

SEP TECHNICAL EVALUATION

TOPIC VIII-2
EMERGENCY GENERATORS

MILLSTONE 1

1.0 INTRODUCTION

The objective of the review is to determine if the onsite AC generator for the Millstone 1 Nuclear Station has sufficient capacity and capability to supply the required automatic safety loads during anticipated occurrences and/or in the event of postulated accidents after loss of offsite power. The requirement that the onsite electric power supplies have capacity and capability to complete the required safety functions is contained in General Design Criterion 17.

Criterion III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 includes a requirement that measures be provided for verifying or checking the adequacy of design by design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program.

Regulatory Guides, IEEE Standards, and Branch Technical Positions which provide a basis acceptable to the NRC staff for compliance with GDC17 and Criterion III include: Regulatory Guide 1.9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies;" Regulatory Guide 1.108, "Periodic Testing of Diesel Generators Used as Onsite Power Systems at Nuclear Power Plants"; IEEE Standard 387-1977, "Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Stations;" BTP ICSE2, "Diesel-Generator Reliability Qualification Testing"; and BTP ICSE17, "Diesel Generator Protective Trip Circuit Bypasses."

Specifically, this review evaluates the loading of the emergency generator, bypasses of protective trips during accident conditions and periodic testing. The SEP reviews for Topics III-1 and III-12 will evaluate the emergency generator qualification.

2.0 CRITERIA

2.1 Emergency Generator Loading. Regulatory Guide 1.9, "Selection of Diesel-Generator Set Capacity for Standby Power Supplies," provides the basis acceptable to the NRC staff for loading emergency generator units. The following criterion is used in this report to determine compliance with current licensing requirements:

- (1) The automatically-connected loads on each diesel-generator unit should not exceed the 2000-hour rating. (Loads must be conservatively estimated utilizing the nameplate ratings of motors and transformers with motor efficiencies of 90% or less. When available, actual measured loads can be used.)

2.2 Bypass of Protective Trips. Branch Technical Position (BTP) ICSB 17, "Diesel-Generator Protective Trip Circuit Bypasses," specifies that:

- (1) The design of standby diesel generator systems should retain only the engine overspeed and the generator differential trips and bypass all other trips under an accident condition
- (2) If other trips, in addition to the engine overspeed and generator differential, are retained for accident conditions, an acceptable design should provide two or more independent measurements of each of these trip parameters. Trip logic should be such that diesel-generator trip would require specific coincident logic.

2.3 Emergency Generator Testing. Regulatory Guide 1.108, "Periodic Testing Of Diesel Generator Units Used as Onsite Electrical Power Systems at Nuclear Power Plants", states that:

- (1) Testing of diesel-generator units, at least once every 18 months, should:
 - (a) Demonstrate proper startup operation by simulating loss of all ac voltage and demonstrate that the diesel generator unit can start automatically and attain the required voltage and frequency within acceptable limits and time.
 - (b) Demonstrate proper operation for design-accident-loading sequence to design-load requirements and verify that voltage and frequency are maintained within required limits.
 - (c) Demonstrate full-load-carrying capability for an interval of not less than 24 hours, of which 22 hours should be at a load equivalent to the continuous rating of the diesel generator and 2 hours at a load equivalent to the 2-hour rating of the diesel generator. Verify that voltage and frequency requirements are maintained. The test should also verify that the cooling system functions within design limits.
 - (d) Demonstrate proper operation during diesel-generator load shedding, including a test of the loss of the largest single load and of complete loss of load, and verify that the voltage requirements are met and that the overspeed limits are not exceeded.

- (e) Demonstrate functional capability at full-load temperature conditions by rerunning the test phase outlined in (a) and (b), immediately following (c), above.
 - (f) Demonstrate the ability to synchronize the diesel generator unit with offsite power while the unit is connected to the emergency load, transfer this load to the offsite power, isolate the diesel-generator unit, and restore it to standby status.
 - (g) Demonstrate that the engine will perform properly if switching from one fuel-oil supply system to another is a part of the normal operating procedure to satisfy the 7-day storage requirement.
 - (h) Demonstrate that the capability of the diesel-generator unit to supply emergency power within the required time is not impaired during periodic testing under (3), below.
- (2) Testing of redundant diesel-generator units during normal plant operation should be performed independently (nonconcurrently) to minimize common failure modes resulting from undetected interdependences among diesel-generator units. However, during reliability demonstration of diesel-generator units during plant preoperational testing and testing subsequent to any plant modification where diesel-generator unit interdependence may have been affected or every 10 years (during a plant shutdown), whichever is the shorter, a test should be conducted in which redundant units are started simultaneously to help identify certain common failure modes undetected in single diesel-generator unit tests.

- (3) Periodic testing of diesel-generator units during normal plant operation should:
- (a) Demonstrate proper startup and verify that the required voltage and frequency are automatically attained within acceptable limits and time. This test should also verify that the components of the diesel-generator unit required for automatic startup are operable.
 - (b) Demonstrate full-load-carrying capability (continuous rating) for an interval of not less than one hour. The test should also verify that the cooling system functions within design limits. This test could be accomplished by synchronizing the generator with the offsite power and assuming a load at the maximum practical rate.
- (4) The interval for periodic testing under (3), above (on a per diesel-generator unit basis) should be no more than 31 days and should depend on demonstrated performance. If more than one failure has occurred in the last 100 tests (on a per nuclear unit basis), the test interval should be shortened in accordance with the following schedule:
- (a) If the number of failures in the last 100 valid tests is one or zero, the test interval should be not more than 31 days.
 - (b) If the number of failures in the last 100 valid tests is two, the test interval should be not more than 14 days.

- (c) If the number of failures in the last 100 valid tests is three, the test interval should be not more than 7 days.

- (d) If the number of failures in the last 100 valid tests is four or more, the test interval should be not more than 3 days.

3.0 DISCUSSION AND EVALUATION

Millstone 1 uses one diesel generator and one gas turbine generator for emergency on-site power. In the event that the diesel generator fails to start, the gas turbine generator assumes the loads normally powered by the DG, as well as its own loads.

3.1 Emergency Generator Loading

Discussion. Millstone Final Safety Analysis Report, Amendment 15 (Reference 1), provided a list of diesel and gas turbine generator loads; this list was subsequently modified by NNECo in a revised load sequencing table (Reference 2).

The diesel generator has a continuous rating of 3330 kVA at 0.8 PF; no 30-minute rating is specified. The worst-case generator load is 3027 HP using nameplate data. With a 90% motor efficiency, as specified in R.G. 1.9, the worst-case load is 3136 kVA at 0.8 PF. The maximum step load change is 829 kVA or 25% of the continuous generator rating.

The gas turbine generator is rated at 12 MW, and derated to 11.1 MW at an ambient temperature of 100°F; no 30-minute rating is specified. The worst-case generator load is 14,831 HP (nameplate). Again using 90% motor efficiency, the worst-case load is 12.293 MW. The maximum step load change for the gas turbine generator is 5.8 MW or 52% of the continuous generator rating.

Millstone 1 Technical Specifications do not require that the diesel and gas turbine generators be sequenced to full emergency loading during each refueling outage (Reference 3).

Evaluation. The total worst-case automatically connected diesel generator load is 3136 kVA or 94% of the generator continuous rating. This is within the requirements of R.G. 1.9. The total worst-case automatically connected gas turbine generator load is 12.293 MW or 111% of the generator continuous rating at 100°F. This does not meet the criteria of R. G. 1.9.

3.2 Bypass of Protective Trips

Discussion. On May 31, 1977, NNECo provided a list of protective trips which render the emergency generators incapable of responding to an automatic emergency start signal (Reference 4). Neither the diesel generator nor the gas turbine generator has any protective trips.

Evaluation. Since neither emergency generator has any emergency trips, Millstone 1 is in agreement with current NRC staff guidelines as listed in BTP ICSB 17.

3.3 Emergency Generator Testing

Discussion. Millstone 1 Technical Specifications, paragraph 4.9.A, require emergency generator testing as follows:

(1) Diesel Generator

- (a) The diesel generator shall be started and loaded once a month to demonstrate operational readiness. The test shall continue until the diesel engine and the generator are at equilibrium temperature at

full load output. During this test, the diesel starting air compressor will be checked for operation and its ability to recharge air receivers.

- (b) During each refueling outage, the conditions under which the diesel generator is required will be simulated and test conducted to demonstrate that it will start and be ready to accept load within 13 seconds.
- (c) During the monthly generator test, the diesel fuel oil transfer pumps shall be operated.

(2) Gas Turbine Generator

- (a) The gas turbine generator shall be fast started and the output breakers closed within 48 seconds once a month to demonstrate operational readiness. The test shall continue until the gas turbine and generator are at equilibrium temperature at full load output. Use of this unit to supply power to the system electrical network shall constitute an acceptable demonstration of operability.
- (b) During each refueling outage, the conditions under which the gas turbine generator is required will be simulated and a test conducted to verify that it will start and be able to accept emergency loads within 48 seconds.

Evaluation. Emergency generator testing defined in the plant Technical Specifications address the criteria listed in paragraph 2.3 to the following extent (evaluation is for both diesel and gas turbine generators except as noted):

- (1) (a) Required voltage and frequency limits are not specified.
 - (b) Load sequencing is not required.
 - (c) No limits are specified for voltage, frequency or duration.
 - (d) Not addressed.
 - (e) Not addressed.
 - (f) Diesel--not addressed; Gas Turbine-- acceptable, is normally used for plant load peaking.
 - (g) Diesel--covered on monthly test; Gas Turbine-- not applicable.
 - (h) Not addressed.
- (2) Not addressed.
- (3) (a) No limits specified for voltage or frequency; no time limit specified for diesel; automatic-start components are not addressed.
- (4) Not addressed.

The Technical Specifications do not meet current licensing criteria for diesel-generator testing. Diesel-generator failure data will be extracted by NRC from Licensee Event Reports and will be considered in the final evaluation of testing adequacy.

4.0 SUMMARY

The automatic diesel generator loading is in compliance with current licensing criteria. The automatic gas turbine generator loading does not meet current licensing criteria, as the worst-case load is 111% of the continuous generator rating at 100°F ambient.

Emergency generator protective trips are in agreement with current NRC staff guidelines as listed in BTP ICSB 17.

Emergency generator testing, as specified by plant Technical Specifications, does not meet licensing criteria.

The review of qualification of the emergency generators will be completed with SEP Topics III-1, Seismic Qualification, and III-12, Environmental Qualification.

5.0 REFERENCES

1. Final Safety Analysis Report, Amendment 15, dated June 15, 1969, pp. VIII-3.12, VIII-3.13.
2. FSAR revision (apparently) received by NRC approximately August 20, 1979, Tables 8.3.9-3 and 8.3.9-4.
3. Millstone Nuclear Power Station Unit No. 1 Technical Specifications, December 1977, pp. 3/4 9-1 and 3/4 9-2.
4. Letter NNRCo (Switzer) to NRC (Lear) dated May 31, 1977, "Evaluation of Diesel Generator Alarm and Control Circuitry."

5. General Design Criterion 17, "Electric Power System," of Appendix A, "General Design Criteria of Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."
6. General Design Criterion III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."
7. "Standard Criteria for Class IE Power Systems and Nuclear Power Generating Stations", IEEE Std. 308, 1974, paragraph 5.2.4.
8. "Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Stations," IEEE Std. 387, 1977.
9. "Selection of Diesel Generator Set Capacity for Standby Power Supplies", Regulatory Guide 1.9.
10. "Periodic Testing of Diesel Generators Used as Onsite Power Systems at Nuclear Plants," Regulatory Guide 1.108.
11. "Diesel-Generator Reliability Qualification Testing," BTP ICSB2 (PSB).
12. "Diesel-Generator Protective Trip Circuit Bypasses," BTP ICSB17 (PSB).