

Mr. Harold B. Ray
 Executive Vice President
 Southern California Edison Company
 San Onofre Nuclear Generating Station
 P.O. Box 128
 San Clemente, California 92674-0128

December 21, 1998

SUBJECT: ISSUANCE OF AMENDMENT FOR SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 2 (TAC NO. MA2186) AND UNIT NO. 3 (TAC NO. MA2187)

Dear Mr. Ray:

The Commission has issued the enclosed Amendment No.146 to Facility Operating License No. NPF-10 and Amendment No.138 to Facility Operating License No. NPF-15 for San Onofre Nuclear Generating Station, Unit Nos. 2 and 3. The amendments authorize revision of the Updated Final Safety Analysis Report in response to your application dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998.

These amendments revise the licensing basis as described in Section 3.5, "Missile Protection," of the Updated Final Safety Analysis Report to incorporate a new turbine missile protection calculation methodology.

A copy of our related Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's next biweekly Federal Register notice.

Sincerely,

Original Signed By

James W. Clifford, Senior Project Manager
 Project Directorate IV-2
 Division of Reactor Projects III/IV
 Office of Nuclear Reactor Regulation

Docket Nos. 50-361
 and 50-362

Enclosures: 1. Amendment No.146 to NPF-10
 2. Amendment No.138 to NPF-15
 3. Safety Evaluation

cc w/encls: See next page

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Mr. Harold B. Ray

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December 21, 1998

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SOUTHERN CALIFORNIA EDISON COMPANY

SAN DIEGO GAS AND ELECTRIC COMPANY

THE CITY OF RIVERSIDE, CALIFORNIA

THE CITY OF ANAHEIM, CALIFORNIA

DOCKET NO. 50-361

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 146
License No. NPF-10

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Southern California Edison Company, et al. (SCE or the licensee) dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

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2. Accordingly, by Amendment No. 146 , the license is amended to authorize revision of the Updated Final Safety Analysis Report (UFSAR) as set forth in the application for amendment by Southern California Edison Company dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998. Southern California Edison Company shall update the UFSAR to reflect the revised licensing basis authorized by this amendment in accordance with 10 CFR 50.761(e).
3. This license amendment is effective as of the date of its issuance and shall be implemented in the next periodic update of the UFSAR in accordance with 10 CFR 50.71(e) that will occur after 60 days of the date of issuance. Implementation of the amendment is the incorporation into the Updated Final Safety Analysis Report, the changes to the description of the facility as described in the licensee's application dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998, and evaluated in the staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION



James W. Clifford, Senior Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Date of Issuance: December 21, 1998



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SOUTHERN CALIFORNIA EDISON COMPANY

SAN DIEGO GAS AND ELECTRIC COMPANY

THE CITY OF RIVERSIDE, CALIFORNIA

THE CITY OF ANAHEIM, CALIFORNIA

DOCKET NO. 50-362

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 3

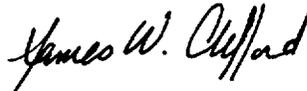
AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 138
License No. NPF-15

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Southern California Edison Company, et al. (SCE or the licensee) dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No. 138, the license is amended to authorize revision of the Updated Final Safety Analysis Report (UFSAR) as set forth in the application for amendment by Southern California Edison Company dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998. Southern California Edison Company shall update the UFSAR to reflect the revised licensing basis authorized by this amendment in accordance with 10 CFR 50.761(e).
3. This license amendment is effective as of the date of its issuance and shall be implemented in the next periodic update of the UFSAR in accordance with 10 CFR 50.71(e) that will occur after 60 days of the date of issuance. Implementation of the amendment is the incorporation into the Updated Final Safety Analysis Report, the changes to the description of the facility as described in the licensee's application dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998, and evaluated in the staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION



James W. Clifford, Senior Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Date of Issuance: December 21, 1998



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 146 TO FACILITY OPERATING LICENSE NO. NPF-10
AND AMENDMENT NO. 138 TO FACILITY OPERATING LICENSE NO. NPF-15

SOUTHERN CALIFORNIA EDISON COMPANY

SAN DIEGO GAS AND ELECTRIC COMPANY

THE CITY OF RIVERSIDE, CALIFORNIA

THE CITY OF ANAHEIM, CALIFORNIA

SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3

DOCKET NOS. 50-361 AND 50-362

1.0 INTRODUCTION

By application dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998, Southern California Edison Company, et al. (SCE or the licensee) requested that the staff approve changes to the Updated Safety Analysis Report for San Onofre Nuclear Generating Station, Unit Nos. 2 and 3. The proposed changes would revise the licensing basis as described in Section 3.5, "Missile Protection" of the Updated Final Safety Analysis Report to incorporate a new turbine missile protection calculation methodology.

As described in the June 12, 1998, amendment application, the existing calculation methodology assumes a turbine missile generation probability and calculates a turbine missile strike-and-damage probability. These probabilities are used to calculate the overall probability of damage to safety-related equipment due to turbine missile strike. The proposed new turbine missile protection calculation methodology would assume a turbine missile strike-and-damage probability and calculate a turbine missile generation probability. These probabilities would then be used to calculate the overall probability of damage to safety-related equipment due to turbine missile strike.

The November 23, 1998, supplemental letter provided clarifying information requested by the staff. The October 29, 1998, supplemental letter provided the licensee's revised no significant hazards consideration determination.

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2.0 BACKGROUND

Part 50 of Title 10 of the Code of Federal Regulations, Appendix A, General Design Criterion (GDC) 4 requires that structures, systems, and components important to safety shall be appropriately protected against environmental and dynamic effects, including the effects of missiles, that may result from equipment failure. Because turbine rotors have large masses and rotate at relatively high speeds during normal reactor operation, failure of a rotor may result in the generation of high energy missiles potentially impacting and damaging safety-related structures, systems and components.

The NRC staff has developed guidance in NUREG-0800, Standard Review Plan (SRP), Section 3.5.1.3, Revision 1, "Turbine Missiles," to address the requirements of GDC 4 for protection of safety-related systems from postulated turbine missiles. SRP 3.5.1.3, Revision 1 references Regulatory Guide (RG) 1.115, "Protection Against Low-Trajectory Turbine Missiles." RG 1.115 establishes an acceptance criteria of an overall annual probability of 1×10^{-7} or less for damage to safety-related systems, structures, and components due to turbine missiles. RG 1.115 also provides the methodology for the calculation of this probability. The overall annual probability (P_4) of damage from turbine missiles to safety-related systems is generally expressed as the product of (1) the probability of turbine failure resulting in the ejection of turbine disk (or internal structure) fragments through the turbine casing (P_1); (2) the probability of ejected missiles perforating intervening barriers and striking safety-related structures, systems, and components (P_2); and (3) the probability of struck structures, systems, or components failing to perform their safety function (P_3). The RG 1.115 methodology assumes a missile generation probability (P_1) of 1×10^{-4} per year (based upon historical data at the time) and states that licensees need to demonstrate through site specific analysis that the strike-and-damage probability (the product of P_2 and P_3) is 1×10^{-3} or less.

Turbine rotor inspections performed at operating plants have identified cracking at the inner radius of turbine disks and disk keyways. These inspections identified stress corrosion as the responsible crack initiation mechanism. The staff has followed these developments closely. On the basis of previous staff reviews and various estimates by others (Bush, 1973; Twisdale, Dunn, and Frank, 1982), for a variety of plant layouts, the staff concluded that if a turbine missile were generated, the probability of unacceptable damage to safety-related structures, systems, and components would be on the order of 10^{-3} or 10^{-2} per unit-year, depending on whether the turbine orientation is favorable or unfavorable, respectively. RG 1.115 defines favorable and unfavorable turbine orientation and lists typical safety-related systems.

Based on these developments and operating experience, the staff has shifted the review emphasis to the prevention of missile-generating turbine failures. In keeping with this shift of emphasis the staff established turbine missile generation probability guidance for determining (1) turbine disk ultrasonic inservice inspection frequencies; and (2) turbine control and overspeed protection system maintenance and testing schedules. This guidance is documented in SRP 3.5.1.3, Draft Revision 3, dated May 1995. Examples of application of this guidance include NUREG-1048, "Safety Evaluation Report Related to the Operation of Hope Creek Generating Station" and the staff's safety evaluation reports for subsequent evolutionary and advanced reactor plants.

3.0 EVALUATION

In a letter dated June 12, 1998, as supplemented by letters dated September 18, 1998, October 29, 1998, and November 23, 1998, the licensee submitted an application for amendment to the facility operating licenses regarding its plans to replace the low pressure (LP) turbine rotors at SONGS, Unit Nos. 2 and 3. The existing LP turbine rotors are double flow with eight stages in each flowpath, and the rotors are of "shrunk-on disk" construction. The new rotors will be designed and manufactured by GEC Alstom Energy Ltd (Alstom). Alstom has provided an updated missile probability analysis methodology in support of the proposed modification to account for the retrofitted turbine design and the interface with the existing turbine overspeed controls, which are not being modified. The licensee considers that the proposed changes do not alter SONGS overall conformance to Regulatory Guide (RG) 1.115 and GDC 4. However, the proposed changes will require a revision to the SONGS licensing basis as described in Section 3.5.1.3 of the Updated Final Safety Analysis Report (UFSAR), to change the existing turbine missile calculation methodology from the strike-and-damage probability to a missile generation probability.

The calculation of the current SONGS probability of damage to safety related structures, systems, and components is based on the guidance provided in RG 1.115. The overall annual probability of damage by turbine missiles to safety-related systems, P_4 , is the product of the turbine missile generation probability (P_1) and the strike-and-damage probability (P_2 times P_3). The current SONGS calculation methodology calculates the turbine missile strike-and-damage probability and assumes a value, as provided in RG 1.115, for the turbine missile generation probability. RG 1.115 states that the overall annual probability of damage by turbine missiles to safety-related systems, P_4 , should be 1×10^{-7} or less. The turbine missile generation probability assumed per RG 1.115 is 1×10^{-4} per unit-year. The SONGS turbine missile strike-and-damage probability for the existing turbine design is 0.9×10^{-3} or less per unit-year. This probability was established by performing a detailed plant specific analysis. The product of these probabilities results in an overall annual probability of turbine missile damage to safety-related systems, structures, and components of 1×10^{-7} or less, which meets the staff acceptance criteria established in RG 1.115.

As part of the turbine retrofit project, the licensee is proposing to replace the existing turbine missile strike-and-damage methodology with a turbine missile generation methodology to demonstrate compliance with GDC 4 for the new rotors. With this change in methodology, the turbine missile generation probability will be a calculated plant specific value. The strike-and-damage probability will be an assumed value which is consistent with SRP 3.5.1.3, Draft Revision 3 and RG 1.115. The overall acceptance criteria of 1×10^{-7} for the annual probability of damage to safety related systems from turbine missiles remains unchanged.

SONGS Unit No. 2 and 3 have an unfavorable turbine generator orientation with respect to turbine missile generation relative to the location of safety-related equipment. The new calculation methodology therefore assumes a strike and damage probability of 1×10^{-2} per unit-year. In order to meet SRP 3.5.1.3, Draft Revision 3 criteria, the probability of turbine missile generation should be no greater than 1×10^{-5} per reactor-year. Alstom, the manufacturer of the replacement rotors has provided a methodology for analyzing missile

generation probability that addresses the design of the new replacement LP turbines in combination with the existing turbine control system. The turbine vendor calculated a probability of turbine missile generation of 1.7×10^{-6} per reactor-year, which meets the acceptance criteria of 1×10^{-5} per reactor-year. The turbine vendor calculation is based on a turbine inspection interval of 10 years and a monthly turbine steam valve testing program. The ten year turbine rotor inspection interval is controlled in the SONGS Preventative Maintenance Program. The monthly testing of the turbine steam valves is controlled in the SONGS Unit Nos. 2 and 3 licensee controlled specifications. These programmatic controls appropriately assure that turbine integrity and protection is maintained within the analysis assumptions. The basic principles of the Alstom methodology are the same as those used in other turbine retrofit projects that have been completed at other nuclear power plants.

The primary objective of the turbine rotor modification is to redesign and replace the existing LP rotors in the SONGS Unit No. 2 and 3 main turbines. The modification is expected to accomplish the following:

- mitigate stress corrosion cracking (SCC) in the area of turbine blading attachment;
- enhance net turbine output capability by using a more efficient "Optiflow" configuration; and
- extend the interval between inspections required for the turbine preventative maintenance program by utilizing improved materials and manufacturing methods.

The Alstom design will accomplish the above objectives by providing an advanced welded turbine rotor design which includes an "Optiflow" configuration. The first four turbine stages are single flow, enabling increased blade heights and reduced leakage to achieve optimum performance. After the first four stages the flow splits and continues through an additional four stages arranged in a conventional double flow configuration. This design provides improved thermal performance and a high degree of reliability and availability.

Each welded rotor consists of five relatively small 3%NiCrMoV forgings welded together to form a single rotor. This welded LP turbine rotor design significantly reduces the probability of a turbine missile because of the following design features:

- Elimination of shrunk fits and keyways;
- Low levels of tangential stress;
- Use of lower strength material which results in improved SCC resistance; and
- Relatively small forgings which provide for high resolution during ultrasonic examination.

Alstom has used the same welded rotor "Optiflow" design for many years in both nuclear and fossil power plants. Some nuclear units have accumulated more than 100,000 operating hours without experiencing SCC on any of these nuclear steam turbine welded rotors. For example, six LP rotors of similar welded construction with identical L-1 and L-0 blades have been in

service for over 60,000 hours at the Ulchin Power Station (Korea Nuclear 9 and 10) and have not experienced cracking problems. This provides additional assurance that the new SONGS LP turbine rotors will perform in service as designed.

The most significant source of turbine failure is a burst-type failure of one or more disk panels of an LP rotor. Failure of other rotors, including the high pressure (HP) and generator rotor, would be contained by the relatively massive and strong turbine casing. Therefore, the probability of missile generation is evaluated as the combination of the probability of two distinct types of LP rotor disk panel failures (1) failure at normal operating speed up to 120 percent of the rated speed due to stress corrosion cracking; and (2) failure due to run-away overspeed greater than 120 percent of the rated speed based on a failure of the protection system. Alstom's basic principles for the SONGS turbine missile probability analysis methodology are the same as previous studies which have been reviewed and accepted by the NRC staff for other nuclear power plants. Alstom's turbine missile analysis methodology provided the following results relative to the operation of the SONGS turbines.

- The total annual calculated probability of failure (at any speed) for the new SONGS LP rotors is 1.7×10^{-6} ; and
- The above listed probability of failure supports turbine inspection intervals of up to ten years, and assumes a monthly turbine valve testing program.

Alstom has performed additional analyses to consider undetectable cracks at the first inspection. The maximum indication permitted by the ultrasonic examination standard (Flat Bottom Hole equivalent) is 0.12 inches. For the purpose of the analysis, Alstom assumed a defect twice the maximum permitted size. The calculated maximum fatigue-extended defect sizes at the end of service life, all of which were assumed to include an overspeed test to 112 percent of normal speed, indicated that only a small amount of fatigue crack growth occurs within the service life of rotors. Therefore, the analyses demonstrated that probability of fracture from a fatigue-extended defect is nearly negligible.

In summary, the Alstom methodology has demonstrated that new turbine rotor design would significantly reduce the probability of LP rotor failure because the total annual calculated probability of failure (at any turbine speed) for the next design is 1.7×10^{-6} . This value is less than the value specified by the NRC staff (1×10^{-5} per reactor-year or less for unfavorably oriented turbines) and therefore, meets the requirements of GDC 4.

The Alstom missile probability analysis methodology has demonstrated that the probability of a turbine generated missile is less than 1×10^{-5} per reactor-year, resulting in an annual overall probability of 1×10^{-7} or less for damage to safety related systems due to turbine missiles. This meets the criteria stated in RG 1.115 which provides an acceptable method of meeting GDC 4. An example of previous application of this guidance in this manner is found in NUREG-0991 (Safety Evaluation and supplements related to operation of Limerick Generating Station, Units 1 and 2, August 1983). The NRC staff finds that replacement of the turbine rotors and extension of turbine rotor inspection intervals and turbine valve testing frequencies will not adversely affect the function of, or failure modes of any

equipment important to safety. The staff concludes that the risk for the proposed plant design meets the relevant requirements of GDC 4 and is therefore acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the California State official was notified of the proposed issuance of the amendments. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (63 FR 60412). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: G. Georgiev

Date: December 21, 1998