UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT UNITS 1 AND 2

DOCKET NOS. 50-282 AND 50-306

INTRODUCTION AND SUMMARY

Northern States Power Company (NSP) was requested by NRC letter dated August 8, 1979 to review the electric power system at Prairie Island Nuclear Generating Plant Units 1 and 2. The review was to consist of:

a) Determining analytically the capacity and capability of the offsite power system and onsite distribution system to automatically start as well as operate all required loads within their required voltage ratings in the event of 1) an anticipated transient, or 2) an accident (such as LOCA) without manual shedding of any electric loads.

b) Determining if there are any events or conditions which could result in the simultaneous or consequential loss of both required circuits from the offsite network to the onsite electric distribution system and thus violating the requirements of GDC 17.

The August 8, 1979 letter included staff guidelines for performing the required voltage analysis and the licensee was further required to perform a test in order to verify the validity of the analytical results. NSP responded by letters dated July 17 and November 20, 1981, April 13 and

August 17, 1982. A detailed review and technical evaluation of the submittals was performed by Lawrence Livermore Laboratory (LLL) under contract to the NRC, with general supervision by NRC staff. This work is reported by LLL in Technical Evaluation Report (TER) No. 19460, "Adequacy of Station Electric Distribution System Voltages, Prairie Island Nuclear Generating Plant Units 1 and 2," dated September 17, 1982 (attached). We have reviewed this report and concur in the conclusions that the offsite power system and the onsite distribution system are capable of providing acceptable voltages for worst case station electric load and grid voltages.

EVALUATION CRITERIA

The criteria used by LLL in this technical evaluation of the analysis includes GDC 5 ("Sharing of Structures, Systems, and Components"), GDC 13 ("Instrumentation and Control"), GDC 17 ("Electric Power Systems") of Appendix A to 10 CFR 50; IEEE Standard 308-1974 ("Class 1E Power Systems for Nuclear Power Generating Stations"), ANSI C84.1-1977 ("Voltage Ratings for Electric Power Systems and Equipment - 60 Hz"), and the staff positions and guidelines in NRC letter to NSP dated August 8, 1979.

ANALYSIS AND TEST FEATURES

Northern States Power Company analyzed each offsite power source to the onsite distribution system under maximum and minimum load conditions with the 345 kV and 161 kV grids at their maximum and minimum anticipated values (351 $\pm$ 3 kV and 168 $\pm$ 2 kV) with the units on-line. The grid voltages used in the minimum voltage analysis were 345 kV and 164.2 kV with the units off-line. The maximum load condition used in the analysis was a unit trip and a safety injection (SI) on Unit 1 with a simultaneous turbine and reactor trip on Unit 2.

The licensee's analysis for maximum load, minimum grid voltage included steady state, block load transfer and sequential loading. The steady state analysis assumed all loads running with minimum grid voltage and maximum load conditions. The block load transfer assumed the same conditions as steady state except that all Class 1E loads started with locked rotor currents. The sequential loading analysis calculated the voltages on the Class 1E buses as each load was sequenced on the bus. In addition the analysis covered the transient effects on the Class 1E buses caused by starting a large non-Class 1E load while all Class 1E equipment was operating. The analysis results show that the worst case Class 1E bus voltages occur under the following conditions:

1. Maximum voltage occurs on the 4160 volt Class 1E buses when the 161 kV is supplying the Class 1E buses through transformer 1R with no loads on the Class 1E buses. Maximum voltage occurs on the 480 volt Class 1E buses when the 345 kV grid is supplying the Class 1E buses through transformer CT12 with no loads on the Class 1E buses.

2. Minimum voltage occurs on the Class 1E buses when the 345 kV grid is at its minimum expected voltage and the Class 1E buses are being supplied from transformer CT11 during steady state, block transfer and sequential loading conditions.

The offsite power to the four 4160 volt Class 1E buses at Prairie Island is provided by a 161 kV and 345 kV grid. Power to these buses is supplied from the grid through the unit auxiliary transformer 1M (345 kV switchyard), reserve transformer 1R (161 kV switchyard), reserve transformer 2R (345 kV switchyard), cooling tower transformer CT12 (345/161/13.8 kV autotransformer) and cooling tower transformer CT11 (345 kV switchyard).

The analysis results show that transformers 1M, 2R and CT 2 provide acceptable voltages to the Class 1E equipment under worst case conditions analyzed. Transformer 1R, which is powered from the 161 kV switchyard, will provide acceptable voltage to the Class 1E equipment under all conditions analyzed provided the 345/161 kV autotransformer is operable and the 345 kV and 161 kV switchyard are interconnected. In the event that the 345/161 kV autotransformer is unavailable and the Spring Creek line is the only source of power to the 161 kV switchyard, this line will not have sufficient capacity to provide acceptable voltage to the Class 1E equipment under worst case conditions analyzed (i.e., accident loads on Unit 1 and simultaneous safe shutdown loads on Unit 2). For the Spring Creek line to be capable of providing acceptable voltage to the Class 1E equipment with the autotransformer inoperable, and when Unit 1 or 2 is in a shutdown mode, the Red Wing Station must be in operation and the 161 kV grid must be maintained at a minimum 102% of nominal voltage. The licensee has existing technical specifications which require that an analysis of plant conditions and of the 161 kV system must be performed before the Spring Creek line can be considered an acceptable source of offsite power. In addition, the voltage analysis shows that cooling tower transformer CT11 does not have sufficient capacity to provide power to both safety trains of Units 1 and 2 under worst case minimum voltage conditions. The licensee has proposed design changes that will prevent the automatic transfer of cooling tower transformer CT12 loads to cooling tower transformer CT11. This will prevent overloading of this power source by allowing CT11 to carry only its dedicated loads of fans for two cooling towers, two cooling water pumps and the loads of one safety train on each unit.

The voltage analyses was verified by taking voltage and load measurements on the grid and 4160 volt buses using transformers 1R, CT11 and CT12 as the offsite power sources. The tests included steady state and transient conditions created by the starting of large motors. A comparison showed that the steady state test results were within 0.2% and the transient test results were within 1.9% of the analytical values. This close correlation verifies the accuracy of the assumptions used in the analysis. We find this to be acceptable.

DESIGN CHANGES

As a result of the voltage analysis, NSP has committed to the following design changes:

1. Installation of a second reserve transformer 2R. The installation of this second reserve transformer has been completed during the recent Unit 2 refueling outage (July 1982).
2. Disabling the automatic transfer of transformer CT12 loads to transformer CT11 on a failure of loss of voltage to CT12. NSP has committed to completing the disabling of the automatic transfer of the loads from transformer CT12 during the next refueling outage of Unit 1 (December 1982).
3. Addition of an interposing relay to the start circuit to the auxiliary building special ventilation exhaust fan. The installation of the interposing relay is scheduled to be completed by June 30, 1983.

We find these commitment dates proposed by the licensee to be acceptable.

CONCLUSIONS

We have reviewed the LLL technical evaluation report and concur in the findings that:

1. NSP has provided verified voltage analysis to demonstrate that upon completion of the proposed design changes Class 1E equipment voltage will remain within acceptable operating limits for the postulated worst case conditions.
2. The voltage analysis was verified by tests and the close correlation showed the analysis to be accurate. We find this to be acceptable.
3. NSP's reaffirmation of compliance to GDC 17 is acceptable.

Based on this evaluation we find the Prairie Island Nuclear Generating Plant Units 1 and 2 to be acceptable with respect to the adequacy of station electric distribution system voltages.

Attachment: LLL Technical
Evaluation Report

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