ENCLOSURE

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

SAFETY EVALUATION

STANDBY DIESEL GENERATOR

AUTOMATIC RETURN TO STANDBY MODE

WNP NO. 2

DOCKET NO. 50-397

1.0 INTRODUCTION

Section 5.6.2.2 (1) of IEEE-387-77 (endorsed by RG 1.9) requires that an automatic start signal to the diesel generator unit shall override all other operating modes and return control of the diesel-generator unit to the automatic control system. In FSAR of WNP-2, the licensee committed that the diesel generator design has the override feature to enable a diesel generator in the test mode to respond to an emergency signal. During the periodic testing of a diesel generator, if a safety-injection actuation signal occurs, the diesel generator in the test mode is disconnected from parallel operation with the offsite power system and maintained in the emergency standby mode. In the event of a loss of voltage in the emergency bus, the diesel generator unit would be ready to accept load.

The letter dated December 2, 1983 from G. Sorensen to A. Schwencer notified that the WNP-2 diesel generator design feature for automatic speed control characteristic switching did not work correctly. Furthermore, it committed to either implement a design change for automatic control characteristic selection at the first refueling outage or provide technical justification for not implementing such a design change. The licensee now provides the technical descriptions and plant test results which demonstrate the adequacy of manual control of the characteristic selection of the automatic speed and voltage control systems for WNP-2 diesel generator and thereby its conformance to all Regulatory requirements.

2.0 DISCUSSION AND REVIEW

The diesel generator design at WNP-2 has the automatic governor control system, which switched from "isochronous" mode to "droop" mode characteristic when the DG was in parallel with the offsite power system by closing both the DG circuit breaker and offsite power incoming breaker. This parallel operation requires speed matching for proper sychronizing which can be implemented with speed control in "isochronous" mode of the diesel generator. As soon as the above two breakers closed, the speed control switched to "droop" mode resulting in a mismatch between the DG speed control and the offsite power system speed. The automatic speed (throttle) governor attempted to reduce speed to the setpoint

of the droop mode by reducing the throttle setting. Since the DG was locked in Sychronism with the offsite power system, the speed (frequency) of the DG in the droop mode could not change. The governor drove the throttle closed to reduce the load to the setpoint which was set for the ischronous mode of the DG, the anti-motoring protection tripped the generator and engine, and the DG was shut-down and locked out. This undesirable event, which was not intended in the design, was corrected by restoring the speed control characteristic (setpoint of load - frequency (speed) characteristic) switch to manual operation so that the operator could switch to "droop" before he did the speed matching required to parallel.

2.1 SPEED AND LOAD CONTROL SYSTEM

The diesel generators in WNP-2 are equipped with an electric automatic speed governor system which controls the diesel engine throttles. This system senses generator output frequency (speed), compares the output frequency with the governor setpoint, and then adjusts the throttle positions (open or close) in a direction so that the output frequency will match the setpoint. The system has no provisions for manual control of throttle position. The throttles are always under the control of the automatic governor system. The governor control setpoint is manually adjustable. The governor speed-load characteristic can be manually switched from "isochronous" to "droop". The governor speed-load characteristic for isochronous mode is constant frequency independent of load (flat) while the characteristic for droop mode is that frequency (speed) setpoint is varied with load such that it increases on decreasing load and decreases on increasing load. The speed-load characteristic in the droop mode is essential to permit stable control of load when the DG is operated in parallel with the offsite power system, with the DG throttle under control of the automatic frequency governor.

Once the DG is paralleled to the offsite power system, it is locked in synchronism with the offsite power system. Its frequency is fixed at the offsite power system frequency. A change in the throttle setting no longer changes DG frequency, it only changes generator load output. If the governor were in "isochronous" any slight mismatch between the DG governor setpoint and the offsite frequency would drive the throttle either fully open or fully closed because no frequency correction occurs. When the frequency (speed) governor has a slope to its speed-load characteristic (droop), stable control of the engine throttle position (and hence generator load) is provided because the frequency septoint of the governor changes with load until it matches the offsite power system frequency. When the DG is in parallel with the offsite power system, the operator controls load by manually raising or lowering the setpoint of the automatic frequency governor. At no load, the frequency setpoint is the same for both the isochronous and droop governor control characteristics. The slope of the frequency load characteristic is about 3 % from no load to full load. The governor setpoint is manually set at 60 Hz with the DG running at no load just before it is shut down and left in standby.

2.2 ANALYSIS AND TEST RESULTS

Reg. Guide 1.108 requires that the rated-load carrying capability (continuous rating) of the DG be demonstrated for a minimum of one hour during periodic

testing. At WNP-2 loading to the DG continuous rating is accomplished by paralleling the DG with the offsite power system. In order to provide stable control to correct the above mentioned problem, the voltage regulator is switched to "parallel" characteristic prior to sychronizing. The same switch picks up a relay that puts the governor in "droop" mode. When the DG is then loaded with the offsite power system to full load (continuous rating), the governor setpoint in "droop" has been adjusted to match the offsite power system's frequency at full load and the voltage regulator setpoint in "parallel" has been adjusted to match the offsite power system's voltage at full load.

During the periodic testing of a diesel generator, if a LOCA occurs, the diesel generator in the test mode is disconnected from parallel operation with the offsite power system by tripping the DG breaker. If a loss of offsite power occurred, then incoming offsite breaker is tripped and the DG would energize the ESF bus and automatically sequence the load as required in the design. This position does not permit manual operation, correction and adjustment of the governor or voltage regulator control characteristic or setpoint. The governor and voltage regulator would control speed and voltage at a setpoint that will rise from the offsite power values along the slope of their control characteristic in proportion to the difference between the applied load and the rated load.

In Special Test Procedure SLT-S47.1-13, the frequency and voltage regulation of the division 2 diesel generator was measured. The frequency regulation was recorded to be 2.6% from no load to rated load and the voltage regulation was measured to be 4.5% from no load to rated load. The permanently connected load and automatically sequenced load to the diesel generators in WNP-2 range from 74 to 96% of the DG continuous rating depending on the ESF division. With the control characteristics set in "parallel", the largest deviation from the offsite system frequency and voltage will occur at the smaller load. The frequency and voltage were measured at a load of 3200kw (72%) with the governor and voltage control characteristics set for "parallel" (or "droop") and no setpoint adjustments following rated loading with the offsite power system. The frequency was 101% of nominal and the voltage was 101.6% of the offsite voltage which was 103.8% of nominal because the offsite power system voltage was 102.2% of nominal (4160 V) at the time of the test.

Transient state response of the DG to step change in load is the same whether the control characteristic is in "parallel" or "isochronous." The transient performance was measured in the special test for starting the largest sequenced load. On the load start, the voltage dropped to 86.5% of nominal and recovered to 105.2% nominal in 0.3 seconds. The frequency dipped to 101% of nominal and recovered to 101.6% of nominal in 1.4 seconds. The measured values for voltage and frequency for the WNP No. 2 DG's in unit operation following interruption of the required rated load testing by tripping the DG breaker are within the requirements set by Reg. Guide 1.9.

3.0 CONCLUSION

RG 1.9 requires that an automatic start-diesel signal shall override all other operating modes and return control of the diesel generator unit to the automatic control system. The original design would have to include correcting the setpoint as well as switching the control characteristics to provide performance identical to the performance in normal standby. The design scheme could switch the DG voltage regulator and governor control characteristic from "parallel" ("droop") to "unit" ("isochronous") in the event of a LOCA while the DG is parallel with the offsite power system for load testing.

Even though the original design failed to work in an acceptable manner, the test result demonstrates that the present design of the WNP-2 DG can automatically provide acceptable voltage and frequency for unit operation within requirements set by RG 1.9 if their control characteristic switches are set for "parallel" ("droop") characteristics. The periodic test at least once per 18 months, during shutdown, will verify the acceptability as required in the Surveillance Requirements of the Technical Specifications. Based on our review of the licensee's test result, the staff has concluded that the diesel generator units at WNP-2 meet the required design criteria and therefore their present design is acceptable.

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Date: October 5, 1989