of a LOCA/degraded voltage event with the current DVR time delay of 21 seconds resulted in approximately 56 seconds, which exceeds the Final Safety Analysis Report (UFSAR) LOCA analysis time duration of 35 seconds, contrary to the NRC requirements specified in NRC letter dated June 2, 1977, and GDC-17 and PDC-21.

This issue is related to the adequacy of the design of the second level of undervoltage (commonly known as "degraded" voltage) protection at NMP-1. It is the position of the NRR staff that in previous license amendment evaluations the NRC staff assumed that either NMP-1's design met the staff position B.(1).(c).(1) when approving the time delays or that the time delays did not impact the accident analysis (i.e., the ECCS injection timing requirements would still have been met even if EDGs powered the buses after the relays timed out). However, subsequent NRC staff reviews determined that NMP-1's design does impact the accident

analysis. Because the safety buses do not disconnect from offsite power following an accident signal, the time delays for both divisions would impact the plant's ECCS injection during a LOCA that occurs during a degraded voltage condition. Therefore, the NRR staff concludes that NMP-1's degraded voltage protection scheme does not meet NRC regulations.

Thus, the NRR staff concludes that the NMP-1 2nd level (degraded) voltage relay time delay, as implemented by the current licensing bases, does not meet PDC-21 and GDC-17 requirements nor does it meet the ECCS injection timing in the NMP-1 accident analysis for an assumed degraded voltage condition concurrent with a LOCA. In addition, the licensee does not meet the criteria specified for the DVR time delay in the NRC letter dated June 2, 1977. The existing design and licensing bases of an allowable 60 second time delay could result in voltage being too low to power ECCS equipment (motors) but high enough to prevent the EDGs from connecting to the safety related buses to support the licensee's 10 CFR 50.46 LOCA analyses assumptions.

## 4.0 REGULATORY REQUIREMENTS

The regulation at 10 CFR Part 50, Appendix B, Criterion III, "Design Control," requires that measures be established to assure that design bases for structures, systems, and components are correctly translated into specifications, drawings, procedures, and instructions.

The NMP-1 PDC 21 requires that sufficient normal and emergency sources of electrical power must be provided to assure a capability for prompt shutdown and continued maintenance of the reactor facility in a safe condition under all credible circumstances.

The regulation at 10 CFR Part 50, Appendix A, GDC-17, "Electric power systems," requires, in part, that nuclear power plants have onsite and offsite electric power systems to permit the functioning of structures, systems, and components that are important to safety. The onsite system is required to have sufficient independence, redundancy, and testability to perform its safety function, assuming a single failure. The offsite power system is required to be supplied by two physically independent circuits that are designed and located so as to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. In addition, this criterion requires provisions to minimize the probability of losing electric power from the remaining electric power supplies as a result of loss of power from the unit, the offsite transmission network, or the onsite power supplies.

The regulation at 10 CFR 50.34(b) requires that "The final safety analysis report shall include information that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the structures, systems, and components and of the facility as a whole, and shall include … (2) A description and analysis of the structures, systems, and components of the facility, with emphasis upon performance requirements, the bases, with technical justification therefore, upon which such requirements have been established, and the evaluations required to show that safety functions will be accomplished. The description shall be sufficient to permit understanding of the system designs and their relationship to safety evaluations…."

## 5.0 CONCLUSION

Based on its review of TIA 2011-003, the NRR staff finds the following:

The licensee must demonstrate that the existing degraded voltage relay time delay setpoints, as specified in Table 3.6.2i of the NMP-1 TS, are adequate to satisfy ECCS injection timing requirements in the NMP-1 accident analysis for a degraded voltage event coincident with an accident. Since the current time delay for the NMP-1 degraded voltage scheme does not satisfy this function as required, the NMP-1 2nd level degraded grid relay time delay, as implemented by the current licensing bases, does not meet regulatory requirements.

Because the safety buses do not disconnect from offsite power within adequate time following an ECCS actuation signal, the time delays for both divisions do not support the analysis for the plant's ECCS injection during a large break LOCA that occurs during a degraded voltage condition. Therefore, the NRR staff concludes that NMP-1's degraded voltage protection design scheme does not support the timing assumptions for establishment of cooling flow in the 10 CFR 50.46 LOCA analyses. Therefore, the NRR staff concludes that the NMP-1 2nd level degraded grid relay time delay specified in its current licensing bases does not meet the regulatory requirements of GDC 17, PDC 21, and 10 CFR Part 50, Appendix B, Criterion III, Design Control.

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Date: