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Docket No. 50-206
LS05-81-03-017

Mr. R. Dietch
Vice President
Nuclear Engineering and Operations
Southern California Edison Company
2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Dear Mr. Dietch:

SUBJECT: SEP TOPICS - VIII-2, "DIESEL GENERATORS" AND VIII-4, "ELECTRICAL PENETRATIONS OF REACTOR CONTAINMENT" (SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1)

Copies of the subject technical evaluation reports, prepared by contractor personnel, are enclosed. These assessments compare your facility, as described in Docket No..50-206, with the criteria currently used by the regulatory staff for licensing new facilities. Please inform us if your as-built facility differs from the licensing basis assumed in our assessments within 30 days of receipt of this letter.

These evaluations will be a basic input to the integrated safety assessment for your facility unless you identify changes needed to reflect the as-built conditions at your facility. These assessments may be revised in the future if your facility design is changed or if NRC criteria relating to this subject is modified before the integrated assessment is completed.

In future correspondence regarding these topics, please refer to the topic numbers in your cover letter.

Sincerely,

Original Signed by
Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

Enclosures:
SEP Topics VIII-2
and VIII-4

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

March 2, 1981

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Division of Licensing

Enclosures:
SEP Topics VIII-2
and VIII-4

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SEP TECHNICAL EVALUATION

TOPIC VIII-2
DIESEL GENERATORS

SAN ONOFRE

Docket No. 50-206

June 1980

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SEP TECHNICAL EVALUATION

TOPIC VIII-2
DIESEL GENERATORS

SAN ONOFRE

1.0 INTRODUCTION

The objective of the review is to determine if the onsite AC generator for the San Onofre 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 ICSB2, "Diesel-Generator Reliability Qualification Testing"; and BTP ICSB17, "Diesel Generator Protective Trip Circuit Bypasses."

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

2.0 CRITERIA

2.1 Diesel 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 diesel 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 Diesel 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

San Onofre utilizes two redundant diesel generators, each of which feeds an independent safety bus. The generators are rated at 6000 KW continuous; no 30-minute rating is specified. The worst-case loading of the two generators is within 3% of one another and the use of protective trips on each generator is identical. Therefore, the discussion and evaluation of one diesel generator which follows is valid for the other diesel generator.

3.1 Diesel Generator Loading

Discussion. In the event of a LOCA concurrent with a loss of offsite power, the more-heavily loaded generator assumes an automatically sequenced load of 4424 KW (nameplate rating[1]). Using a 90% efficiency factor, as specified in RG 1.9 when nameplate ratings are used, the calculated automatically sequenced load is 4915 KW.

The maximum step load occurs ten seconds after receipt of a Safety Injection Signal. The magnitude of the step change is 4122 KW (69% of continuous capacity). San Onofre Technical Specifications require a partial load sequencing and 4422 KW load test of at least one hour during each refueling outage[2]).

Evaluation. The calculated worst-case automatically-connected load is 4915 KW, 82% of the generator's continuous rated load capacity. Therefore, the total automatically-connected load meets the requirements of RG 1.9.

3.2 Bypass of Protective Trips

Discussion. On May 17, 1978, Southern California Edison (SCEC) provided a list of protective trips which render the diesel generators incapable of responding to an automatic emergency start signal[3]. The only diesel generator protective trips which are not bypassed under emergency conditions are overspeed and high differential.

Evaluation. All diesel generator protective trips are bypassed under emergency conditions except overspeed and high differential. Therefore, the diesel generator protective trips meet the requirements of BTP ICSB17.

3.3 Diesel Generator Testing

Discussion. San Onofre Technical Specifications, paragraph 4.4.B, require diesel-generator testing as follows:

(1) At least once per 31 days on a staggered test basis by:

(a) Verifying the diesel starts from ambient condition,

(b) Verifying a fuel transfer pump can be started and transfers fuel from the storage system to the day tank,

(c) Verifying the diesel generator is synchronized and running at $\geq$4422 kW for $\geq$60 minutes,

(d) Verifying the diesel generator is aligned to provide standby power to the associated emergency buses,

(e) Verifying the day tank contains a minimum of 290 gallons of fuel,

(f) Verifying the fuel storage tank contains a minimum of 37,500 gallons of fuel, and

(g) Verifying that the automatic load sequencer is OPERABLE with the interval between each load block within ± 10% of its design interval.

(2) At least once per 3 months verify that a sample of diesel fuel from the fuel storage tank is within the acceptable limits as specified by the supplier when checked for viscosity, water, and sediment.

(3) At least once per refueling cycle by:

(a) Subjecting the diesel to an inspection in accordance with procedures prepared in conjunction with its manufacturer's recommendations for this class of standby service,

(b) Simulating a loss of offsite power (loss of voltage on Busses 1C and 2C) in conjunction with a safety injection signal, and:

[1] Verifying operation of circuitry which locks out noncritical equipment,

[2] Verifying the diesel starts from ambient condition on the auto start signal, energizes the emergency busses with permanently

connected loads and the auto connected emergency loads through the load sequencer (with exception of the feedwater, safety injection, charging and refueling water pumps whose respective breakers may be racked-out to the test position) and operates for 5 minutes while its generator is loaded with the emergency loads.

[3] Verifying that on the safety injection actuation signal, all diesel generator trips, except engine overspeed and generator differential, are automatically bypassed.

[4] Verifying the diesel generator operates for $\geq$60 minutes while loaded to $\geq$4422 kW.

(c) Verifying the generator capability to reject a load of 2611 kW without tripping.

Evaluation. Diesel-generator testing defined in the plant Technical Specifications address the criteria listed in paragraph 2.3 to the following extent:

(1) (a) Voltage, frequency and time limits not specified

(b) Voltage, frequency and time limits not specified

(c) Minimum duration is 60 minutes

(d) Acceptable

(e) Not addressed

(f) Not addressed

(g) Covered under monthly test

(h) Not addressed

(2) Not addressed

(3) (a) Voltage, frequency and time limits not specified

(b) Minimum test load is 4422 kW; generator is rated at 600 kW

(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 San Onofre diesel generator loading, at 82% of rated generator capacity, complies with current licensing requirements as defined in RG 1.9. The bypass of diesel generator protective trips meets current NRC staff guidelines. Diesel-generator testing, as specified by plant Technical Specifications, does not meet current licensing criteria. The review of qualification of the diesel-generators will be completed with SEP Topics III-1, Seismic Qualification, and III-12, Environmental Qualificaition.

5.0 REFERENCES

1. Letter, SCEC (Haynes) to NRR (Ziemann), dated August 9, 1979, Attachment 1.

2. San Onofre Technical Specifications and Bases, October 1966, Paragraph 4.4.B.3.

3. Letter, SCEC (Baskin) to NRR (Ziemann), dated May 17, 1978.

4. General Design Criterion 17, "Electric Power System," of Appendix A, "General Design Criteria of Nuclear Power Plants," to 10 CRF Part 50, "Domestic Licensing of Production and Utilization Facilities."

5. General Design Criterion III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CRF Part 50, "Domestic Licensing of Production and Utilization Facilities."

6. "Standard Criteria for Class IE Power Systems and Nuclear Power Generating Stations," IEEE Std. 308, 1974, paragraph 5.2.4.

7. "Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Stations," IEEE Std. 387, 1977.

8. "Selection of Diesel Generator Set Capacity for Standby Power Supplies," Regulatory Guide 1.9.

9. "Periodic Testing of Diesel Generators Used as Onsite Power Systems at Nuclear Plants," Regulatory Guide 1.108.

10. "Diesel-Generator Reliability Qualification Testing", BTP ICSB2 (PSB).

11. "Diesel-Generator Protective Trip Circuit Bypasses," BPT ICSB17 (PSB).

SEP TECHNICAL EVALUATION

TOPIC VIII-4
ELECTRICAL PENETRATIONS OF REACTOR CONTAINMENT

SAN ONOFRE NUCLEAR STATION UNIT NO. 1

Southern California Edison

Docket No. 50-206

January 1980

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SEP TECHNICAL EVALUATION

TOPIC VIII-4
ELECTRICAL PENETRATIONS OF REACTOR CONTAINMENT

SAN ONOFRE NUCLEAR STATION UNIT NO. 1

1.0 INTRODUCTION

This review is part of the Systematic Evaluation Program (SEP), Topic VIII-4. The objective of this review is to determine the capability of the electrical penetrations of the reactor containment to withstand short circuit conditions of the worst expected transient fault current resulting from single random failures of circuit overload protection devices.

General Design Criterion 50, "Containment Design Basis" of Appendix A, "General Design Criteria for Nuclear Power Plants" to 10 CFR Part 50 requires that penetrations be designed so that the containment structure can, without exceeding the design leakage rate, accommodate the calculated pressure, temperature, and other environmental conditions resulting from any loss-of-coolant accident (LOCA).

IEEE Standard 317, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations", as augmented by Regulatory Guide 1.63, provides a basis of electrical penetrations acceptable to the staff.

Specifically, this review will examine the protection of typical electrical penetrations in the containment structure to determine the ability of the protective devices to clear faults prior to exceeding the penetration design rating under LOCA temperatures.

2.0 CRITERIA

IEEE Standard 317, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations" as supplemented by

Nuclear Regulatory Commission Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants" provides the basis acceptable to the NRC staff. The following criteria are used in this report to determine compliance with current licensing requirements:

(1) IEEE Standard 317, Paragraph 4.2.4 -- "The rated short circuit current and duration shall be the maximum short circuit current in amperes that the conductors of a circuit can carry for a specified duration (based on the operating time of the primary overcurrent protective device or apparatus of the circuit) following continuous operation at rated continuous current without the temperature of the conductors exceeding their short circuit design limit with all other conductors in the assembly carrying their rated continuous current under the specified normal environmental conditions."

This paragraph is augmented by Regulatory Guide 1.63, Paragraph C-1 -- "The electric penetration assembly should be designed to withstand, without loss of mechanical integrity, the maximum possible fault current versus time conditions that could occur given single random failures of circuit overload protection devices."

(2) IEEE Standard 317, Paragraph 4.2.5 -- "The rated maximum duration of rated short circuit current shall be the maximum time that the conductors of a circuit can carry rated short circuit current based on the operating time of the backup protective device or apparatus, during which the electrical integrity may be lost, but for which the penetration assembly shall maintain containment integrity."

3.0 DISCUSSION AND EVALUATION

In this evaluation, the results of typical containment penetrations being in at LOCA temperature initially concurrent with a random failure of the circuit protective devices will be analyzed.

Southern California Edison provided information (Reference 1) on typical penetrations. No evaluation of the data was provided. Southern California Edison has established a temperature limit of 194°F (90°C) before seal failure for the low voltage penetration, a temperature limit of 842°F (450°C) for the medium voltage penetration, and a temperature limit of 300°F (149°C) for the dc penetration based on the melting point of the material comprising the hermetical seal. Maximum short circuit current available (I_{sc}) was provided by Southern California Edison for a three-phase bolted fault. Rated current (I_r) for each penetration was also provided.

The following formula (Reference 2) was used to determine the time allowed before a short circuit would cause the penetration to heat up to the temperature limit.

$$t = \frac{A^2}{I^2} \quad .0297 \log \frac{T_2+234}{T_1+234} \qquad \text{(Formula 1)}$$

where

t	=	time in seconds
I	=	current in amperes
A	=	conductor area in circular mils
T_1	=	initial temperature (133°C, LOCA condition)
T_2	=	maximum penetration temperature before failure.

This is based on the heating effect of the short circuit current on the conductor and does not take into account heat losses of the conductor. For times less than several seconds, this heat loss is negligible.

In evaluating the capability of the penetration to withstand LOCA temperature with a short circuit current, Formula 1 was used to calculate the time required to heat the conductor from the LOCA temperature to penetration failure temperature for currents from rated current to maximum short circuit current in 20% increments. Times for the primary and secondary overcurrent devices to interupt these fault currents were calculated. Where breaker ratings provided by the licensee indicated minimum and maximum fault clearing times, the maximum time was used for conservatism.

3.1 Typical Low-Voltage (0-1000V) Penetrations (WPC-23). This penetration uses 4/0 conductors and has a rated continuous current capacity of 188 amps. SCE has calculated the maximum available short circuit current to be 27530 amps. This penetration provides 480 V ac power to Residual Heat Removal Pump B.

The temperature limit for the hermetic seal of the penetration is $90^{\circ}C$ which is $43^{\circ}C$ below the design temperature inside containment during a LOCA. Therefore, it does meet current licensing requirements regardless of the electrical status of the circuit.

3.1.1 Low-Voltage Penetration Evaluation. With the initial temperature of the penetration at $133^{\circ}C$ (LOCA), penetration WPC-23 does not meet current requirements of RG 1.63 and IEEE Std. 317 for any current regardless of the operation of the primary or secondary protective devices.

3.2 Typical Medium-Voltage (>1000 V) Penetration. Penetration number JB1A0 has been identified by Southern California Edison as being typical of medium-voltage penetrations. This penetration provides 4160 V ac power to Reactor Coolant Pump A. The maximum short circuit current available has been determined by SCE to be 43825 amps. At this current, the penetration limiting temperature is reached in 1.04 seconds. Rated current is 565 amps and the penetration uses 500 MCM cable.

The primary breaker will not operate to clear any faults between rated and maximum short circuit current in sufficient time to prevent exceeding the 842°F (450°C) limit provided by the licensee.

The normal secondary breaker will operate to clear any fault current prior to reaching the penetration seal limiting temperature. The alternate secondary breaker (used when power is supplied by the start-up transformer) will not operate to clear any faults prior to exceeding the penetration seal temperature limit.

3.2.1 Medium Voltage Penetration Evaluation. Penetration JB1A0 does not meet current requirements for any fault current regardless of the operation of the primary and alternate secondary breaker. Using the normal secondary breaker and assuming failure of the primary breaker, the penetration meets the requirements of RG 1.63 and IEEE Std. 317.

3.3 Typical DC Penetration. Penetration number EPC-6 has been identified by Southern California Edison as being typical of direct current penetrations. This penetration is used to provide 125 V dc power to Emergency RCP Thermal Cooling Pump. The maximum available short circuit current has been determined by SCE to be 5953 amps. At this current the penetration temperature limit will be exceeded in 0.27 second. The rated current is 116.7 amps and the penetration uses 2/0 cable.

The primary breaker will operate to interrupt any short circuit current prior to reaching the 149°C penetration temperature limit from LOCA temperature initially. The secondary breaker will not operate to prevent the penetration seal temperature limit from being exceeded for any fault current.

3.3.1 DC Penetration Evaluation. Penetration EPC-6 does not meet current requirements of RG 1.63 and IEEE Std. 317 for any short circuit conditions with a failure of the primary breaker.

4.0 SUMMARY

From LOCA temperatures initially, penetrations WPC-23 and EPC-6 do not meet current licensing requirements for a short circuit fault and random failure of the primary circuit breakers. Penetration JB1A0 will exceed its design temperature rating for any fault current when operating from the alternate secondary power supply. When operating from the normal secondary supply, the secondary breaker is expected to clear any fault prior to exceeding penetration seal limiting temperature. Penetration WPC-23 exceeds its temperature limit at LOCA temperature regardless of the electrical status of the circuit.

The review of Topic III-12, "Environmental Qualification," may result in changes to the electrical penetration design and therefore, the resolution of the subject SEP topic will be deferred to the integrated assessment, at which time, any requirements imposed as a result of this review will take into consideration design changes resulting from other topics.

5.0 REFERENCES

1. Southern California Edison letter (Haynes) to NRC (Ziemann) dated June 15, 1979.

2. IPC&A Publication P-32-382, "Short Circuit Characteristics of Insulated Cable."