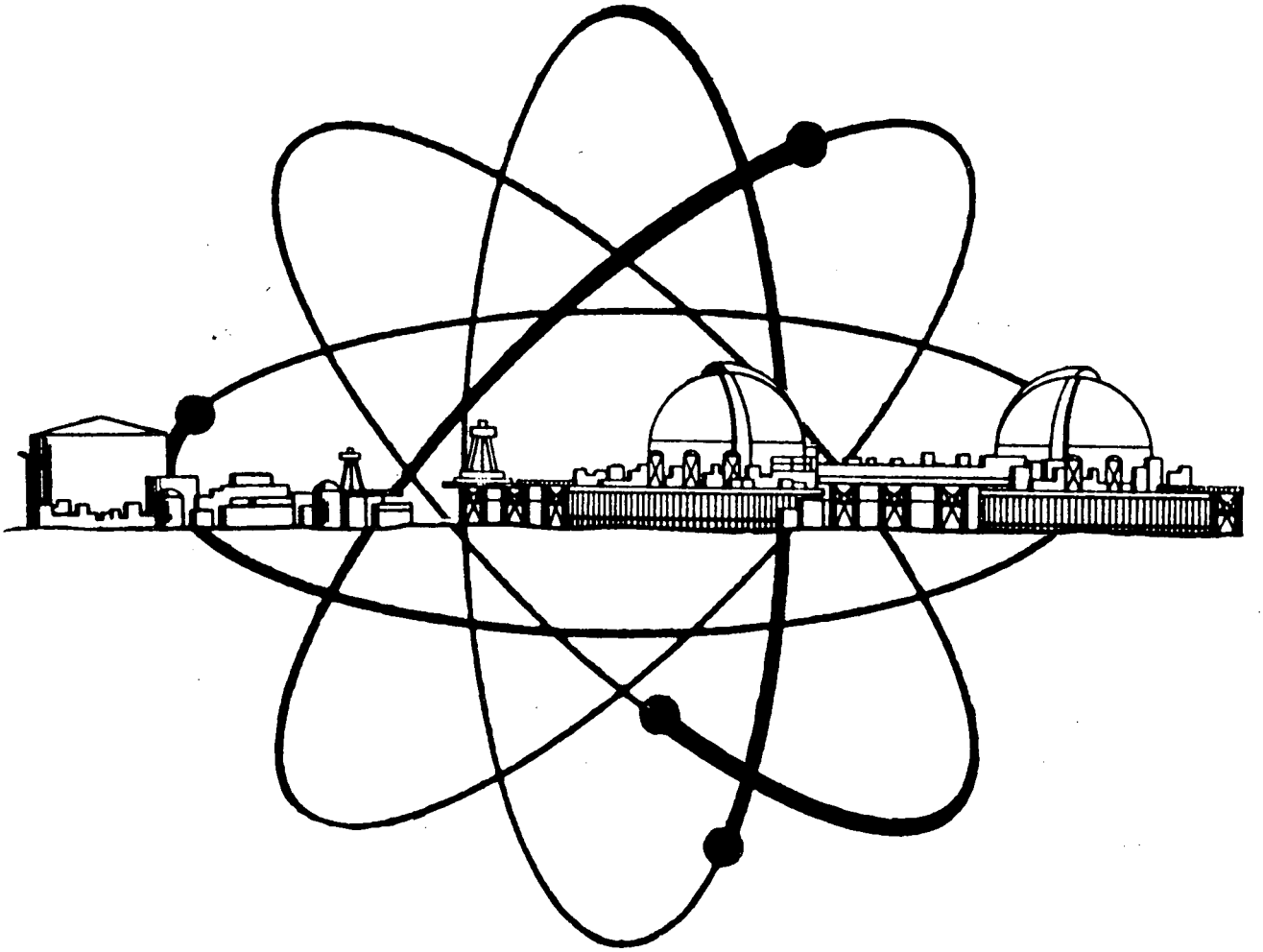
ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

FOR 1987

SAN ONOFRE NUCLEAR GENERATING STATION UNITS 1, 2, & 3



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I. INTRODUCTION

San Onofre Nuclear Generating Station (SONGS) consists of three pressurized water nuclear reactors housed in separate containment buildings. Unit 1 attained initial criticality June 1967, and operated until February 1982 when it was shut down for seismic modifications. The Unit was brought back into service during December 1984. Unit 2 and Unit 3 attained initial criticality in July 1982 and August 1983, respectively, and have been in operation since then.

To monitor the operations of SONGS Units 1, 2 and 3, and to fulfill the requirements of the SONGS Technical Specifications, an annual operational Radiological Environmental Monitoring Program (REMP) was conducted at SONGS during 1987. This program was designed to quantify ambient radiation levels in the environs of SONGS, and to identify and quantify concentrations of radioactivity in various environmental media in the vicinity of SONGS which have a potential exposure pathway to man. Thermoluminescent dosimeters (TLD's) were used to measure direct radiation levels. Sampled environmental media included the following: soil, shoreline sediment (beach sand), air, local crops, non-migratory marine species, kelp, drinking water, ocean water, and ocean bottom sediments. Each of the samples were analyzed for both naturally-occurring and SONGS-related radionuclides.

The Program

In its operational phase, the REMP was conducted in accordance with Sections 3.18 and 4.18 of the SONGS Unit 1 Technical Specifications, and Section 3/4.12 of the SONGS Units 2 and 3 Technical Specifications.

Objectives

The objectives of the operational REMP are:

1. To fulfill the obligation for radiological surveillance required by Technical Specifications.

2. To determine whether there is any significant increase in the concentration of radionuclides in critical pathways.

3. To detect any significant change in ambient gamma radiation levels.

4. To verify that the operation of SONGS Units 1, 2 and 3 have no assessable detrimental effects on the health and safety of the public or the environment.

Sample Collection

Samples of various environmental media were obtained in order to meet the stated objectives. The selection of sample types was based on established critical pathways for the transfer of radionuclides through the environment to man, experience gained during the preoperational phase, and the evaluation of data during the operational phase. Sampling locations were determined with consideration given to site meteorology, local demographs, and land uses.

Sampling locations were divided into two classes -- indicator and control. Control stations were at locations considered to be unaffected by SONGS operations. All others are considered indicator and may be expected to manifest effects of SONGS operations.

Sample Analysis

Environmental samples were collected at different locations (listed in Appendix A) in the vicinity of SONGS, and then submitted to a contracted radiological laboratory. Each sample was analyzed using standard radio-chemical procedures. The results of the analyses are summarized in Appendix B, and presented in Appendix I by sample type and analysis. The tabulated means, ranges and standard deviations presented in Appendix B were calculated using standard statistical methods according to the format specified in USNRC Regulatory Guide 4.8 (1975).

To assure quality of sample analyses, a portion of the REMP was devoted to quality control. The main aspects of this part of the program included process quality control, instrument quality control, comprehensive data reviews, and EPA interlaboratory cross-check analyses. The results of the EPA cross-check analyses are presented in Appendix C.

The impact of SONGS on the surrounding environment was assessed through a series of analyses. These analyses included: (1) comparison of data between indicator and control locations for each sample and analysis type, (2) identification of radionuclide concentrations exceeding administrative investigation levels, (3) historical trending of radionuclide concentrations in sampled environmental media over a period of several years, and (4) comparison of operational to preoperational environmental data. Summaries and comparisons of indicator to control locations are presented in Section II (page 3) of the report. Other data comparisons are presented in the Appendices.

II. RESULTS AND DISCUSSIONS OF 1987 ENVIRONMENTAL DATA

A. Direct Radiation

The purpose of this program element was to measure the amount of environmental gamma radiation in the vicinity of SONGS. To accomplish this task, calcium sulfate ($CaSO_4$:Dy) and lithium fluoride (LiF) thermoluminescent dosimeters (TLDs) were placed at each of 67 indicator and control locations, collected, and analyzed at prescribed intervals. The control location was situated in Huntington Beach. The calcium sulfate TLDs were collected quarterly and were replaced with re-zeroed dosimeters, while the lithium fluoride dosimeters were collected after an exposure time of one year (i.e., at the end of 1987). A total of 268 calcium sulfate TLDs and 67 lithium fluoride TLDs were collected and analyzed throughout the year 1987.

After the samples were analyzed, the measured doses were corrected for pre- and post-field exposure times. During the course of the year, the quarterly dose measured by the calcium sulfate TLDs from the indicator locations ranged from 8.90 to 91.3 mrem, with an average dose of 19.02 mrem. San Onofre Site Boundary (location No. 13) had the highest TLD reading in all four quarters. The doses measured at this location ranged from 26.6 to 91.3 mrem, with an average dose of 50.4 mrem. The quarterly dose measured by the calcium sulfate dosimeters from the control location, on the other hand, ranged from 20.6 to 22.0 mrem with an average dose of 21.2 mrem.

In most of the locations, a correlation can be seen between the control and indicator locations. Data however indicate that the external radiation level in the control location of Huntington Beach is somewhat higher than the indicator locations. This correlation indicates other factors such as environmental and seasonal variations are responsible and that plant effects are negligible.

The annual direct radiation dose indicated by the lithium fluoride dosimeters ranged from 29.9 to 200.1 mrem for all indicator locations with an average dose of 75.6 mrem. The dose measured from the control location was 79.4 mrem. The site boundary (location No. 13) showed a value of 200.1 mrem.

Doses measured at indicator locations were considered significant if they were greater than doses measured at the control locations by 25 percent. Using this criterion, it was determined that there were no significant doses at indicator locations during 1987, except SONGS site boundary, and that SONGS operations had negligible impact on this environmental medium.

It was determined that there were three quarterly doses that exceeded preliminary investigation levels. A 32.3 mrem dose was measured at the Site Boundary (location No. 13) during the second quarter, 51.3 mrem during the third quarter, and a dose of 91.3 mrem was measured during the fourth quarter of 1987.

Only one annual dose, namely that measured at Units 2/3 site boundary (location 13) exceeded 1.25 times the control. The dose measured at this location was 200.1 mrem.

The dose recorded at the SONGS site boundary (location No. 13) in each quarter of 1987 and the annual dose of 200.1 mrem are higher than the control due to vehicles containing radioactive waste to be shipped for disposal being parked adjacent to the TLD location. Calculations show that the values observed are reasonable and are consistent with values expected as a result of such occurence.

Because virtually all the measured doses at locations near SONGS were considered comparable to the direct radiation dose measured at Huntington Beach, it was concluded that SONGS operations had a detectable, but negligible impact on this environmental medium.

B. Airborne Particulate Analysis

Air particulate samples were collected on a weekly basis from eight indicator locations and from a control station in Huntington Beach. After collection, the samples were analyzed for gross beta activity with a lower limit of detection of 0.001 pCi/m3 of air. Samples were also composited quarterly and analyzed for 11 naturally-occurring and Station-related radionuclides by gamma spectral analysis, radiostrontium by beta counting, and gross alpha radioactivity by alpha counting.

Gross beta activity was detected in each weekly airborne particulate sample collected in 1987. The concentrations of gross beta activity in the samples collected from the indicator locations ranged from 0.010 to 0.062 pCi/m^3, averaging 0.0215 pCi/m^3 of air. The concentrations of gross beta activity in the samples from Huntington Beach ranged from 0.009 to 0.056 pCi/m^3, averaging 0.0188 pCi/m^3 of air. See Figures 1 through 4 for 1987 monthly average airborne particulates gross beta activity for selected locations. Figures 5 and 6 also show the weekly and monthly gross beta activity in the air samples.

Beryllium-7 was the only gamma-emitting radionuclide detected in each quarterly composite airborne particulate sample from both indicator and control locations. The concentrations of beryllium-7 in the samples from the indicator locations ranged from 0.074 to 0.157 pCi/m^3, averaging 0.109 pCi/m^3 of air. The concentrations of beryllium-7 in the samples collected from the control location ranged from 0.075 to 0.107 pCi/m^3, averaging 0.092 pCi/m^3.

When the quarterly-composite samples were analyzed for strontium-90 and gross alpha radioactivity, no strontium-90 was detected in any of the composite samples. No gross alpha radioactivity was detected in any of the samples using a lower limit of detection of 0.0003 pCi/m^3 of air.

Since the natural radioactivity seen in indicator samples collected from the indicator locations was commensurate to the radioactivity found in samples collected from the control location, the impact of SONGS operations on this environmental medium is considered to be negligible.

C. Radioiodine in Air

In 1987, weekly air radioiodine (i.e., iodine-131) samples were collected by adsorption on charcoal cartridges from eight locations in the vicinity of SONGS (which served as indicator locations), and from Huntington Beach (which served as a control location). By the end of 1987, a total of 468 air cartridges had been analyzed for their iodine-131 content.

Iodine-131 was above detection limits in 7 of the 468 samples analyzed during 1987. See Table II-1 for a listing of radioiodine activity detected in the weekly air samples. The lower limit of detection of I-131 in these samples was 0.04 pCi/m^3. The concentrations of iodine-131 in the samples collected from the control locations were all below the lower limit of detection of 0.04 pci/m^3.

The concentration of iodine-131 was above the lower limit of detection in location 5 (Units 2/3 switchyard) during the weeks of 9/1/87 through 10/6/87. The range of I-131 was 0.06 to 0.34 pci/m3 during this period. Location 6 (SONGS Meteorological Tower) also indicated 0.10 pCi/m^3 of iodine-131 in the week of 9/15/87. The detectable iodine-131 levels were due to purging of the containment during the refueling outage activities of Unit 2. This release did not cause any impact on off-site samples. The two locations identified above, numbers 5 and 6, are within the exclusion of area boundary (on-site sample) and are not considered to be environmental samples. The maximum iodine-131 radioactivity level observed (0.34 pCi/m^3) also did not exceed the NRC reporting level of 0.9 pCi/m^3.

TABLE II-1

1987 WEEKLY RADIOIODINE IN AIR (pCi/m^3)
SONGS UNITS 1, 2, AND 3

Date	Location*								
	1	2	3	5**	6**	9	10	11	12
1/6	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
1/13	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
1/20	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
1/27	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
2/3	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
2/10	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
2/17	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
2/24	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
3/3	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
3/10	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
3/17	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
3/24	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
3/31	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
4/7	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
4/14	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
4/21	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
4/28	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
5/5	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
5/12	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
5/19	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
5/26	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
6/2	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
6/9	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
6/16	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
6/23	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
6/30	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

Note:
<LLD - less than the lower limit of detection (0.04 pCi/m^3)
* Location 1 - City of San Clemente; location 2 - Camp San Onofre; location 3 - Huntington Beach; location 5 - Units 2/3 Switchyard; location 6 - SONGS Meteorological Tower; location 9 - State Beach Park; location 10 - Bluff; location 11 - Mesa E.O.F.; location 12 - SONGS Evaporation Pond
**Located within SONGS Exclusion Area Boundary, not an environmental sample

TABLE II-1 (Continued)

1987 WEEKLY RADIOIODINE IN AIR (pCi/m^3)
SONGS UNITS 1, 2, AND 3

Date	Location* 1	2	3	5**	6**	9	10	11	12
7/7	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
7/14	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
7/21	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
7/28	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
8/4	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
8/11	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
8/18	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
8/25	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
9/1	<LLD	<LLD	<LLD	0.06	<LLD	<LLD	<LLD	<LLD	<LLD
9/8	<LLD	<LLD	<LLD	0.34	<LLD	<LLD	<LLD	<LLD	<LLD
9/15	<LLD	<LLD	<LLD	0.15	0.10	<LLD	<LLD	<LLD	<LLD
9/22	<LLD	<LLD	<LLD	0.20	<LLD	<LLD	<LLD	<LLD	<LLD
9/29	<LLD	<LLD	<LLD	0.07	<LLD	<LLD	<LLD	<LLD	<LLD
10/6	<LLD	<LLD	<LLD	0.17	<LLD	<LLD	<LLD	<LLD	<LLD
10/13	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
10/20	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
10/27	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/3	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/10	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/17	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/24	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/1	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/8	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/15	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/22	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/29	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

Note:
<LLD - less than the lower limit of detection (0.04 pCi/m^3)
* Location 1 - City of San Clemente; location 2 - Camp San Onofre; location 3 - Huntington Beach; location 5 - Units 2/3 Switchyard; location 6 - SONGS Meteorological Tower; location 9 - State Beach Park; location 10 - Bluff; location 11 - Mesa E.O.F.; location 12 - SONGS Evaporation Pond
** Located within SONGS Exclusion Area Boundary, not an environmental sample

D. Drinking Water

In 1987, drinking water samples were collected on a monthly basis from two indicator locations and from a control location situated in Huntington Beach. Upon collection, the samples were analyzed for tritium as well as for 12 naturally-occurring and SONGS-related radionuclides. Afterwards, the samples were filtered so that the suspended solids and filtrate could be analyzed separately for gross alpha and gross beta activity. Samples from each location were also composited quarterly, and filtered in the same manner. In each instance, the suspended solids were analyzed for gross beta concentrations, and the filtrates were analyzed for gross beta activity and for tritium.

Part A. Monthly Drinking Water Results

Unfiltered Samples
No gamma-emitting radionuclides or tritium were detected in any of the samples.

Drinking Water Solids
Gross alpha activity was not detected in the suspended solids (LLD of 0.2 pCi/l) from the Tri-Cities Municipal Water District Reservoir samples, but was found in the solid residue of 8 samples collected from the San Clemente Golf Course. Gross alpha activity in the samples ranged from 0.3 to 1.4 pCi/l, averaging 0.8 pCi/l. The control location activity was below the lower limit of detection.

Gross beta activity was found in suspended solids from each sampling location. Gross beta activity was seen in solids of 22 out of 24 samples collected from the Tri-Cities Municipal Water District Reservoir and the San Clemente Golf Course. Gross beta activity in these samples ranged from 0.2 to 10 pCi/l of water, averaging 2.0 pCi/l of water. Gross beta activity was also seen in the solids of five samples collected from Huntington Beach. Gross beta activity in these samples ranged from 0.2 to 1.1 pCi/l of water, averaging 0.4 pCi/l of water.

Drinking Water Filtrate
Gross alpha activity was not found in any of the samples collected from Tri-Cities Municipal Water District Reservoir, San Clemente Golf Course or from Huntington Beach. The lower limit of detection for gross alpha was 3.0 pCi/l in these samples.

Gross beta activity, however, was found in each sample. Gross beta activity in the filtrate from Tri-Cities Municipal Water District Reservoir and the San Clemente Golf Course Well ranged from 8.0 to 21.0 pCi/l, averaging 12.3 pCi/l. Gross beta activity in the samples collected from Huntington Beach control ranged from 4.0 to 10.0 pCi/l, averaging 7.2 pCi/l.

Part B. Quarterly Drinking Water Composite Results

Drinking Water Solids

Gross alpha activity was not detected in the composite samples from the Tri-Cities Municipal Water District Reservoir, but was found in all four quarterly composites from the San Clemente Golf Course Well. Gross alpha activity in these samples ranged from 0.30 to 1.40 pCi/l, averaging 0.62 pCi/l. Gross alpha activity was not detected in composite samples from Huntington Beach.

Gross beta activity was found in samples from each sampling location. Gross beta activity was seen in all four quarterly composite samples collected from the Tri-Cities Municipal Water District Reservoir and the San Clemente Golf Course Well. Gross beta activity in these samples ranged from 0.20 to 6.00 pCi/l of water, averaging 1.56 pCi/l. Gross beta activity in the composite samples from Huntington Beach was below the lower limit of detection of 0.10 pCi/l.

Drinking Water Filtrate

Gross alpha activity was not found in the composite samples collected from Tri-Cities Municipal Water District Reservoir, San Clemente Golf Course Well, or from Huntington Beach.

Gross beta activity was seen in each quarterly composite sample. Gross beta activity in the composite samples from Tri-Cities Municipal Water District Reservoir and the San Clemente Golf Course Well ranged from 11.0 to 21.0 pCi/l, averaging 13.9 pCi/l. Gross beta activity in the samples collected from Huntington Beach ranged from 7.0 to 10.0 pCi/l, averaging 8.8 pCi/l.

Tritium was not detected in any of the quarterly composite samples because its concentration was below the lower limit of detection of 100 pCi/l.

Conclusions

No gamma-emitting radionuclides or tritium were found in the monthly drinking water samples or in the quarterly composite samples. Gross alpha and gross beta activities were, however, seen in a number of samples collected throughout 1987. The presence of gross alpha and gross beta in the indicator and control locations is due to natural sources of radioactivity, and there is no indication that gross alpha or gross beta is accumulating in either drinking water filtrate or drinking water solids. The impact of SONGS operations, then, on the environment and on the public has been negligible.

E. Local Crops

Representative fleshy crops were collected semiannually in 1987 from farms in San Clemente (which served as the indicator location), and from a garden situated SSE Oceanside (which served as the control location). Leafy vegetables were not collected due to their unavailability. (Leafy vegetables have not been grown within 22 miles of SONGS since 1981.) After collection, the edible portion of the samples was analyzed quantitatively for 12 gamma-emitting radionuclides, as well as for tritium and radiostrontium by beta counting. The results of the analyses are summarized (below) based on "as received" wet sample weights.

Cucumbers, green beans, tomatoes, and cauliflower were collected from the San Clemente and Oceanside sampling locations. Upon analysis, potassium-40 was the only radionuclide detected in samples. The concentrations of potassium-40 in the samples ranged from 1.31 to 2.60 pCi/g, wet weight averaging 1.78 pCi/g.

Upon analysis, one radionuclide was detected in the samples, namely, potassium-40. Potassium-40 was detected in each sample. The concentrations of potassium-40 in the samples ranged from 1.50 to 2.60 pCi/g, wet weight averaging 1.87 pCi/g. The concentrations of strontium-90 were below the lower limit of detection of 0.004 pCi/g, wet.

No Station-related radionuclides were detected in the samples collected from San Clemente and Oceanside, indicating that SONGS operations had a negligible impact on this environmental medium.

F. Soil

To determine if there is evidence of a build-up of radionuclides in the land near SONGS, soil samples were collected from the Visitor's Center (East Site Boundary), Old Route 101, Basilone Road, and Camp San Onofre (which served as indicator locations in the vicinity of SONGS), and from Huntington Beach which served as a control location. Surface soil was collected from all indicator and control locations. Soil samples were also collected at the depth of 3 inches from all locations in accordance with HASL-300 procedures.

After collection, each soil sample was analyzed for 12 naturally-occurring and SONGS-related radionuclides via gamma spectral analysis, and for radiostrontium by beta counting. The analyses indicated that potassium-40, cesium-137, and strontium-90 were present in detectable quantities in one or more of the samples. The findings are summarized in terms of dry sample weights.

Surface Soil Sample Results

Several radionuclides were detected in surface soil collected from the indicator and control locations. Potassium-40 was detected in each sample. The concentrations of potassium-40 in the samples from the indicator locations ranged from 6.1 to 20.0 pCi/g, averaging 13.4 pCi/g. The concentration of potassium-40 in the sample from the control location was 19.0 pCi/g of sample.

Cesium-137 was found in samples collected from Basilone Road, Old Route 101, and Camp San Onofre. The concentrations of cesium-137 in the samples (indicator) were 0.03, 0.03, and 0.13 pCi/g, respectively. Cesium-137, however, was not found in the samples collected from the East Site Boundary (Visitor's Center) and Huntington Beach control location.

Finally, strontium-90 was not detected in any of the samples collected from the control and indicator locations. The lower limit of detection of strontium-90 in the samples was 0.01 pCi/g.

Soil Profile Analysis

Potassium-40, cesium-137, and strontium-90 were found in varying amounts in the soil samples taken at 3 inches in different locations in Huntington Beach.

Potassium-40 was detected in all of the samples. The concentrations of potassium-40 in the samples collected from indicator locations and at depth of 3 inches ranged from 5.4 to 20.0 pCi/g of sample, averaging 15.4 pCi/g. The concentration of potassium-40 in the sample collected from Huntington Beach at the depth of 3 inches was 18.0 pCi/g.

Cesium-137 was detected in the sample collected from the control location and in three samples collected from indicator locations (except East Site Boundary) at a depth of 3 inches. The concentrations of cesium-137 in these samples ranged from 0.07 to 0.26 pCi/g, dry. The lower limit of detection of cesium-137 in soil is 0.05 pCi/g.

Finally, strontium-90 was detected in only one sample collected from East Site Boundary at a concentration of 0.03 pCi/g. The lower limit of detection of strontium-90 in soil is 0.01 pCi/g.

Conclusions

Several radionuclides were found in surface soil samples collected near SONGS, and from Huntington Beach. They include potassium-40, cesium-137, and strontium-90. The potassium-40 levels vary between sampling locations. This is a naturally-occurring phenomenon that is not related to SONGS operations. Potassium-40, cesium-137, and strontium-90 were also found in soil profile analyses conducted in 1987. To assess the importance of detecting strontium-90 in the surface soil samples, data collected from the indicator locations over a period of six years were compared to similar data collected from Huntington Beach. (See Table E-1.) These data indicate that the concentrations of each of these radionuclides seen at both indicator and control locations are similar. Because of this, the activity can be attributed to atmospheric nuclear weapons tests and not SONGS operations.

G. Shoreline Sediment (Sand)

Beach sand was collected semiannually in 1987 from three indicator locations, and from a control location situated in Newport Beach. After collection, the samples were analyzed for 19 different Station-related and naturally-occurring radionuclides. The results of the analyses are summarized in Table II-2 in terms of "as received" wet sample weights.

In 1987, three radionuclides were detected in shoreline sediment samples. They include potassium-40, radium-226, and thorium-228. All three are naturally-occurring (i.e., non-SONGS related) radionuclides. The variation of the concentrations of these radionuclides in the shoreline sediment samples is considered to be characteristic of this environmental medium.

Because SONGS-related radionuclides were not seen in the shoreline sediment samples, the impact of SONGS operations on shoreline sediment is considered to be negligible.

TABLE II-2

CONCENTRATIONS OF RADIONUCLIDES (pCi/g, wet weight)
DETECTED IN SHORELINE SEDIMENT (SAND)
IN 1987

Sample Location	Collection Date	K-40	Ra-226	Th-228
0.5 miles S. of Unit 1	4/17/87	13.6	0.26	0.25
	9/24/87	12.8	0.18	0.16
	11/06/87*	12.7*	0.24*	0.22*
San Onofre Surfing Beach	4/17/87	12.8	0.26	0.42
	9/24/87	12.0	0.33	0.46
S. San Onofre State Beach	4/17/87	14.9	0.14	0.12
	9/24/87	11.8	0.16	0.15
Newport Beach	4/17/87	17.4	0.20	0.51
	9/24/87	12.4	0.59	1.50

* This special analysis was performed for location 1 only.

H. Ocean Water

In 1987, ocean water samples were collected on a monthly basis in the vicinity of each of the Station discharge outfalls (which served as the indicator locations), and from Newport Beach (which served as the control location). Upon collection, each sample was analyzed for 19 naturally-occurring and Station-related, gamma-emitting radionuclides. Every other month, samples were also analyzed for gross beta activity. Finally, samples, composited quarterly, were analyzed for tritium.

Throughout 1987, potassium-40 was the only gamma-emitting radionuclide detected in the monthly gamma spectral analyses of samples from both the indicator and the control locations. Potassium-40 was detected in each sample. The concentrations of potassium-40 in the samples from the indicator locations ranged from 290 to 350 pCi/l, averaging 318 pCi/l. The concentrations of potassium-40 in the samples from the control location ranged from 300 to 350 pCi/l, averaging 317 pCi/l.

Gross beta activity was detected in each bimonthly ocean water sample. The concentrations of gross beta activity in the ocean water collected from the indicator locations ranged from 700 to 1000 pCi/l, averaging 789 pCi/l. The concentrations of gross beta activity in the ocean water collected from the control location ranged from 700 to 800 pCi/l, averaging 750 pCi/l. After subtracting the contribution of potassium-40 to the gross beta activity, the concentrations of gross beta activity in the ocean water collected from the indicator locations ranged from below detectability to 13 pCi/l, averaging 6 pCi/l. The concentrations of gross beta activity in the ocean water collected from the control location ranged from below detectability to 7 pCi/l, averaging 5 pCi/l. Using these data, it was determined that potassium-40 accounted for at least 99 percent of the gross beta activity detected in each of the samples.

Tritium was detected in the first and second quarters composite samples obtained from the SONGS Unit 1 outfall. The concentrations of tritium in these samples were 4200 and 14400 pCi/l, respectively. The high tritium concentration can be attributed to a radioactive liquid effluent release from SONGS Unit 1 that was in progress at the time the sample was collected. These ocean water samples, although technically not a "lost sample," should not be considered as a true "environmental" sample. To prevent the recurrence of such a situation, the radiological environmental monitoring sample station was moved from the turbulent area near the SONGS Unit 1 discharge to a new location 2000 feet downcoast of the SONGS Unit 1 discharge. The concentration of tritium in the ocean water sample from the second quarter was 72% of the Nuclear Regulatory Commission Reporting level of 2×10^4 pCi/l.

Virtually all of the observed radioactivity in each of the samples can be attributed to naturally-occurring potassium-40. The variation of potassium-40 in ocean water is considered characteristic of this environmental medium. These data indicate that SONGS operations had a negligible impact on this environmental medium.

I. Non-Migratory Marine Species

Part I. Analysis of the Flesh Portion of the Marine Animals

During 1987, non-migratory marine species were collected near SONGS to determine the amount of radioactivity that could be consumed by man or in the food chain to man. To determine potential doses to the public, two species of adult fish, crustacea and mollusks, were collected on a quarterly basis at the SONGS Unit 1 outfall, at the SONGS Unit 2/3 outfall and from Newport Beach. Species collected at each of the locations in 1987 are listed in parentheses at the beginning of each summary description (below). Upon collection, the flesh portion of each sample type was analyzed for three naturally-occurring radionuclides, for 16 gamma-emitting Station-related radionuclides, and for aqueous and bound tritium. The results were subsequently reported to Edison in terms of both wet and dry sample weights. Because results based on a wet sample weight are most useful for calculating doses, the results of sample analyses are summarized below in terms of "as received" wet sample weights.

Indicator Locations:

SONGS Unit 1, Fish (Sheephead):
Potassium-40 was the only naturally-occurring radionuclide detected in the flesh portion of the samples. The concentrations of potassium-40 ranged from 2.40 to 2.90 pCi/g of sample, averaging 2.72 pCi/g of sample.

Plant-related radionuclides detected in flesh portion of the sheephead included cobalt-60 and cesium-137. Cobalt-60 was detected in samples from the second quarter at concentrations of 0.011 pCi/g, wet weight. Finally, cesium-137 was detected in samples collected throughout the year. The concentrations of cesium-137 ranged from 0.0051 to 0.0096 pCi/g, averaging 0.0074 pCi/g.

Aqueous and bound tritium were not detected in the flesh portion of the samples.

SONGS Unit 1, Fish (Black Perch):
Upon analysis, potassium-40 was the only naturally-occurring radionuclide detected in the flesh of black perch. Potassium-40 was seen in samples collected throughout 1987. The concentrations of potassium-40 ranged from 2.00 to 2.60 pCi/g, averaging 2.28 pCi/g.

Plant-related radionuclides detected in the flesh of black perch included cobalt-60 and cesium-137. Cobalt-60 was detected only in one sample. The concentration of cobalt-60 in the sample was 0.003 pCi/g in the second quarter of 1987. Cesium-137 was detected in each of the samples. The concentrations of cesium-137 ranged from 0.0046 to 0.0052 pCi/g, averaging 0.0049 pCi/g.

Aqueous and bound tritium were not detected in the flesh of the black perch.

Indicator Locations (continued)

SONGS Unit 1, Crustacea (Spiny Lobster):
Potassium-40 was detected in the flesh portion of each sample. The concentrations of potassium-40 ranged from non-detectable to 3.20 pCi/g, averaging 2.25 pCi/g.

Plant-related radionuclides detected in the flesh of spiny lobster included cobalt-60, silver-110m, and cesium-137. Cobalt-60 was detected in samples collected during the first quarter. The measured concentration of cobalt-60 was 0.005 pCi/g. Silver-110m was detected in the sample collected during the second quarter. The measured concentration of silver-110m was 0.006 pCi/g. Cesium-137, on the other hand, was detected in three of four samples. The concentrations of cesium-137 ranged from non-detectable to 0.0057 pCi/g, averaging 0.0034 pCi/g.

Aqueous and bound tritium were not detected in the flesh of the spiny lobster samples.

SONGS Unit 1, Mollusks (Bay Mussel and Sea Hare):
Three naturally-occurring radionuclides were detected in the flesh portion of the mollusks, namely: potassium-40, radium-226, and thorium-228. Potassium-40 was seen in each sample set. The concentrations of potassium-40 ranged from 0.99 to 1.77 pCi/g, averaging 1.40 pCi/g. Radium-226 was detected in samples collected during the first, second, and third quarters. The measured concentrations of radium-226 were 0.06, 0.16, and 0.12 pCi/g, respectively. Finally, thorium-228 was detected in samples collected during the first, second, and third quarters at concentrations of 0.06, 0.33, and 0.31 pCi/g, respectively.

Plant-related radionuclides detected in the flesh of the mollusks included cobalt-58 and cobalt-60. Cobalt-58 was detected in each sample. The concentrations of cobalt-58 ranged from 0.006 to 0.054 pCi/g, averaging 0.022 pCi/g. Likewise, cobalt-60 was detected in each set of samples. The concentrations of cobalt-60 ranged from 0.023 to 0.052 pCi/g, averaging 0.032 pCi/g. Cesium-137 was not detected in any of the samples collected during the year. The lower limit of detection of cesium-137 in the samples was 0.003 pCi/g.

Aqueous and bound tritium were not detected in the flesh portion of the mollusks.

Indicator Locations (continued)

SONGS Units 2/3, Fish (Sheephead):
Potassium-40 was the only naturally-occurring radionuclide detected in the flesh portion of the sheephead. The concentrations of potassium-40 in the samples ranged from 2.50 to 3.00 pCi/g, averaging 2.80 pCi/g.

The only plant-related radionuclides detected in the flesh of sheephead was cesium-137. Cesium-137 was detected in each set of samples. The concentrations of cesium-137 ranged from 0.0062 to 0.0078 pCi/g, averaging 0.0070 pCi/g.

Aqueous and bound tritium were not detected in the flesh of the sheephead.

SONGS Units 2/3, Fish (Black Perch):
Potassium-40 was seen in each sample set. The concentrations of potassium-40 in the flesh of the black perch ranged from 2.20 to 2.80 pCi/g, averaging 2.42 pCi/g.

Cesium-137 was the only plant-related radionuclide detected in the flesh of black perch. Cesium-137 was detected in samples collected during all four quarters at concentrations of 0.0056, 0.0049, 0.0043 and 0.0038 pCi/g, respectively, averaging 0.0046 pCi/g.

Aqueous and bound tritium were not detected in the flesh of black perch.

SONGS Units 2/3, Crustacea (Spiny Lobster):
Potassium-40 was detected in each sample set. The concentrations of potassium-40 in the flesh of spiny lobster ranged from 2.10 to 3.40 pCi/g, averaging 2.65 pCi/g.

The only plant-related radionuclides detected in flesh of spiny lobster included cesium-137. This radionuclide was detected in the fourth quarter sample. The concentration of cesium-137 was 0.0043 pCi/g, in the fourth quarter.

Aqueous and bound tritium were not detected in the flesh portion of the spiny lobster.

SONGS Units 2/3, Mollusks (Bay Mussel):
Potassium-40 was seen in each set of quarterly samples. The concentrations of potassium-40 in the flesh of the bay mussel ranged from 0.65 to 0.89 pCi/g, averaging 0.80 pCi/g.

Plant-related radionuclides detected in flesh of the mollusks included cobalt-58 and cobalt-60. Cobalt-58 was detected in a sample collected during the third quarter. The concentration of cobalt-58 in this sample was 0.006 pCi/g. Cobalt-60, however, was detected in each quarterly sample except the fourth quarter. The concentrations of cobalt-60 ranged from non-detectable to 0.006 pCi/g, averaging 0.004 pCi/g.

Aqueous and bound tritium were not detected in the flesh of the mollusk samples.

Newport Beach Control Location:

Newport Beach, Fish (Sheephead):
Potassium-40 was detected in each sample set. The concentrations of potassium-40 in the flesh of the sheephead ranged from 2.50 to 2.70 pCi/g, averaging 2.58 pCi/g.

Cesium-137 was the only plant-related radionuclide detected in the flesh of sheephead, and was detected in each set of samples. The concentrations of cesium-137 ranged from 0.0047 to 0.0057 pCi/g, averaging 0.0050 pCi/g.

Aqueous and bound tritium were not detected in the flesh of sheephead.

Newport Beach, Fish (Black Perch):
Potassium-40 seen in each set of samples. The concentrations of potassium-40 in the flesh of the black perch ranged from 2.20 to 2.60 pCi/g, averaging 2.45 pCi/g.

Cesium-137, the only plant-related radionuclide detected in flesh of the black perch, was detected in each set of samples. The concentrations of cesium-137 ranged from 0.0044 to 0.0059 pCi/g, averaging 0.0048 pCi/g.

Aqueous and bound tritium were not detected in the flesh portion of the black perch samples.

Newport Beach, Crustacea (Spiny Lobster):
Potassium-40 was detected in the flesh of each spiny lobster sample analyzed. The concentrations of potassium-40 ranged from 2.10 to 2.80 pCi/g, averaging 2.62 pCi/g.

Cesium-137, the only plant-related radionuclide detected in flesh portion of spiny lobster, was detected in second and fourth quarter samples. The concentrations of cesium-137 ranged from 0.0037 to 0.0038 pCi/g, averaging 0.0019 pCi/g.

Aqueous and bound tritium were not detected in the flesh of the spiny lobster samples.

Newport Beach, Mollusks (Keyhole Limpet):
Potassium-40 was seen in each set of samples. The concentrations of potassium-40 in the flesh portion of the keyhole limpet ranged from 0.57 to 0.86 pCi/g, averaging 0.68 pCi/g.

Plant-related radionuclides detected in flesh of the mollusks included silver-110m and cesium-137. Silver-110m was detected in samples collected during the first, second, and fourth quarters. The concentrations of silver-110m in the samples were 0.0031, 0.0048, and 0.0023 pCi/g, respectively. Cesium-137 concentrations were 0.0030 and 0.0013 pCi/g in the second and fourth quarter samples, respectively.

Aqueous and bound tritium were not detected in the flesh of the mollusks.

Part II. Analysis of the Bone Portion of the Marine Animals

To determine if there is evidence of a build-up of radionuclides in the non-migratory marine species, the bone portion of each sample of marine species collected during 1987 was analyzed for three naturally-occurring radionuclides, for 16 gamma-emitting Station-related radionuclides, for aqueous and bound tritium, and for strontium-90. The results were subsequently reported to Edison in terms of both wet and dry sample weights. For consistency with Part I of this section, the results of sample analyses are summarized below in terms of "as received" wet sample weights.

Indicator Locations:

SONGS Unit 1, Fish (Sheephead):
Potassium-40 was the only naturally-occurring radionuclide detected in the bone of the sheephead. The concentrations of potassium-40 ranged from 0.50 to 0.80 pCi/g, averaging 0.67 pCi/g.

No plant-related radionuclides were detected in bone samples collected during the four quarters of 1987.

Strontium-90, aqueous tritium, and bound tritium were not detected in the bone of the sheephead samples.

SONGS Unit 1, Fish (Black Perch):
Potassium-40, a naturally-occurring radionuclide, was detected in flesh of black perch collected from the third and fourth quarters at an average concentration of 0.50 pCi/g.

Plant-related gamma-emitting radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the samples.

SONGS Unit 1, Crustacea (Spiny Lobster):
Potassium-40 was detected in the bone portion of each sample. The concentrations of potassium-40 ranged from 0.70 to 0.92 pCi/g, averaging 0.82 pCi/g.

Plant-related radionuclides detected in the bone of spiny lobster included cobalt-60. Cobalt-60 was detected in samples collected during the first quarter at a concentration of 0.006 pCi/g.

Strontium-90, aqueous tritium, and bound tritium were not detected in the flesh portion of the spiny lobster.

Indicator Locations (continued)

SONGS Unit 1, Mollusks (Bay Mussel):
The results listed below correspond to bay mussel collected during the first, second, third and fourth quarters, because sea hare have no bones or shell.

Potassium-40 was observed in the shell of bay mussel collected during the four quarters of 1987. The concentrations of potassium-40 in the samples were 0.16, 0.09, 0.16, and 0.07 pCi/g, in that order.

Plant-related gamma-emitting radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the shell portion of the bay mussel.

SONGS Units 2/3, Fish (Sheephead):
Potassium-40 was the only naturally-occurring radionuclide detected in the bone of sheephead. The concentrations of potassium-40 ranged from 0.30 to 1.40 pCi/g, averaging 0.78 pCi/g.

Plant-related radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the bone of the sheephead samples.

SONGS Units 2/3, Fish (Black Perch):
Potassium-40, a naturally-occurring radionuclide, was detected in the bone of black perch collected from the first quarter at a concentration of 0.40 pCi/g.

Plant-related gamma-emitting radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the bone portion of the black perch.

SONGS Units 2/3, Crustacea (Spiny Lobster):
Potassium-40 was detected in the bone of each sample of spiny lobster. The concentrations of potassium-40 ranged from 0.79 to 1.00 pCi/g, averaging 0.95 pCi/g.

The only plant-related radionuclide detected in the bone of spiny lobster included cobalt-60. Cobalt-60 was detected in the sample collected during the second quarter at a concentration of 0.003 pCi/g.

Strontium-90, aqueous tritium, and bound tritium were not detected in the flesh portion of the spiny lobster.

SONGS Units 2/3, Mollusks (Bay Mussel):
The results listed below correspond to bay mussel collected during the first, second, third and fourth quarters.

Potassium-40 was observed in the shell of bay mussel collected during all four quarters of 1987. The concentrations of potassium-40 in the samples ranged from 0.07 to 0.16, averaging 0.12 pCi/g.

Strontium-90, aqueous tritium, and bound tritium were not detected in the shell portion of the bay mussel.

Newport Beach Control Location:

Newport Beach, Fish (Sheephead):
Potassium-40, the only naturally-occurring radionuclide detected in the bone of sheephead, was observed in samples from the first, third, and fourth quarters. The concentrations of potassium-40 in the bone of sheephead were 1.30, 0.40, and 0.40 pCi/g, respectively.

Plant-related radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the bone of the sheephead samples.

Newport Beach, Fish (Black Perch):
Potassium-40, a naturally-occurring radionuclide, was detected in bone of black perch collected during the first and second quarters. The concentrations of potassium-40 in the samples were 0.30 and 0.30 pCi/g, respectively.

Plant-related gamma-emitting radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the bone portion of the black perch.

Newport Beach, Crustacea (Spiny Lobster):
Potassium-40 was detected in the bone portion of each sample of spiny lobster. The concentrations of potassium-40 ranged from 0.84 to 1.09 pCi/g, averaging 0.94 pCi/g.

Plant-related, gamma-emitting radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the flesh portion of the spiny lobster.

Newport Beach, Mollusks (Keyhole Limpet):
Potassium-40 was observed in the shell of keyhole limpet collected during the first, second and fourth quarters of 1987. The concentrations of potassium-40 in the samples were 0.30, 0.17 and 0.25 pCi/g, respectively.

Plant-related, gamma-emitting radionuclides, strontium-90, aqueous tritium, and bound tritium were not detected in the bone portion of the keyhole limpet.

Part III. Conclusions

Plant-related radionuclides seen in minute quantities in the flesh portion of marine species collected near SONGS include cobalt-58, cobalt-60, silver-110m, and cesium-137. To determine whether or not these radionuclides are accumulating in the marine animals, concentrations of each of these radionuclides seen in sheephead (a fish), crustacea, and mollusks were plotted versus time from 1978 through 1987. See Figures 7 - 15. Although these concentrations were determined in marine species collected near the SONGS Unit 1 outfall, the concentrations are representative of the entire area near SONGS. Trending of these data indicates that the concentrations of each of these radionuclides are greater than or equal to concentrations measured at the control location, but are not accumulating in the marine animals. The highest concentrations of cobalt-58, cobalt-60 and cesium-137 seen in the marine animals in 1987 were less than half a percent of the reporting levels established by Nuclear Regulatory Commission.

No aqueous or bound tritium was found in the flesh of any of the marine species collected in 1987.

No strontium-90, aqueous tritium or bound tritium was found in the bone or shell portions of the marine species. Two radionuclides that were detected in a few crustacea and mollusk samples include cobalt-60 and silver-110m. There is no evidence that these radionuclides are accumulating in the bone (or shell) of these marine species. Because bone and/or shell is not normally ingested, no reporting limits have been established by the Nuclear Regulatory Commission for these media.

Dose Calculations:

Results of ingestion dose calculations have been listed in Tables II-3A and II-3B. Data show that the ingestion dose due to consumption of marine species is a very small fraction of the maximum permissible dose. The dose values in the table have been calculated using USNRC Regulatory Guide 1.109 parameters. The fish consumption rates of 6.9, 16, and 21 kg/year for child, teen, and adult have been taken from Table E-5 of the Guide. Ingestion dose factors for radionuclides of interest in mrem per picocurie ingested were taken from Tables E-11 through E-13 of the Guide.

Based on these data, it was concluded that (1) SONGS operations has had a detectable, but minimal impact on this environmental medium, and (2) the potential dose to members of the public from consumption of marine species near SONGS is negligible.

Table II-3A

MAXIMUM WHOLE BODY INGESTION DOSE FOR SONGS 1 IN MREM/YEAR

Radionuclide (Critical Organ)	Concentration (pCi/g, Wet Weight)	Species Type	Annual Dose (mrem/yr) Child	Teen	Adult
Co-58 (Gi-LLi)	0.054	Sea Hare	2.05 E-3 (3.91 E-3)	1.94 E-3 (1.16 E-2)	1.89 E-3 (1.71 E-2)
Co-60 (Gi-LLi)	0.052	Sea Hare	5.60 E-3 (1.05 E-2)	5.27 E-3 (3.05 E-2)	5.15 E-3 (4.39 E-2)
Ag-110m (Gi-LLi)	0.006	Spiny Lobster	1.20 E-5 (1.79 E-3)	1.13 E-5 (5.23 E-3)	1.11 E-5 (7.61 E-3)
Cs-134 (Liver)	0.010(LLD)	All	5.59 E-3 (2.65 E-2)	1.46 E-2 (3.15 E-2)	2.54 E-2 (3.11 E-2)
Cs-137 (Liver)	0.0096	Sheephead	3.06 E-3 (2.07 E-2)	7.97 E-3 (2.29 E-2)	1.44 E-2 (2.20 E-2)

Note:
Numbers in parenthesis show the dose calculated to critical organ. Annual whole body dose limit is 3 mrem (per reactor), and critical organ dose limit is 10 mrem (per reactor) for the liquid effluent.

Table II-3B

MAXIMUM WHOLE BODY INGESTION DOSE FOR SONGS 2 AND 3 IN MREM/YEAR

Radionuclide (Critical Organ)	Concentration (pCi/g, Wet Weight)	Species Type	Annual Dose (mrem/yr) Child	Teen	Adult
Co-58 (Gi-LLi)	0.006	Bay Mussel	2.28 E-4 (4.35 E-4)	2.15 E-4 (1.29 E-3)	2.10 E-4 (1.90 E-3)
Co-60 (Gi-LLi)	0.006	Bay Mussel	6.45 E-4 (1.21 E-3)	6.08 E-4 (3.51 E-3)	5.95 E-4 (5.06 E-3)
Ag-110m (Gi-LLi)	0.01 (LLD)	All	2.01 E-5 (2.99 E-3)	1.89 E-5 (8.72 E-3)	1.85 E-5 (1.27 E-2)
Cs-134 (Liver)	0.01 (LLD)	All	5.59 E-3 (2.65 E-2)	1.46 E-2 (3.15 E-2)	2.54 E-2 (3.11 E-2)
Cs-137 (Liver)	0.0078	Sheephead	2.49 E-3 (1.68 E-2)	6.48 E-3 (1.86 E-2)	1.17 E-2 (1.79 E-2)

Note:
Numbers in parenthesis show the dose calculated to critical organ. Annual whole body dose limit is 3 mrem (per reactor), and critical organ dose limit is 10 mrem (per reactor) for the liquid effluent.

J. Kelp Sampling

Kelp was collected during May and November 1987 from the San Onofre and San Mateo Kelp Beds, as well as from a kelp bed in Laguna Beach. One sample was collected from the Barn Kelp Bed during the second semi-annual period. Upon collection, the samples were analyzed by gamma-spectral analysis for 19 different naturally-occurring and Station-related radionuclides. The samples were also analyzed for both aqueous and bound tritium. At the end of the year, no aqueous or bound tritium had been detected in the samples. Gamma-emitting radionuclides detected in the samples included potassium-40, iodine-131, and cesium-137. The results of these analyses are summarized below in terms of wet sample weights.

Naturally-occurring potassium-40 was detected in each sample. The concentrations of potassium-40 in the samples from the indicator locations ranged from 5.4 to 6.0 pCi/g, averaging 6.4 pCi/g. The concentrations of potassium-40 in the samples from the control location ranged from 4.8 to 8.2 pCi/g, averaging 6.5 pCi/g.

Iodine-131 was also detected in all kelp samples. The concentrations of iodine-131 in the samples from the indicator locations ranged from 0.016 to 0.034 pCi/g. The average concentration of iodine-131 was 0.012 pCi/g. The concentrations of iodine-131 in samples collected from the control location ranged from 0.004 to 0.028 pCi/g, averaging 0.016 pCi/g.

Cesium-137 was detected in two samples collected from the indicator locations, and in two samples collected from the control location. The concentrations of cesium-137 in the samples from the indicator locations ranged from non-detectable to 0.0046, averaging 0.0010 pCi/g. Cesium-137 was detected in samples during the first and second sampling periods from the control location. The concentrations of cesium-137 in these samples were 0.0035 pCi/g for May and 0.0035 pCi/g for November.

To determine if these radionuclides are accumulating in kelp with time, data were examined from 1982 through 1987. See Appendix E, Table E-5. The data indicate that the concentrations of potassium-40 at both indicator and control locations have remained commensurate, as anticipated. The frequency of detection and concentrations of iodine-131 and cesium-137 in kelp have increased, however, in the past few years. The amounts of the radionuclides, though, are still considered to be minute. Doses via the ingestion pathway to members of the public were not calculated, because kelp near SONGS has not been harvested commercially since 1977.

K. Ocean Bottom Sediments

To determine the amount of radioactivity in ocean bottom sediments in the vicinity of the Station in 1987, representative samples were collected semiannually near each of the Station discharge outfalls (which served as indicator locations), and from Newport Beach (which served as a control location). After collection, the samples were analyzed by gamma-spectral analysis for 19 naturally-occurring, and Station-related radionuclides. The results of these analyses are summarized in Table II-3 in terms of "as received" wet sample weights.

In 1987, five radionuclides were detected in ocean bottom sediment samples. They include potassium-40, cobalt-60, cesium-137, radium-226, and thorium-228. Potassium-40, radium-226, and thorium-228 are all naturally-occurring (i.e., non-Station related) radionuclides. The variation of the concentrations of these radionuclides in the ocean bottom sediment samples is considered to be characteristic of this environmental medium. Cobalt-60 was found in one sample collected East of the Unit 1 outfall in May 1987. The concentration of cobalt-60 in this sample was 0.05 pCi/g, wet weight. Cesium-137 was detected in one sample collected at Unit 3 outfall in November 1987. The concentration of cesium-137 was 0.08 pCi/g.

Because only extremely low levels of cobalt-60 and cesium-137 were observed in the samples, the impact of SONGS operations on ocean bottom sediments is considered to be minimal.

TABLE II-4

CONCENTRATIONS OF RADIONUCLIDES (pCi/g, wet weight)
DETECTED IN OCEAN BOTTOM SEDIMENTS
IN 1987

Sample Location	Collection Date	K-40	Ra-226	Th-228	Co-60	Cs-137
SONGS Unit 1 (E)	5/15/87	10.4	0.39	0.42	0.05	<LLD
	11/18/87	10.2	0.54	0.82	<LLD	<LLD
SONGS Unit 1 (W)	5/15/87	8.4	0.77	0.95	<LLD	<LLD
	11/18/87	10.7	0.77	1.04	<LLD	<LLD
SONGS Unit 2	5/15/87	10.3	0.09	0.08	<LLD	<LLD
	11/18/87	12.5	0.24	0.24	<LLD	<LLD
SONGS Unit 3	5/15/87	8.9	0.25	0.29	<LLD	<LLD
	11/18/87	11.4	0.30	0.50	<LLD	0.08
Newport Beach	5/15/87	14.5	0.20	0.30	<LLD	<LLD
	11/16/87	14.0	0.24	0.43	<LLD	<LLD

Radionuclides not listed in the Table were at concentrations below detection limits (i.e., <LLD).

III. CONCLUSIONS

Levels of radioactivity in environmental media depend on many components, including the following: site release rates; meteorology; number, location, size and date of nuclear weapons testing; seasonal variability of fallout; soil conditions; local terrain and variability in the natural environment.

Radiological environmental data collected throughout 1987 have been evaluated to determine the impact, if any, of San Onofre operations on the surrounding environment. To accomplish this, several methods of evaluation were employed, namely:

(1) Compilation and verification of all data, as well as a determination of those data considered to be significantly greater than background levels, (i.e., 1.25 times background levels for TLD direct radiation doses, and twice background levels for radionuclide concentrations).

(2) Comparison of data (exceeding background levels) against reportability levels contained in the plant Technical Specifications.

(3) Examination of time-dependent variations of pertinent radioiostopes in selected environmental media throughout the year at both indicator and control locations.

(4) Comparison of radioactivity in various media in 1987 against the levels observed in pre-operational years.

(5) Historical trending of radionuclides in various media over the past six years.

In comparing these findings to the conservatively-defined limits of the facility operating licenses, it is concluded that the radiological environmental impact of San Onofre Units 1, 2 and 3 operations through 1987 has been minimal, and the resulting dose to man is negligible.

IV. REFERENCES

1. Land Use Census for SONGS Units 1, 2 and 3 Radiological Environmental Monitoring Program, 1987.

2. ODCM, "Offsite Dose Calculation Manual for SONGS Units 2 and 3," 1987.

3. ODCM, "Offsite Dose Calculation Manual for SONGS Unit 1," 1987.

4. USNRC Draft Regulatory Guide 4.8, Table 1, "Standard Format and Principal Content of Environmental Technical Specifications," December 1975.

5. USNRC Regulatory Guide 4.13, "Performance, Testing and Procedural Specifications for Thermoluminescent Dosimetry - Environmental Applications," 1977.

6. USNRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs," Rev. 1, February 1979.

7. SONGS Unit 1 Provisional Operating License, DPR-13, Sections 3.18 and 4.18, effective prior to January 1, 1985.

8. SONGS Unit 2 Operating License NPF-10, Section 3/4.12.1.

9. SONGS Unit 3 Operating License NPF-15, Section 3/4.12.1.

10. USNRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR 50, Appendix I," Rev. 1, October 1977.

APPENDIX A

SAMPLE TYPE AND SAMPLING LOCATION

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE* (miles)	DIRECTION*
Direct Radiation			
1	City of San Clemente (SDG&E Offices)	5.6	NW
2	Camp San Mateo	3.5	N
3	Camp San Onofre	2.6	NE
4	Camp Horno	4.5	E
5	Camp Las Pulgas	8.5	E
6	Old Route 101 - East-Southeast	3.0	ESE
7	Old Route 101 - East-Southeast	0.5	ENE
8	Noncommissioned Officers Beach Club	1.5	NW
9	Basilone Road/I-5 Freeway Offramp	2.0	NW
10	Bluff	0.7	WNW
11	Former Visitors Center	0.3	NW
12	South Edge of Switchyard	0.2	E
13	Site Boundary	0.4	SE
14	Huntington Beach Generating Station	37	NW
15	East-Southeast Site Boundary	0.2	SE
16	East Site Boundary	0.4	ESE
17	Transit Dose	-	-
18	Transit Dose	-	-
19	San Clemente Highlands	5.0	NNW
20	San Clemente Pier	5.3	NW
21	Concordia Elementary School - San Clemente	3.5	NW
22	Coast Guard Station - San Mateo Point	2.7	WNW
23	San Clemente General Hospital	8.2	NW
24	San Clemente High School	6.0	NW

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.

TABLE A-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE* (miles)	DIRECTION*
Direct Radiation (Continued)			
25	Convalescent Home - San Clemente	8.0	NW
26	Dana Hills High School	11.0	NW
27	U.S. Post Office - Dana Point	10.6	NW
28	Doheny Fire Station - Capistrano Beach	9.5	NW
29	San Juan Capistrano Fire Station	10.8	NW
30	Laguna Beach Fire Station	17.5	NW
31	Aurora Park Mission Viejo	18.7	NNW
32	Santa Ana Police Department	32.0	NW
33	Camp Talega	5.7	N
34	San Onofre School	1.9	NW
35	Range 312 (Marine Corps Base, Camp Pendleton)	4.7	NNE
36	Range 208C (Marine Corps Base, Camp Pendleton)	4.2	NE
37	Laguna Niguel Fire Station	14.2	NW
38	San Onofre State Beach Park	3.3	SE
39	Basilone Road Trailer Park	1.4	NNW
40	SCE Training Center - Mesa	0.7	NNW
41	Old Route 101 - East	0.4	E
42	Horno Canyon	4.7	E
43	Edson Range (Marine Corps Base, Camp Pendleton)	10.6	SE
44	Fallbrook Fire Station	18.0	E
45	Interstate 5 Weigh Station	2.0	ESE
46	San Onofre State Beach Park	1.0	SE
47	Camp Las Flores	8.6	SE
48	Mainside (Marine Corps Base, Camp Pendleton)	15.0	ESE

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.

TABLE A-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE* (miles)	DIRECTION*
Direct Radiation (Continued)			
49	Camp Chappo	12.8	ESE
50	Oceanside Fire Station	15.5	SE
51	Carlsbad Fire Station	18.6	SE
52	Vista Fire Station	21	ESE
53	San Diego County Operations Center	45	SE
54	Escondido Fire Station	32	ESE
55	San Onofre State Beach (Unit 1)	0.2	WSW
56	San Onofre State Beach (Unit 1)	0.1	SW
57	San Onofre State Beach (Unit 2)	0.1	SSW
58	San Onofre State Beach (Unit 3)	0.1	S
59	SONGS Meteorological Tower	0.3	WNW
60	Transit Control Storage Area	-	-
61	MCB** - Camp Pendleton	0.7	N
62	MCB** - Camp Pendleton	0.6	NNE
63	MCB** - Camp Pendleton	0.6	NE
64	MCB** - Camp Pendleton	0.5	ENE
65	MCB** - Camp Pendleton	0.7	E
66	San Onofre State Beach	0.6	ESE
67	SONGS Evaporation Pond	0.6	NW

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.

** MCB - Marine Corps Base

TABLE A-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE* (miles)	DIRECTION*
Airborne			
1	City of San Clemente (City Hall)	5.5	NW
2	Camp San Onofre (Camp Pendleton)	1.8	NE
3	Huntington Beach Generating Station	37.0	NW
5	Units 2 and 3 Switchyard**	0.13	NNE
6	SONGS Meteorological Tower**	0.3	WNW
9	State Beach Park	0.6	ESE
10	Bluff	0.7	WNW
11	Mesa EOF	0.7	NNW
12	Former SONGS Evaporation Pond	0.6	NW
Soil Samples			
1	Camp San Onofre	2.5	NE
2	Old Route 101 - Southeast	3.0	ESE
3	Basilone Road/I-5 Freeway Offramp	2.0	NW
4	Huntington Beach Generating Station	37.0	NW
5	East Site Boundary (visitor's center)	0.2	NNW
Ocean Water			
A	Station Discharge Outfall - Unit 1	0.5	SSW
B	Outfall - Unit 2	0.7	SW
C	Outfall - Unit 3	0.7	SW
D	Newport Beach	30.0	NW

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.

** Not required by Technical Specifications.

TABLE A-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE* (miles)	DIRECTION*
Drinking Water			
1	Tri-Cities Municipal Water District Reservoir	8.7	NW
2	San Clemente Golf Course Well	3.5	NNW
3	Huntington Beach	37.0	NW
Shoreline Sediment (Beach Sand)			
1	San Onofre State Beach	0.6	SE
2	San Onofre Surfing Beach	0.9	NW
3	San Onofre State Beach	3.1	SE
4	Newport Beach (North End)	30.0	NW
Local Crops			
1	San Mateo Canyon, San Clemente Canyon	2.6	NW
2	Southeast of Oceanside	22.0	SE

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.

TABLE A-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

TYPE OF SAMPLE AND SAMPLING LOCATION		DISTANCE* (miles)	DIRECTION*
Non-Migratory Marine Animals			
A	Unit 1 Outfall	0.6	WSW
B	Units 2 and 3 Outfall	0.7	SSW
C	Newport Beach	30.0	NW
Kelp			
A	San Onofre Kelp Bed	1.5	S
B	San Mateo Kelp Bed	3.5	WNW
C	Barn Kelp Bed	6.6	SSE
D	Newport Beach	30.0	NW
Ocean Bottom Sediments			
A	Unit 1 Outfall	0.5	W
B	Unit 1 Outfall	0.6	W
C	Unit 2 Outfall	0.8	SSW
D	Unit 3 Outfall	0.9	S
E	Newport Beach	30.0	NW

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.

TABLE A-2

SECTOR AND DIRECTION DESIGNATION FOR RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATION MAP

DEGREES TRUE NORTH FROM SONGS 2 AND 3 MID-POINT			NOMENCLATURE	
Sector Limit	Center Line	Sector Limit	22.5° Sector*	Direction
348.75	0 & 360	11.25	A	N
11.25	22.5	33.75	B	NNE
33.75	45.0	56.25	C	NE
56.25	67.5	78.75	D	ENE
78.75	90.0	101.25	E	E
101.25	112.0	123.75	F	ESE
123.75	135.0	146.25	G	SE
146.25	157.0	168.75	H	SSE
168.75	180.0	191.25	J	S
191.25	202.5	213.75	K	SSW
213.75	225.0	236.25	L	SW
236.25	247.5	258.75	M	WSW
258.75	270.0	281.15	N	W
281.25	292.5	303.75	P	WNW
303.75	315.0	326.25	Q	NW
326.25	337.5	348.75	R	NNW

* Distance (miles) and Direction (sector) are measured relative to Units 2 and 3 midpoint. Direction is determined from degrees true north.