September 8, 2000

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

SUBJECT: SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3 - ISSUANCE OF AMENDMENTS ON RELAXING THE CURRENT 3-YEAR INSPECTION FREQUENCY FOR REACTOR COOLANT PUMP FLYWHEELS TO A 10-YEAR INTERVAL (TAC NOS. MA8735 and MA8736)

Dear Mr. Ray:

The Commission has issued the enclosed Amendment No. 170 to Facility Operating License No. NPF-10 and Amendment No. 161 to Facility Operating License No. NPF-15 for San Onofre Nuclear Generating Station, Units 2 and 3, respectively. The amendments consist of changes to the Technical Specifications (TSs) in response to your application dated April 20, 2000 (PCN-503), and supplemented by letter dated June 6, 2000.

The amendments revise TS 5.5.2.5, "Reactor Coolant Pump Flywheel Inspection Program" by changing the volumetric examination frequency of the upper flywheel on each of the primary reactor coolant pump motors from a 3-year to a 10-year cycle.

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,
/RA/ by Stephen Dembek for/
L. Raghavan, Senior Project Manager, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-361 and 50-362

Enclosures:
1. Amendment No. 170 to NPF-10
2. Amendment No. 161 to NPF-15
3. Safety Evaluation

cc w/encls: See next page

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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 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 170
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 April 20, 2000, and supplemented by letter dated June 6, 2000, 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, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C(2) of Facility Operating License No. NPF-10 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, as revised through Amendment No. 170 , are hereby incorporated in the license. Southern California Edison Company shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 30 days of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Stephen Dembek, Chief, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: September 8, 2000

ATTACHMENT TO LICENSE AMENDMENT NO. 170

FACILITY OPERATING LICENSE NO. NPF-10

DOCKET NO. 50-361

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
5.0-11	5.0-11

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.5 Reactor Coolant Pump Flywheel Inspection Program

Surveillance of the primary coolant pump flywheels shall consist of a 100% volumetric inspection of the flywheels each 10 years.

5.5.2.6 Secondary Water Chemistry Program

This program provides controls for monitoring secondary water chemistry to inhibit SG tube degradation and low pressure turbine disc stress corrosion cracking. The program shall include:

a. Identification of a sampling schedule for the critical parameters and control points for these parameters;

b. Identification of the procedures used to measure the values of the critical parameters;

c. Identification of process sampling points;

d. Procedures for the recording and management of data;

e. Procedures defining corrective actions for all off-control point chemistry conditions; and

f. A procedure identifying (a) the authority responsible for interpretation of data and (b) the sequence and timing of administrative events, required to initiate corrective action.

5.5.2.7 Explosive Gas and Storage Tank Radioactivity Monitoring Program

This program provides controls for potentially explosive gas mixtures contained in the Gaseous Radwaste System, the quantity of radioactivity contained in gas storage tanks, and the quantity of radioactivity contained in unprotected outdoor liquid storage tanks. The gaseous radioactivity quantities shall be determined following methodology comparable with Branch Technical Position (BTP) ETSB 11-5, "Postulated Radioactive Release due to Waste Gas System Leak or Failure". The liquid radwaste quantities shall be determined in accordance with Standard Review Plan, Section 15.7.3, "Postulated Radioactive Release due to Tank Failures".

(continued)

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 3

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 161
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 April 20, 2000, and supplemented by letter dated June 6, 2000, 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, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C(2) of Facility Operating License No. NPF-15 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, as revised through Amendment No. 161 , are hereby incorporated in the license. Southern California Edison Company shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 30 days of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Stephen Dembek, Chief, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: September 8, 2000

ATTACHMENT TO LICENSE AMENDMENT NO. 161

FACILITY OPERATING LICENSE NO. NPF-15

DOCKET NO. 50-362

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
5.0-11	5.0-11

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.5 Reactor Coolant Pump Flywheel Inspection Program

Surveillance of the primary coolant pump flywheels shall consist of a 100% volumetric inspection of the flywheels each 10 years.

5.5.2.6 Secondary Water Chemistry Program

This program provides controls for monitoring secondary water chemistry to inhibit SG tube degradation and low pressure turbine disc stress corrosion cracking. The program shall include:

a. Identification of a sampling schedule for the critical parameters and control points for these parameters;

b. Identification of the procedures used to measure the values of the critical parameters;

c. Identification of process sampling points;

d. Procedures for the recording and management of data;

e. Procedures defining corrective actions for all off-control point chemistry conditions; and

f. A procedure identifying (a) the authority responsible for interpretation of data and (b) the sequence and timing of administrative events, required to initiate corrective action.

5.5.2.7 Explosive Gas and Storage Tank Radioactivity Monitoring Program

This program provides controls for potentially explosive gas mixtures contained in the Gaseous Radwaste System, the quantity of radioactivity contained in gas storage tanks, and the quantity of radioactivity contained in unprotected outdoor liquid storage tanks. The gaseous radioactivity quantities shall be determined following methodology comparable with Branch Technical Position (BTP) ETSB 11-5, "Postulated Radioactive Release due to Waste Gas System Leak or Failure". The liquid radwaste quantities shall be determined in accordance with Standard Review Plan, Section 15.7.3, "Postulated Radioactive Release due to Tank Failures".

(continued)

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 170 TO FACILITY OPERATING LICENSE NO. NPF-10

AND AMENDMENT NO. 161 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 April 20, 2000 (PCN-503), and supplemented by letter dated June 6, 2000, Southern California Edison Company, et al. (SCE or the licensee) requested changes to the Technical Specifications for San Onofre Nuclear Generating Station (SONGS), Units 2 and 3. The proposed changes would relax reactor coolant pump (RCP) flywheel inservice inspection (ISI) requirements to a 10-year frequency for SONGS, Units 2 and 3. The licensee's submittal included a plant-specific report, "RCP Flywheel Safe-Life Evaluation — SONGS Unit 2 and 3," which provided an engineering analysis based on fracture mechanics. Presently, SONGS's RCP flywheel inspection is performed in accordance with its licensing commitment to Regulatory Guide (RG) 1.14, "Reactor Coolant Pump Flywheel Integrity," which provides guidelines on conducting surface and ultrasonic volumetric (UT) examinations of RCP flywheels coinciding with each individual plant's ISI schedule as required by Section XI of the American Society of Mechanical Engineers (ASME) Code.

The supplemental letter dated June 6, 2000, provided clarifying information that was within the scope of the April 20, 2000, application and the original *Federal Register* notice and did not change the staff's initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

The function of the RCP in the reactor coolant system (RCS) of a pressurized water reactor plant is to maintain an adequate cooling flow rate by circulating a large volume of primary coolant water at high temperature and pressure through the RCS. A concern about overspeed of the RCP and its potential for failure led to the issuance of RG 1.14 in 1971. The regulatory position of RG 1.14 concerning ISI calls for an in-place UT examination of the areas of higher stress concentration at the bore and keyway at approximately 3-year intervals and a surface examination of all exposed surfaces and complete UT examination at approximately 10-year

intervals. The flywheel inspection schedule is to coincide with the individual plant's ISI schedule as required by Section XI of the ASME Code.

Operating power plants have been inspecting their flywheels for more than 20 years, and no flaws have been identified that affect flywheel integrity. This inspection record, and the licensee's concern over inspection costs and personnel radiation exposure, prompted the licensee to submit this report to demonstrate through fracture mechanics analysis that flywheel inspections can be reduced without impairing plant safety.

3.0 EVALUATION AND VERIFICATION

3.1 Applicable Requirements

The primary regulatory position of RG 1.14 regarding flywheel design addresses three critical speeds: (a) the critical speed for ductile fracture, (b) the critical speed for non-ductile fracture, and (c) the critical speed for excessive deformation of the flywheel. This regulatory position specifies, as a design criterion, that the normal speed of the flywheel should be less than one-half of the lowest of these three critical speeds, and the loss-of-coolant accident (LOCA) overspeed should be less than the lowest of these three critical speeds.

RG 1.14 was issued in 1971. Since then, the methodology regarding ductile and non-ductile fracture of a variety of structures and components has advanced significantly, and standard evaluation procedures and acceptance criteria against component fracture have now been specified in the ASME Code. It has been established that applying linear elastic fracture mechanics (LEFM) to metal components to assess the structural integrity is more conservative than applying the elastic-plastic fracture mechanics and the net-section collapse methodology (EPFM) and the net-section collapse methodology where ductility are considered. Hence, meeting the code requirements is equivalent to meeting the intent of RG 1.14.

3.2 Analysis for Critical Crack Depths Based on Non-Ductile Fracture

3.2.1 Licensee's Evaluation

The licensee's submittal provides the critical crack depths based on LEFM analysis to address non-ductile fracture. The LEFM analysis considers a postulated radial semi-elliptical surface flaw with an aspect ratio of 1 (crack depth) to 4 (crack length), which is assumed to be located at the bore of the flywheel. The licensee then used the methodology of Appendix A of Section XI of the ASME Code to calculate the stress intensity factor (K_I) of the postulated flaw due to applied stresses. The applied stresses were obtained by the licensee using finite element method analysis with the loading from the centrifugal force and shrink-fit. Using a fracture toughness of 140 ksi$\sqrt{in}$ for both K_{Ia} and K_{Ic} and applying the acceptance criteria of IWB-3610, i.e., $K_I < K_{Ia}/\sqrt{(10)}$ for normal and upset conditions and $K_I < K_{Ic}/\sqrt{(2)}$ for emergency and faulted conditions, the licensee calculated the allowable crack depths for the normal operating speed (normal and upset conditions) to be 4.1 inches for the Allis-Chalmers flywheels and 3.4 inches for the ABB Combustion Engineering flywheels. The corresponding allowable crack depths for the accident speed (emergency and faulted conditions) are more than 4 inches for both the Allis-Chalmers flywheels and the ABB Combustion Engineering flywheels.

The final crack depths were calculated based on an initial crack depth of 0.25 inch and a flaw growth for the plant life using the ASME Appendix A fatigue growth curves. This calculation gave a final crack depth of 0.27 inch for the Allis-Chalmers flywheels and 0.26 inch for the ABB Combustion Engineering flywheels. Since the final crack depths are smaller than the allowable depths calculated for the limiting normal and upset conditions, the licensee concluded that the flaw tolerance analysis meets the ASME Code for detected flaws and the inspection frequency for the RCP flywheels can be reduced to 10-year intervals.

3.2.2 Staff's Evaluation

The licensee's analysis focused on the non-ductile fracture of the flywheel in RG 1.14. Since the publication of RG 1.14 in 1971, more appropriate EPFM methodology has been developed to predict ductile fracture. The staff determined that performing an EPFM analysis is not necessary because the LEFM analysis is appropriate for the thick section of the flywheel in its operating temperature range.

For the licensee's LEFM analysis, the staff finds use of the semi-elliptical surface flaw for the postulated flaw and the use of the Appendix A methodology to calculate K_I and to estimate the fatigue crack growth to be acceptable. Further, since the required safety factor for postulated flaws (e.g., a safety factor of 2 used in reactor pressure vessel pressure temperature limits calculation) is less than that for detected flaws (e.g., a safety factor of $\sqrt{(10)}$ in flaw evaluations specified in the ASME Code), using the acceptance criteria of IWB-3610 is conservative. However, there are areas in the licensee's LEFM analysis that the staff disagrees with. First, the licensee's use of the fracture toughness of 140 ksi$\sqrt{(in)}$ for the flywheel material American Society for Testing and Materials (ASTM) A543, Grade B, Class I, is inappropriate. Second, the licensee's assumed initial flaw depth of 0.25 inch is not fully justified. The licensee's fracture toughness value was derived from the K_{Ic} - Charpy V-Notch impact energy correlation for the fracture toughness of a material at the upper-shelf energy region. This is too optimistic, because it is very unlikely that the flywheel material would be in the upper-shelf region at an operating temperature of 100 °F. In this review, the staff used a K_{Ic} value of 100 ksi$\sqrt{(in)}$ from a Combustion Engineering (CE) topical report SIR-94-080, Revision 1, submitted by Entergy Operations, Inc., for Arkansas Nuclear One units on April 4, 1995, where some flywheels were reported to be made of ASTM A543, Grade B, Class I, material. With this K_{Ic} value, the licensee's allowable flaw depths become 1.0 inch for the Allis-Chalmers flywheels and 1.6 inches for the ABB CE flywheels. Also, since the initial postulated crack depth of 0.25 inch has not been substantiated, the staff used an initial postulated crack depth of 0.33 inch in this review. The initial postulated flaw depth of 0.33 inch was based on industry experience with the inspection of ferritic components with short metal paths. This has also been used in the staff's review of the topical reports of the same subject from Westinghouse Owners Group (WOG) and ABB CE Owners Group (CEOG).

Since the revised final crack depths (0.35 inch for the Allis-Chalmers flywheels and 0.34 inch for the ABB CE flywheels) are still smaller than the revised allowable depths (1.0 inch for the Allis-Chalmers flywheels and 1.6 inches for the ABB CE flywheels) for the limiting normal and upset conditions, the staff determined that the licensee's flaw tolerance analysis meets the intent of IWB-3610 of the ASME Code, and the licensee has demonstrated the structure integrity of the RCP flywheels for the plant life. Hence, the inspection frequency for the RCP flywheels can be reduced to 10-year intervals. It should be mentioned that the licensee used the same value for K_{Ia} and K_{Ic} in its evaluation. This is equivalent to replacing the criterion of IWB-3610 for normal

and upset conditions, $K_I < K_{Ia}/\sqrt{(10)}$, by $K_I < K_{Ic}/\sqrt{(10)}$. This minor relaxation is allowed because IWB-3610 is for actual cracks discovered during inservice inspections. In the LEFM analysis for the RCP flywheels, the cracks are postulated cracks. This is consistent with the staff position in previous reviews of the WOG topical report WCAP-14535 submitted by Duquesne Light Company for Beaver Valley Power Station, Unit Nos. 1 and 2, on January 24, 1996, and the CEOG topical report mentioned above on the same subject. The staff's safety evaluations for the two topical reports were issued on September 12, 1996 (see WCAP-14535A, submitted to NRC by letter from Duquesne Light Company dated December 20, 1996), and May 21, 1997 (see SIR-94-080-A, Rev. 1, dated September 30, 1997). Recently, a similar modification, i.e., the use of K_{Ic} instead of K_{Ia}, in pressure-temperature (P-T) limits evaluation for reactor pressure vessels has been adopted as Code Case N-640, and the staff has approved several applications.

3.3 Compliance with the Excessive Deformation Failure Criterion

The concern of RG 1.14 over excessive deformation is the enlargement of the bore that could cause a separation of the flywheel from the shaft or could cause an unbalance of the flywheel leading to structural failure. The staff believes that the concern here is the loss of shrink-fit at high speed. Once it happens, the keys on the flywheels may not be able to prevent the slight relative displacement between the wheel and the shaft from happening. Consequently, the balance of the flywheel might be altered.

The licensee reported in its submittal that the shrink-fit is 0.0155 inch for the Allis-Chalmers flywheels and 0.0125 inch for the ABB CE flywheels. The remaining shrink-fits at their corresponding accident speeds are 0.001 inch for the Allis-Chalmers flywheels and 0.004 inch for the ABB CE flywheels, as reported in the licensee's supplement. Since the remaining shrink-fit is very small for the Allis-Chalmers flywheels and the implementation of the initial shrink-fit was likely to involve uncertainty, the staff determined that it is possible that the flywheels may lose their shrink-fit completely at the accident speed. However, since Allis-Chalmers flywheels were designed with two axial keys and six circumferential keys, there is no danger for the flywheels to move out of position relative to the shaft at the accident speed. The only concern is that the balance of the flywheel might be altered due to the slight relative displacement between the wheel and the shaft spider arms. The ABB CE flywheels shrink-fit is large enough to satisfy the excessive deformation failure criteria discussed in RG 1.14.

3.4 Summary

The staff has completed its review of the licensee's submittals and has determined that the criteria and the evaluation methodology in the reports are appropriate and meet the intent of RG 1.14. For the RG criteria on the critical speeds that affect flywheel integrity, the staff concluded that all flywheels meet the proposed non-ductile fracture criteria and will have adequate fracture toughness during their service periods. Although the ABB CE flywheels satisfy the excessive deformation criterion of RG 1.14, the Allis-Chalmers flywheels satisfy only the excessive deformation criterion with a small margin (at accident speed). Consequently, it should be noted that if such an accident does occur to the Allis-Chalmers flywheels in the future, the licensee should monitor the vibration level of the flywheel-shaft assembly in the subsequent restart. For regular ISI, the licensee should either conduct a qualified in-place UT examination over the volume from the inner bore of the flywheel to the circle of one-half the outer radius or conduct a surface examination (magnetic particle testing and/or liquid penetrant testing) of exposed surfaces defined by the volume of the disassembled flywheels once every 10 years.

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 surveillance requirement. 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 (65 FR 31360). 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: S. Sheng

Date: September 8, 2000