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

ENVIRONMENTAL IMPACT APPRAISAL

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 55 TO PROVISIONAL OPERATING LICENSE NO. DPR-13

SOUTHERN CALIFORNIA EDISON COMPANY

STEAM GENERATOR REPAIR PROGRAM AND RESTART

SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1

DOCKET NO. 50-206

Date: June 8, 1981

TABLE OF CONTENTS

1.0 STEAM GENERATOR REPAIR PROJECT

Southern California Edison Company has modified (by sleeving or plugging) approximately 7000 steam generator tubes at San Onofre Nuclear Generating Station Unit No. 1. The Nuclear Regulatory Commission, evaluated the environmental impact and conclude that the actions will not significantly affect the quality of the human environment.

2.0 BACKGROUND

In April 1980 San Onofre 1 experienced leakage in the steam generator tubes and decided to shut down to investigate. During testing to locate the leaking tubes, the licensee discovered that many of the tubes had experienced significant degradation just above the tubesheet on the hot side (inlet side) of the steam generator because of caustic intergranular attack. This condition is difficult to detect by conventional eddy current testing methods. However, by a combination of several testing methods, including removal and laboratory testing of several sample tubes, the licensee identified and determined the extent of the problem. If the degradation exceeds certain bounds, the technical specifications require the licensee to submit the proposed remedial action for approval by the Nuclear Regulatory Commission (NRC). In fulfillment of those technical specifications, Southern California Edison Co. (SCE) submitted a plan in September 1980 to the NRC to install sleeves in the San Onofre 1 steam generator tubes.[1]

3.0 DESCRIPTION OF SLEEVING PROGRAM

SCE chose the option of steam generator tube sleeving to restore the integrity of the San Onofre 1 steam generator tubes. In simple terms, sleeving is the insertion of tubes within the existing steam generator tubes. The program involves several steps. First, to reduce radiation levels inside the steam generator channel head, the channel head is decontaminated using a high-pressure water/grit spray. Second, the inside surface of the bottoms of the tubes are cleaned to prepare for sleeve insertion and joining. The surface cleaning process also reduces radiation levels inside the channel head. Then, the sleeves are manually inserted. The upper and lower ends of the sleeves are expanded. Next, the bottom of the sleeve is hard-rolled into the tubesheet. Some sleeves located in the out-of-sludge regions are rigidly joined at their upper ends to the steam generator tubes using a proprietary process. These joined tubes were ultrasonically tested to ensure that the sleeves have been properly joined. The remainder of the sleeves are expanded and rolled near the top of the sleeve to form a leak-limiting upper joint. More than 90% of the sleeves in the SONGS 1 steam generators are the leak-limiting mechanically joined type.

4.0 ENVIRONMENTAL IMPACTS OF THE SLEEVING PROJECT

The environmental impacts of occupational exposure and public radiation exposure are discussed in the following sections.

4.1 Occupational Exposure

We have reviewed the work procedures and practices that Southern California Edison has used during the steam generator tube sleeving project. Based on this review and on meetings with the applicant, the staff concludes that SCE took adequate steps to assure that the occupational radiation exposures associated with the tube sleeving project were maintained as low as is reasonably achievable (ALARA) and that the individual doses were maintained within the requirements of 10 CFR Part 20, "Standards for Radiation Protection."

Before initiating the steam generator sleeving work, SCE used decontamination and shielding techniques in the steam generator channel head area to reduce dose rates. These techniques resulted in reducing the dose rates in the hot leg channel heads of the steam generators by a factor of approximately 3.4.[15] Other ALARA measures implemented by SCE during the steam generator resleeving project included use of a steam generator mockup for training workers, use of remote and semiremote tooling whenever practicable, and routine air sampling, and contamination and radiation surveys. Measures such as these are recommended in Regulatory Guide 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable," in order to minimize individual occupational radiation exposures and maintain the overall collective occupational radiation exposure as low as is reasonably achievable.

To determine the relative environmental significance of the approximately 3500 person-rems expended, comparisons were made with (1) the doses expected from normal operation of nuclear plants and (2) other nonnuclear risks.

Table 4.1 shows the occupational dose history for San Onofre 1.[2,3] Approximately 800 person-rems of the total exposure for 1980 was due to the steam generator repair project. The remaining 2700 person-rems for the steam generator project were accrued during the first half of 1981 as the project reached completion. With the addition of 3496 person-rems for the sleeving project, the average annual dose for the 12½ years of dose history at Unit 1 (1969 through mid-1981) will be approximately 685 person-rems. Occupational exposure estimates were not specifically considered in the San Onofre 1 Final Environmental Statement (FES).[4] However, in recent environmental statements for new pressurized water reactors (e.g., Summer FES), NRC has provided an estimate of 410 person-rems per reactor unit as the average annual occupational dose (through 1979).[5]

TABLE 4.1

ANNUAL COLLECTIVE[2,3] OCCUPATIONAL DOSE AT SAN ONOFRE 1

Year	Collective Occupational Dose (person-rems)
1969	42
1970	155
1971	50
1972	256
1973	353
1974	71
1975	292
1976	880
1977	847
1978	401
1979	139
1980	2322

This estimate is based on reported data from power reactors that are operating with radiation protection programs in accordance with NRC guidance and regulations. A summary of this data is provided in Table 4.2.[2,3] These data show that 410 person-rems per reactor unit per year is roughly the average of the wide range of doses incurred at all pressurized water reactor (PWR) units over the last several years (through 1979). The amount of dose incurred at any single reactor unit in a year is highly dependent on the amount of major maintenance performed that year. Operating data from U.S. pressurized water reactors indicate that units requiring high levels of special maintenance work can average as much as 1300 person-rems per year over the life of the unit.[2,6] Although the doses for these particular plants far exceed the average of 410 person-rems for PWRs, these doses are included in the average and are considered normal deviations from the average, particularly since such maintenance contributes to effective and safe plant operation and since it is carried out with procedures that maintain exposures ALARA. As Table 4.2 shows, the person-rems estimate for the sleeving project is within the historical range of doses above the average for a single unit in a year.

We calculate that 3496 person-rems, the occupational dose expended for the sleeving project, corresponds to a risk of less than one premature fatal cancer in the exposed workforce population. We also calculate that 3496 person-rems correspond to a risk of less than one genetic effect to the ensuing five generations. These risks are based on risk estimators derived in the BEIR Report[7] and WASH-1400[8] from data for the population as a whole. New information in the BEIR III Report[9] would lead to an even lower estimated risk for premature fatal cancers. These risks are incremental risks; risks in addition to the normal risks of fatal cancer and generic effects we all face continuously. For a population of 2400 (the size of the workforce for the steam generator repair project), these normal risks would be expected to result in about 460 cancer deaths and about 140 genetic effects (genetic effects are genetic diseases or malformations),[7,10,11] plus about 720 additional genetic effects among their remaining descendents.

To make the health risk associated with radiation dose more understandable, risk comparisons can be made with nonnuclear activities commonly participated in by many individuals. One rem of radiation is numerically comparable to a lifetime mortality risk of about 10^{-4}.[7] Table 4.3 presents the equivalent risk of 10^{-4} for several common activities--risks which many people take routinely and consider to be insignificant.[12] The average dose to a worker for the sleeving project will be roughly 1.5 rems. As Table 4.3 shows, the lifetime risk from radiation dose for the average sleeving project worker is smaller than the lifetime risk associated with many common activities.

Another perspective of an occupational risk comes from comparison of occupational mortality risks in the United States. One such comparison is shown in Table 4.4. It indicates that radiation exposure in the workplace, as experienced at an average radiation worker exposure rate, results in a relatively low occupational risk.

Some have critcized occupationally related cancer estimates as being overly conservative.[13] However, most experts feel the risk estimates in Table 4.4 relating to occupational exposure to low-LET (linear energy transfer) radiation

TABLE 4.2

OCCUPATIONAL DOSE AT U.S. LIGHT WATER REACTORS[2,3]
(Person-rems per reactor unit)

Year	PWR Average	BWR Average	Low	High
1969	165	195	42	298
1979	684	127	44	1639
1971	307	255	50	768
1972	464	286	61	1032
1973	783	380	85	5262
1974	331	507	71	1430
1975	318	701	21	2022
1976	460	549	58	2648
1977	396	828	87	3142
1978	429	604	48	1621
1979	510	733	30	2140
1980	578	1136	22	3626

TABLE 4.3

LIFETIME MORTALITY RISKS
NUMERICALLY EQUIVALENT TO ONE REM[20]

Type of Activity	Equivalent Risk to One Rem
Smoking cigarettes	1 carton
Drinking wine	66 bottles
Automobile driving	6,600 miles
Commercial flying	33,000 miles
Canoeing	1.6 days[†]
Being a man aged 60	1.8 days

[†]Eight hours per day.

TABLE 4.4

OCCUPATIONAL RISKS
(Events per year per 100,000 workers)

	Mining & Quarrying	All U.S. Industies	Trade	Radiation Exposure
Fatal Accidents†	63	14	6	<1
Delayed Effects				
Actual	Readily Observable	Occasionally Observable	Not Observable	Not Observable
Estimated	?	Includes 115-219 lethal cancers*	?	4-6 lethal cancers**

†1976 data, from "Accident Facts, 1977 Edition," National Safety Council.

*Estimates from "Toxic Chemicals and Public Protection, A Report to the President by the Toxic Substances Strategy Committee," Council on Environmental Quality, Government Printing Office, May 1980. Assumes 20-38% of all cancers are associated with occupatio

**Estimates from BEIR-III, 1980, assuming an average radiation worker exposure rate of 0.5 rem/hr; exposure at the limit, 5 rems/yr, would yield an estimate of from 37 to 63 lethal cancers per year per 100,000 workers.

are also overestimates. NRC staff finds that the comparisons just presented are reasonable. The risks of occupational exposures in the range of 0.5 rem per year to 5 rem per year do not significantly affect a typical worker's total risk of mortality.

In summary, so far as occupational radiation dose is concerned, the staff concludes that the 3486 person-rem expended for the sleeving project at San Onofre 1 falls within the normal range of annual occupational doses which have been observed in recent years at operating reactors. Although the doses resulting from the steam generator repair project will increase the annual occupational exposure average at San Onofre 1 to approximately 685 person-rems, this is still well below the 1300 person-rems per year annual average referenced in NRC current Final Environmental Statements as being an upper-bound dose average of PWRs experiencing high levels of special maintenance work. SCE described appropriate steps to ensure that occupational doses were maintained within the limits of 10 CFR Part 20 and ALARA. The additional health risks over normal risks because of these doses are quite small, less than 1% of normal risk to the project workforce as a whole. The risk to an average individual in the workforce will be lower than the risk incurred from participation in many commonplace activities. The individual risks associated with exposures involved in the repair program will be controlled and limited so as not to exceed the limits set forth in 10 CFR Part 20 for occuptional exposure. For the foregoing reasons, the staff concludes that the environmental impact because of occupational exposure will not significantly affect the quality of the human environment.

4.2 Public Radiation Exposure

The amounts of radioactivity which were released in liquid and gaseous effluents as a result of the sleeving project are presented in Table 4.5. Table 4.5 also presents effluent releases for 1978[16] and 1979[17] from San Onofre 1 and the FES[4] annual average effluent release estimates.

SCE took several steps to minimize releases.[14] To minimize airborne releases, the channel head decontamination process and the surface preparation process used was a wet process, thus entraining removed material in water. The air from the channel head where the work was performed was exhausted through the opposite manway using a high efficiency particulate filter to control airborne concentrations during channel head work. Also, enclosure tents were erected at selected locations inside containment to control contamination during process equipment maintenance. The water from the decontamination process and the surface preparation process was treated by filters and demineralizers to minimize liquid releases.

As Table 4.5 shows, the releases from the sleeving project are small compared to both the FES estimates and San Onofre's actual annual releases.

TABLE 4.5

RADIOACTIVE EFFLUENTS FROM SAN ONOFRE 1

Type of Radioactive Effluent	SCE Estimates[5] for Release During Sleeving (Ci)	San Onofre 1[16] 1978 Releases (Ci)	San Onofre 1[17] 1979 Releases (Ci)	FES[4] Estimates of Annual Average Releases (Ci/yr)
Gaseous				
Noble Gases	Negligible†	1.8(+3)	6.3(+2)	4.4(+3)
Iodine	Negligible†	2.1(-4)	1.2(-4)	5.5(-2)
Particulates	5.5(-6)***	2.5(-3)	2.1(-5)	**
Tritium	10.0	2.7(+1)	2.8(+1)	**
Liquid				
Mixed fission and activation products	2.6	1.2(+1)	1.1(+1)	1.8(+1)
Tritium	5.4	2.4(+3)	2.3(+3)	8.8(+3)

†Below lower limits of detectability for plant instrumentation.

*1.8(+3) means 1.8×10^{-3}.

**No estimate was given in FES, but FES stated that there would be particulates and tritium in the gaseous releases.

***SCE reported a 0.54 Ci release in November 1980, but the activity was believed to come from a contaminated flask, and was not an actual release. No further explanation was necessary, since the release was within technical specifications.

NRC estimates of doses to individual members of the public as well as the population as a whole in the area surrounding San Onofre are based on the radioactive effluents generated from the sleeving project (summarized in Table 4.5) and on the calculational methods presented in Regulatory Guides 1.109,[18] 1.111,[19] and 1.113.[10] The doses to individuals offsite from the sleeving project will be less than 10% of the limits of 40 CFR Part 190. The annual limits of 40 CFR Part 190 are 25 millirems to the total body or any organ except the thyroid and 75 millirems to the thyroid. The doses to the population within 50 miles will be less than 1 person-rem to the thyroid or total body from liquid effluents, and less than 1 person-rem to the thyroid or total body from airborne effluents. Every year the same population of about 7 million will receive a cumulative total body dose of more than 700,000 person-rems from the natural background radiation (about 0.1 rem per year) in the vicinity of San Onofre.[12] Thus, the population total body dose from the sleeving project is less than 0.0001% of the annual dose from natural background. On these bases, the staff concludes that the doses to individuals in unrestricted areas and to the population within 50 miles from gaseous and liquid effluents from the sleeving project will not be environmentally significant.

The sleeving project generated about 860 cubic meters of solid waste containing about 170 curies of radioactivity.[5] During 1978 and 1979, San Onofre 1 generated an annual average of 108 cubic meters of solid waste per year containing 129 curies of radioactivity. Therefore, the radioactive content of the solid wastes from the sleeving project are of the same order of magnitude as the solid waste normally generated annually at San Onofre. This volume of waste is a very small part of the amount of solid waste handled each year by the nuclear industry; therefore, this waste does not represent a significant effect on the quality of the human environment.

Since no larger radioactive effluents are expected from San Onofre after sleeving (over presleeving operation), the staff concludes that the impact on biota other than man will also be no larger after sleeving.

In summary, the radioactive releases to the public resulting from the sleeving project were less than those from normal plant operation. These releases are also much less than the estimates presented in the FES. The doses from these releases are small compared to the limits of 40 CFR Part 190 and to the annual doses from natural background radiation. SCE took appropriate steps to minimize releases. The amount of radioactivity in the solid wastes for the sleeving project is not greatly different from normal. Therefore, the radiological impact of the sleeving project will not significantly affect the quality of the human environment.

5.0 RADIOLOGICAL ASSESSMENT CONCLUSIONS

Based on our review of the proposed steam generator repair program, NRC staff has reached the following conclusions (discussed in greater detail above).

(1) The final total dose of 3496 person-rems for the sleeving project is within the expected range of doses incurred at light water power reactors in a year.

(2) The risks to the workers involved in the sleeving project from radiation exposure are no larger than the risks incurred by:

   (a) workers in other industrial businesses, and

   (b) most people, working or not, from commonplace activities such as driving a car.

(3) SCE took appropriate steps to ensure that occupational doses were maintained as low as is reasonably achievable and within the limits of 10 CFR Part 20.

(4) Offsite doses resulting from the steam generator repair program were:

   (a) no larger than those incurred during normal operation of San Onofre 1, and

   (b) small in comparison to the dose members of the public in the vicinity of San Onofre 1 receive from natural background radiation.

On the basis of the foregoing statements, the staff concludes that the steam generator repair program at San Onofre Nuclear Generating Station Unit No. 1 will not significantly affect the quality of the human environment.

6.0 BASIS AND CONCLUSION FOR NOT PREPARING AN ENVIRONMENTAL IMPACT STATEMENT

The NRC has reviewed the Steam Generator Repair Program relative to the requirements set forth in 10 CFR Part 51 of the Commission's regulations. The NRC has determined, based on this assessment, that this action will not significantly affect the quality of the human environment. Therefore, the Commission has determined that an Environmental Impact Statement need not be prepared, and that, pursuant to 10 CFR 51.5(c)(1), the issuance of a negative declaration to this effect is appropriate.

7.0 REFERENCES

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2. U.S. Nuclear Regulatory Commission, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors, 1979," Vol. 1, USNRC Report NUREG-0713, March 1981.

3. Letter from C. Hinson, NRC, to W. Krieger, NRC Subject "Preliminary LWR Exposure Data for 1980" dated May 29, 1981.

4. U.S. Atomic Energy Commission, "Final Environmental Statement Related to Operation of San Onofre Nuclear Generating Station, Unit 1, October 1973.

5. U.S. Nuclear Regulatory Commission, "Final Environmental Statement Related to the Operation of Summer Pressurized Water Reactor, USNRC Report NUREG-0719, 1981.

6. U.S. Nuclear Regulatory Commission, "Final Environmental Statement Related to Steam Generator Repair at Surry Power Station, Unit 1," USNRC Report NUREG-0692, July 1980.

7. National Academy of Sciences/National Research Council, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Report of the Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR Report), November 1972.

8. U.S. Nuclear Regulatory Commission, "Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," Executive Summary, WASH-1400 (NUREG-75/014), October 1975.

9. National Academy of Sciences/National Research Council, "The Effects on Population of Exposures to Low Levels of Ionizing Radiation," Report of the Committee on the Biological Effects of Ionizing Radiation (BEIR III Report), 1980.

10. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents From Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."

11. American Cancer Society, "1979 Cancer Facts and Statistics," 1980.

12. National Council on Radiation Protection and Measurements, "Natural Background Radiation in the United States," NCRP No. 45, 1975.

13. R. Peto, "Distorting the Epidemiology of Cancer, the Need for a More Balanced Overview," Nature 284, 297-298, March 27, 1980.

14. Letter from K. P. Baskin, Southern California Edison Co., to D. M. Crutchfield, NRC, Subject: Steam Generator Repair, dated November 26, 1980.

15. Letter from K. P. Baskin, Southern California Edison, to D. M. Crutchfield, NRC, Subject: Steam Generator Repair Program, dated May 29, 1981.

16. "1978 Effluent Report, San Onofre 1."

17. "1979 Effluent Report, San Onofre 1."

18. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance With 10 CFR Part 50, Appendix I," Revision 1.

19. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.111, "Methods of Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases From Light-Water-Cooled Reactors," Revision 1.

20. E. Pochin, "The Acceptance of Risk," British Medical Bulletin 31(3), 1975.